

BLACK AND VEATCH KANSAS CITY MO

NATIONAL DAM SAFETY PROGRAM. DREXEL LAKE DAM (MO 20046), OSAGE --ETC(U)

APR 79 P R ZAMAN, L K LAMPE, H L CALLAHAN

DACW43-79-C-0040

NL

1. CF
 $\text{Al} = \text{A}$
 $\text{C} = \text{C}$

END
DATE
FILMED
11-81
DTIC

OSAGE-GASCONADE BASIN

①

AD A106300

LEVEL II

DREXEL LAKE DAM

BATES COUNTY, MISSOURI

MO 20046

**PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION**

FILE COPY



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

St. Louis District

**DTIC
ELECT
OCT 28 1981
E**

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

FOR: STATE OF MISSOURI

APRIL 1979

This document has been approved
for public release and sale; its
distribution is unlimited.

81 10 26 082

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
	AD-A106 300	
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Drexel Lake Dam (MO 20046) Bates County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
6. AUTHOR(s) Black & Veatch, Consulting Engineers		7. PERFORMING ORG. REPORT NUMBER
8. 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		9. CONTRACT OR GRANT NUMBER(s) DACW43-79-C-0040
10. 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. REPORT DATE April 1979
12. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		13. NUMBER OF PAGES Approximately 40
		14. SECURITY CLASS. (of this report) UNCLASSIFIED
15. DISTRIBUTION STATEMENT (of this Report) Approved for release; distribution unlimited.		16. DECLASSIFICATION/DOWNGRADING SCHEDULE
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) National Dam Safety Program. Drexel Lake Dam (MO 20046), Osage - Gasconade Basin, Bates 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.		

DD FORM 1 JAN 78 1073

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

INSTRUCTIONS FOR PREPARATION OF REPORT DOCUMENTATION PAGE

RESPONSIBILITY. The controlling DoD office will be responsible for completion of the Report Documentation Page, DD Form 1473, in all technical reports prepared by or for DoD organizations.

CLASSIFICATION. Since this Report Documentation Page, DD Form 1473, is used in preparing announcements, bibliographies, and data banks, it should be unclassified if possible. If a classification is required, identify the classified items on the page by the appropriate symbol.

COMPLETION GUIDE

General. Make Blocks 1, 4, 5, 6, 7, 11, 13, 15, and 16 agree with the corresponding information on the report cover. Leave Blocks 2 and 3 blank.

Block 1. Report Number. Enter the unique alphanumeric report number shown on the cover.

Block 2. Government Accession No. Leave Blank. This space is for use by the Defense Documentation Center.

Block 3. Recipient's Catalog Number. Leave blank. This space is for the use of the report recipient to assist in future retrieval of the document.

Block 4. Title and Subtitle. Enter the title in all capital letters exactly as it appears on the publication. Titles should be unclassified whenever possible. Write out the English equivalent for Greek letters and mathematical symbols in the title (see "Abstracting Scientific and Technical Reports of Defense-sponsored RDT/E," AD-667 000). If the report has a subtitle, this subtitle should follow the main title, be separated by a comma or semicolon if appropriate, and be initially capitalized. If a publication has a title in a foreign language, translate the title into English and follow the English translation with the title in the original language. Make every effort to simplify the title before publication.

Block 5. Type of Report and Period Covered. Indicate here whether report is interim, final, etc., and, if applicable, inclusive dates of period covered, such as the life of a contract covered in a final contractor report.

Block 6. Performing Organization Report Number. Only numbers other than the official report number shown in Block 1, such as series numbers for in-house reports or a contractor/grantee number assigned by him, will be placed in this space. If no such numbers are used, leave this space blank.

Block 7. Author(s). Include corresponding information from the report cover. Give the name(s) of the author(s) in conventional order (for example, John R. Doe or, if author prefers, J. Robert Doe). In addition, list the affiliation of an author if it differs from that of the performing organization.

Block 8. Contract or Grant Number(s). For a contractor or grantee report, enter the complete contract or grant number(s) under which the work reported was accomplished. Leave blank in in-house reports.

Block 9. Performing Organization Name and Address. For in-house reports enter the name and address, including office symbol, of performing activity. For contractor or grantee reports enter the name and address of the contractor or grantee who prepared the report, and identify the appropriate corporate division, school, laboratory, etc., of the author. List city, state, and ZIP Code.

Block 10. Program Element, Project, Task Area, and Work Unit Numbers. Enter here the number code from the applicable Department of Defense form, such as the DD Form 1498, "Research and Technology Work Unit Summary" or the DD Form 1634, "Research and Development Planning Summary," which identifies the program element, project, task area, and work unit or equivalent under which the work was authorized.

Block 11. Controlling Office Name and Address. Enter the full, official name and address, including office symbol, of the controlling office. (Equates to funding/sponsoring agency. For definition see DoD Directive 5200.20, "Distribution Statements on Technical Documents.")

Block 12. Report Date. Enter here the day, month, and year or month and year as shown on the cover.

Block 13. Number of Pages. Enter the total number of pages.

Block 14. Monitoring Agency Name and Address (if different from Controlling Office). For use when the controlling or funding office does not directly administer a project, contract, or grant, but delegates the administrative responsibility to another organization.

Blocks 15 & 15a. Security Classification of the Report: Declassification/Downgrading Schedule of the Report. Enter in 15 the highest classification of the report. If appropriate, enter in 15a the declassification/downgrading schedule of the report, using the abbreviations for declassification/downgrading schedules listed in paragraph 4-207 of DoD 5200.1-R.

Block 16. Distribution Statement of the Report. Insert here the applicable distribution statement of the report from DoD Directive 5200.20, "Distribution Statements on Technical Documents."

Block 17. Distribution Statement (of the abstract entered in Block 20, if different from the distribution statement of the report). Insert here the applicable distribution statement of the abstract from DoD Directive 5200.20, "Distribution Statements on Technical Documents."

Block 18. Supplementary Notes. Enter information not included elsewhere but useful, such as: Prepared in cooperation with ... Translation of (or by) ... Presented at conference of ... To be published in ...

Block 19. Key Words. Select terms or short phrases that identify the principal subjects covered in the report, and are sufficiently specific and precise to be used as index entries for cataloging, conforming to standard terminology. The DoD "Thesaurus of Engineering and Scientific Terms" (TEST), AD-672 000, can be helpful.

Block 20. Abstract. The abstract should be a brief (not to exceed 200 words) factual summary of the most significant information contained in the report. If possible, the abstract of a classified report should be unclassified and the abstract to an unclassified report should consist of publicly-releasable information. If the report contains a significant bibliography or literature survey, mention it here. For information on preparing abstracts see "Abstracting Scientific and Technical Reports of Defense-Sponsored RDT&E," AD-667 000.

OSAGE-GASCONADE BASIN

DREXEL LAKE DAM

BATES COUNTY, MISSOURI

MO 20046

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

APRIL 1979

DREXEL LAKE DAM
BATES COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20046

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:
BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

Accession For	
FTIS CRAGI	<input checked="checked" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	

UNDER DIRECTION OF
ST. LOUIS DISTRICT CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

APRIL 1979



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

IN REPLY REFER TO

SUBJECT: Drexel Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Drexel 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

SIGNED

SUBMITTED BY: _____
Chief, Engineering Division

SIGNED

APPROVED BY: _____
Colonel, CE, District Engineer

30 JUL 1979

Date

30 JUL 1979

Date

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

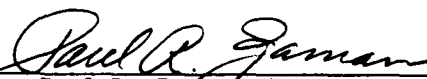
Name of Dam	Drexel Lake Dam
State Located	Missouri
County Located	Bates County
Stream	North Sugar Creek
Date of Inspection	5 April 1979

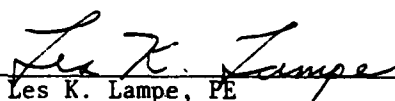
Drexel Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, 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 and would potentially cause appreciable damage to the water treatment plant for the City of Drexel within the estimated damage zone which extends 0.5 miles downstream of the dam.

Our inspection and evaluation indicates 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 not pass the probable maximum flood without overtopping but will pass 20 percent of the probable maximum flood, which is greater than the calculated 100-year flood. The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. Considering the size of the dam and reservoir and the downstream hazard potential, the appropriate spillway design capacity for this dam should be 50 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.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Seepage and stability analyses required by the guidelines were not available. Detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report on the dam is attached.


Paul R. Zaman, PE
Illinois 62-29261


Les K. Lampe, PE
Kansas 7407


Harry L. Callahan, Partner
Black & Veatch



OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
DREXEL LAKE DAM

TABLE OF CONTENTS

<u>Paragraph No.</u>	<u>Title</u>	<u>Page No.</u>
SECTION 1 - PROJECT INFORMATION		
1.1	General	1
1.2	Description of Project	1
1.3	Pertinent Data	2
SECTION 2 - ENGINEERING DATA		
2.1	Design	5
2.2	Construction	5
2.3	Operation	5
2.4	Evaluation	5
2.5	Geology	5
SECTION 3 - VISUAL INSPECTION		
3.1	Findings	6
3.2	Evaluation	6
SECTION 4 - OPERATIONAL PROCEDURES		
4.1	Procedures	7
4.2	Maintenance of Dam	7
4.3	Maintenance of Operating Facilities	7
4.4	Description of Any Warning System in Effect	7
4.5	Evaluation	7
SECTION 5 - HYDRAULIC/HYDROLOGIC		
5.1	Evaluation of Features	8
SECTION 6 - STRUCTURAL STABILITY		
6.1	Evaluation of Structural Stability	10
SECTION 7 - ASSESSMENT/REMEDIAL MEASURES		
7.1	Dam Assessment	11
7.2	Remedial Measures	11

TABLE OF CONTENTS (Cont'd)

LIST OF PLATES

<u>Plate No.</u>	<u>Title</u>
1	Location Map
2	Vicinity Topography
3	Plan
4	Section
5	Spillway Sections
6	Photo Index

LIST OF PHOTOGRAPHS

<u>Photo No.</u>	<u>Title</u>
1	View of Lake from Dam
2	Upstream Face of Dam Looking South
3	Crest of Dam Looking South
4	Downstream Face of Dam Looking South
5	Intake Structure and Inflow Pipe
6	Spillway Crest
7	South Dam Abutment and Spillway Discharge Channel
8	Spillway Discharge Channel Looking Upstream
9	Spillway Discharge Channel Looking Downstream
10	Damage Zone Looking Downstream from the Dam

APPENDIX

Appendix A - Hydrologic Computations

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 Drexel 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) Drexel Dam is an earth structure located on North Sugar Creek in northwestern Bates County, Missouri (Plate 1). The dam is 460 feet long and forms a 26-acre water supply and fishing lake. The structure is well maintained with rock riprap on both the upstream and downstream faces. The spillway is located at the left abutment, and the water intake to the treatment plant is near the middle of the dam. The watershed is primarily comprised of crop and grass land. Topography of the contributing watershed is characterized by flat lands to gently rolling hills. Topography in the vicinity of the dam is shown on Plate 2.

(2) The spillway is located at the left abutment of the dam. It consists of a concrete overflow weir, a concrete wall along the left abutment of the dam, and a discharge channel consisting of natural earth, broken shale, and limestone. The side slopes of the channel are moderately tree covered.

(3) An intake structure for the water treatment plant is located in the dam about 130 feet north of the south abutment. The structure is a square concrete tower with multilevel inlets. Reportedly a 3-inch diameter pipe goes from the intake structure, through the dam, to the water treatment plant located near the downstream face at the north end of the dam.

(4) Water is pumped into Drexel Lake from another lake located approximately 3/4 mile south of the dam. The 6-inch diameter inflow pipe is located approximately 150 feet north of the south abutment.

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

b. Location. The dam is located in northwestern Bates 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 Drexel, Missouri, in Section 6 of T42N, R33W.

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 Drexel 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 Drexel Lake Dam the flood damage zone extends downstream for 0.5 mile. Within the damage zone are four homes and the water treatment plant for the City of Drexel.

e. Ownership. The dam is owned by the City of Drexel. Information can be obtained from City Hall, Drexel, Missouri 64742.

f. Purpose of Dam. The dam forms a 26-acre lake for water supply and fishing.

g. Design and Construction History. Data relating to the design and construction were not available. The dam was built in 1953.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, withdrawals to the water treatment plant, and outflow through the spillway all combine to maintain a relatively stable water surface elevation. During periods of little or no rainfall and heavy water usage, water is pumped into Drexel Lake from a lake located south of Drexel to maintain the pool level for water supply and recreational uses.

1.3 PERTINENT DATA

a. Drainage Area - 2,920 acres

b. Discharge at Damsite.

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

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

(3) Estimated ungated spillway capacity at maximum pool elevation 3,480 cfs (top of dam El. 972.8).

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

(1) Top of dam - 972.8 \pm (see Plate 3)

(2) Spillway crest - 965.0

(3) Streambed at toe of dam - 950.0 \pm

(4) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 4,700 feet \pm

(2) Length of normal pool - 3,200 feet \pm

e. Storage (Acre-feet).

(1) Top of dam - 502

(2) Spillway crest - 112 (from 1974 inventory)

(3) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 88

(2) Spillway crest - 26

g. Dam.

(1) Type - Earth embankment

(2) Length - 460 feet

(3) Height - 17 feet \pm

(4) Top width - 9 feet

(5) Side slopes - upstream face 1.0 V to 2.5 H, downstream face 1.0 V to 2.8 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. Spillway.

(1) Type - Concrete weir with natural earth, shale, and limestone channel.

(2) Width of channel - 50 to 60 feet, varies.

(3) Crest elevation - 965.0 feet m.s.l.

(4) Gates - None.

(5) Upstream channel - Not applicable.

(6) Downstream channel - Open channel comprised of natural earth, broken limestone, and shale located on the left end of the embankment.

j. Regulating Outlets - The intake structure and 3-inch diameter pipe to the treatment plant could be used to drawdown the lake. The small diameter of the pipe would necessitate a long drawdown time.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were unavailable.

2.2 CONSTRUCTION

Construction records were unavailable, however, the owners stated that the dam was built in 1953.

2.3 OPERATION

The maximum recorded loading on the dam is unknown.

2.4 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. Detailed seepage and stability analyses should be performed as required by the guidelines.
- c. Validity. The validity of the design, construction, and operation could not be determined due to the lack of engineering data.

2.5 GEOLOGY

The dam is located in a valley formed in limestones and shales of the Pennsylvanian System, Marmaton Group. These are overlain by the Summit Silt Loam soil series, a residual clayey silt and silty clay soil varying in thickness from 0 to 5 feet. The foundation and abutments of the dam are anticipated to be shale and limestone overlain by silty clay. Limestone and shale are exposed in the spillway channel and downstream channel below the spillway. The bedding is horizontal and thin with closed bedding planes and a few widely spaced, closed, vertical joints.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Drexel Lake Dam was made on 5 April 1979. The inspection team included professional engineers with experience in dam design and construction, hydrologic - 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. There was no observable erosion of either the upstream or downstream slope of the embankment. The limestone riprap on both slopes is in good condition. The dam is well maintained. Brush is regularly removed from the embankment and the grass cover beyond the riprap on the downstream slope of the embankment is mowed regularly. No sloughing or seepage was observed on the downstream embankment. No settlement of the embankment was noticed, nor were any significant animal burrows present in the embankment.

c. Appurtenant Structures. The inspection team observed the following items pertaining to appurtenant structures. The spillway constructed at the left abutment of the embankment appears to be in good condition. The spillway has a concrete sill at the upstream end which serves as a broad-crested weir. The base of the spillway is unlined and is broken shale and limestone. The right wall of the spillway is a concrete wall 5 feet high, extending approximately 80 feet along the right side of the spillway discharge channel. The left side of the spillway channel is natural earth, broken shale, and limestone, with a moderate cover of brush and small trees. Minor erosion of the bottom and left side of the spillway channel has occurred.

d. Reservoir Area. No slides or excessive erosion due to wave action were observed along the shore of the reservoir. A minor amount of siltation has occurred at the upstream end of the reservoir.

e. Downstream Channel. Open channel comprised of broken limestone and shale located at the left end of the dam embankment.

3.2 EVALUATION

None of the conditions observed are significant enough to indicate a need for immediate remedial action. The inspection team observed no deficiencies at the dam at the time of the inspection.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, withdrawals to the water treatment plant, and capacity of the uncontrolled spillway. During periods of little or no rain and heavy water usage, water is pumped into Drexel Lake in a 6-inch cast iron pipe from a lake located approximately 3/4 mile south of the dam. Water is withdrawn from Drexel Lake by a 3-inch pipe which connects to the treatment plant near the downstream face of the dam.

4.2 MAINTENANCE OF DAM

Trees and brush are regularly removed from the embankment. Grass on or near the embankment is cut periodically as necessary.

4.3 MAINTENANCE OF OPERATING FACILITIES

Maintenance of the inflow pipe and the withdrawal pipe is performed as needed for water supply operations.

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

At the time of the inspection no deficiencies were observed. The dam appears to be in good condition and well maintained.

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 Drexel and Freeman Quadrangle Maps. The spillway and dam layouts are from surveys made during the inspection. The soils of the watershed consist of the Summit Silt Loam soil series. This soil is an upland residual soil developed from weathering of shales and thin limestones of Pennsylvanian age. The soil consists of a mixture of sand, silt, clay, and organic matter. The near-surface soil is predominantly clayey silt; the deeper soil is predominantly silty clay. For engineering purposes, the near surface soil is classified ML-CL, and the deeper soil is classified as CL. The lower permeability of the deeper soil may cause increased runoff during long periods of high precipitation. Soils are generally thicker on the uplands and in the valleys and thinner on valley slopes.

c. Visual Observations.

(1) The spillway is in good condition.

(2) The intake structure and 3-inch line to the water treatment plant could be used to drawdown the pool. Because of the minor capacity of the pipeline, drawdown of the pool would require a considerably long time.

(3) A spillway and exit channel are located near the left abutment. Spillway discharges are not anticipated to 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 20 percent of the probable maximum flood without overtopping the dam. This flood is greater than the 100-year flood. The distribution for the 100-year frequency rainfall was supplied by the St. Louis District, Corps of Engineers. 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. Based on the amount of water impounded by the dam and the hazard classification, the spillway should be designed to pass 50 percent of the maximum probable flood. The portion of the estimated peak discharge

of the probable maximum flood overtopping the dam would be 14,650 cfs of the total discharge from the reservoir of 22,960 cfs. The estimated duration of overtopping is 6.7 hours with a maximum height of 4.6 feet. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 5,520 cfs of the total discharge of the reservoir of 10,530 cfs with a maximum depth over the dam of 2.4 feet. The estimated duration of overtopping is 4.3 hours. The riprap on the upstream and downstream slopes of the dam will provide protection from erosion during overtopping. Failure of upstream water impoundments shown on the 1975 revised 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 0.5 mile downstream of the dam. There are four dwellings and the water treatment plant for the City of Drexel 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. No known post construction changes.

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

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. No deficiencies were observed by the inspection team during the visual inspection.

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 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. The present spillway has the capacity to pass 20 percent of the probable maximum flood without overtopping the dam. In order to pass 50 percent of the probable maximum flood as required by the Recommended Guidelines, the spillway size and/or height of dam would need to be increased.

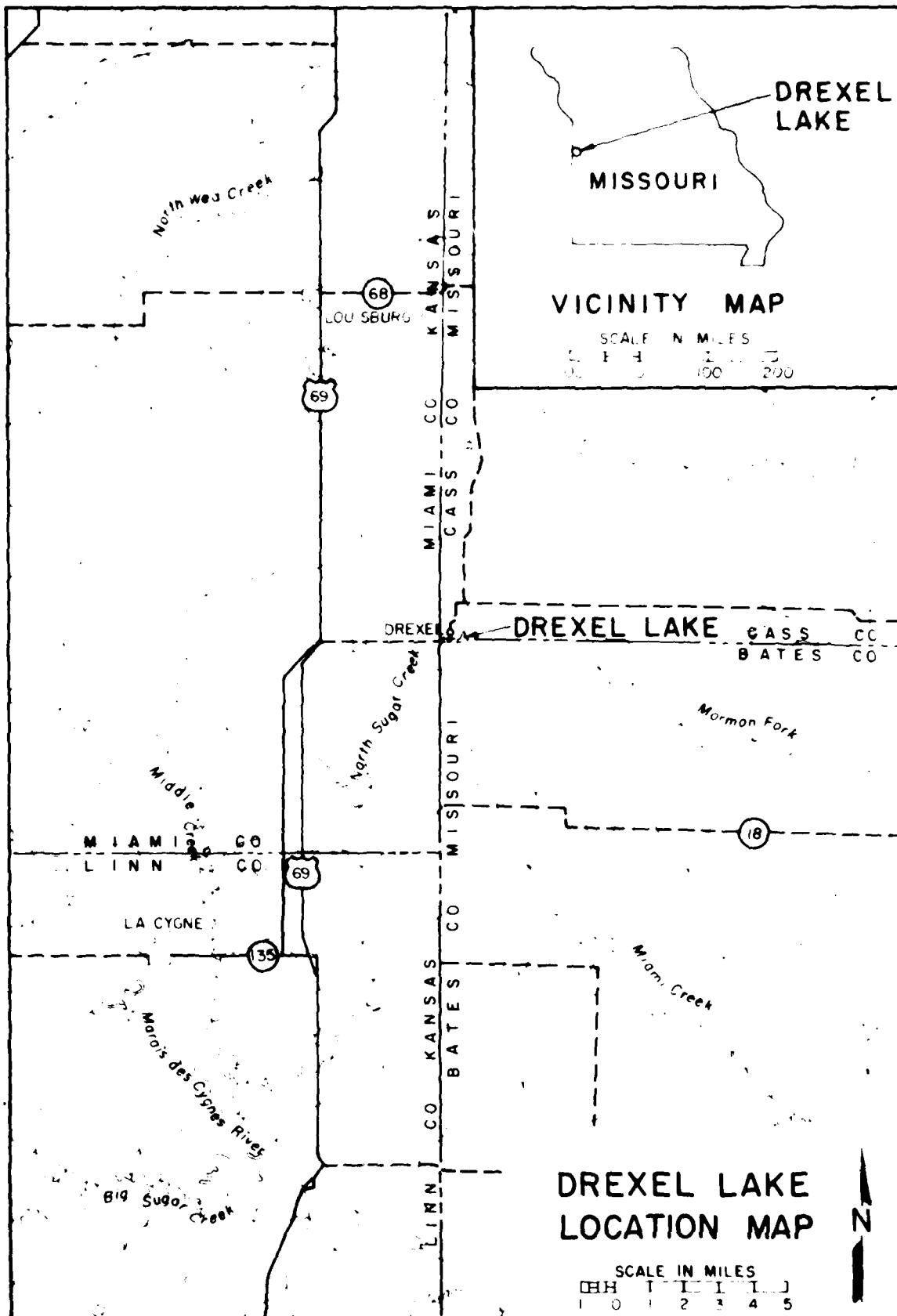
b. O&M Maintenance and Procedures. The following O&M maintenance and procedures are recommended:

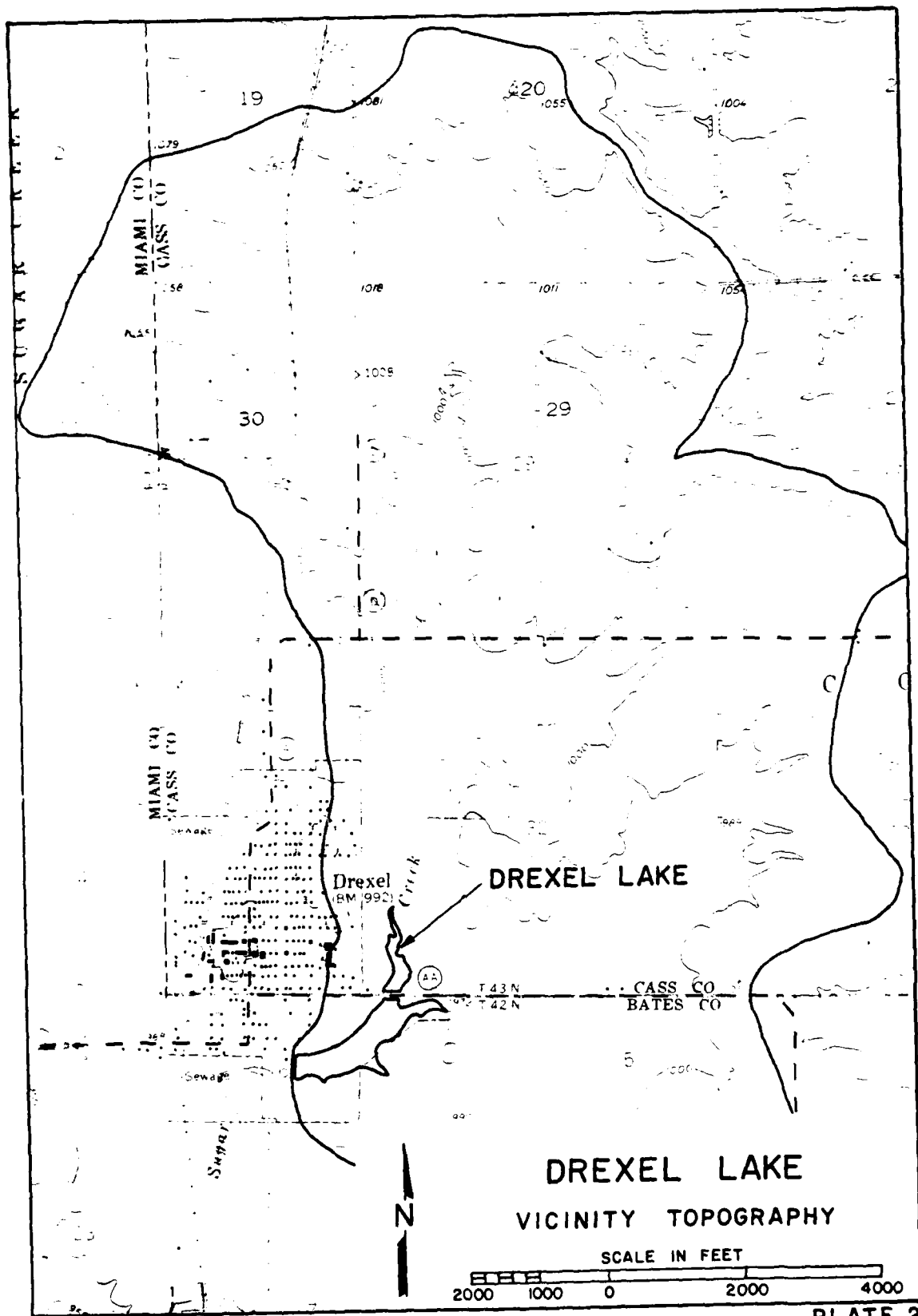
(1) Check the downstream face of the dam periodically for seepage and stability problems. If seepage flows are observed or sloughing on the downstream embankment slope is noted, the dam should immediately be inspected and the condition evaluated by an engineer experienced in design and construction of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

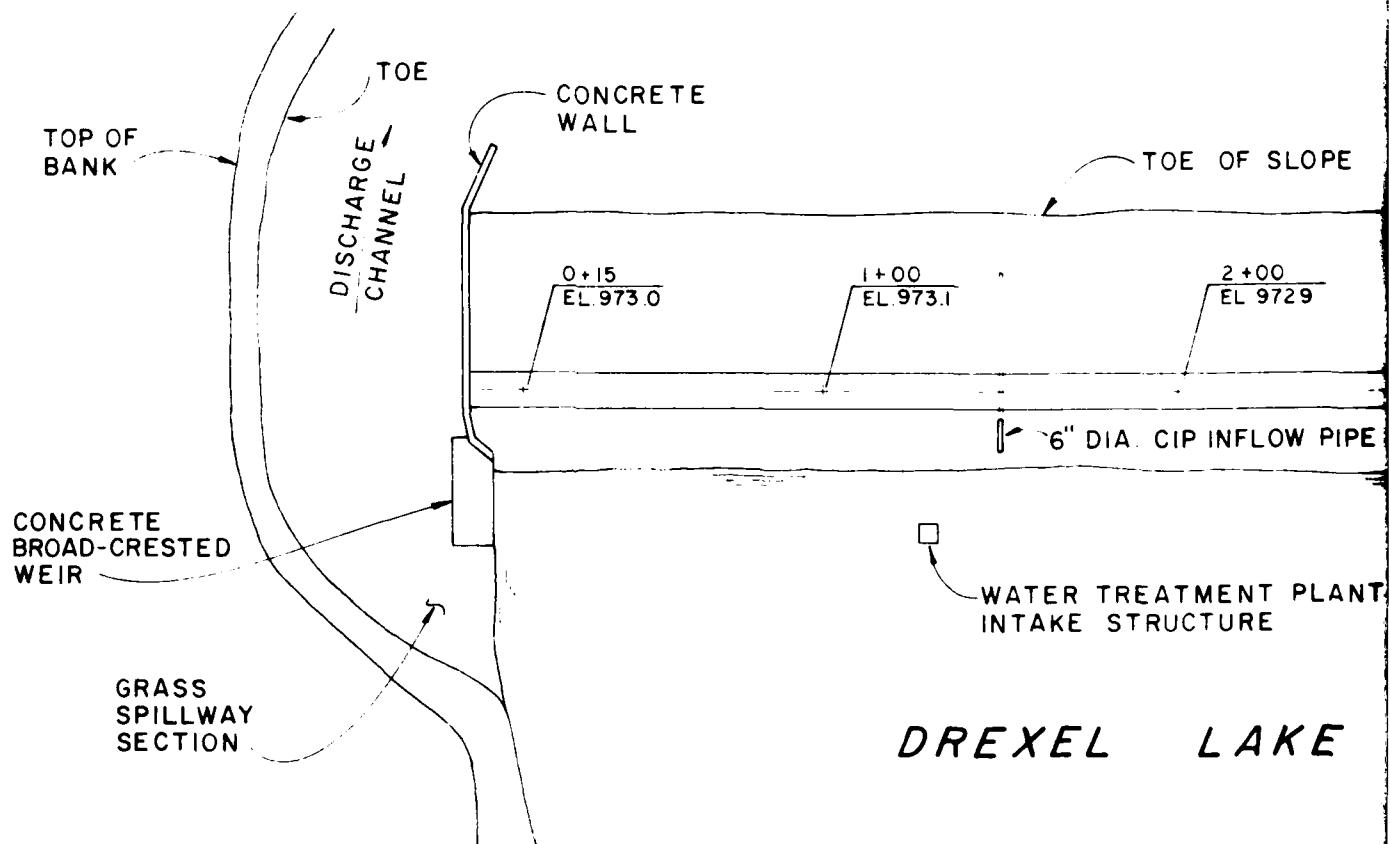
(2) The present regular maintenance program should be continued to control the growth of brush and grass on the dam embankment.

(3) Seepage and stability analysis should be performed by a professional engineer experienced in the design and construction of dams to satisfy the requirements of the guidelines.

(4) 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 deficiencies are observed.







WATER
TREATMENT
PLANT

TOE OF SLOPE

2+00
EL 9729

3+00
EL 9728

4+00
EL 973.1

4+60
EL 971.5

5+50
EL 973.5

CL DAM

CIP INFLOW PIPE

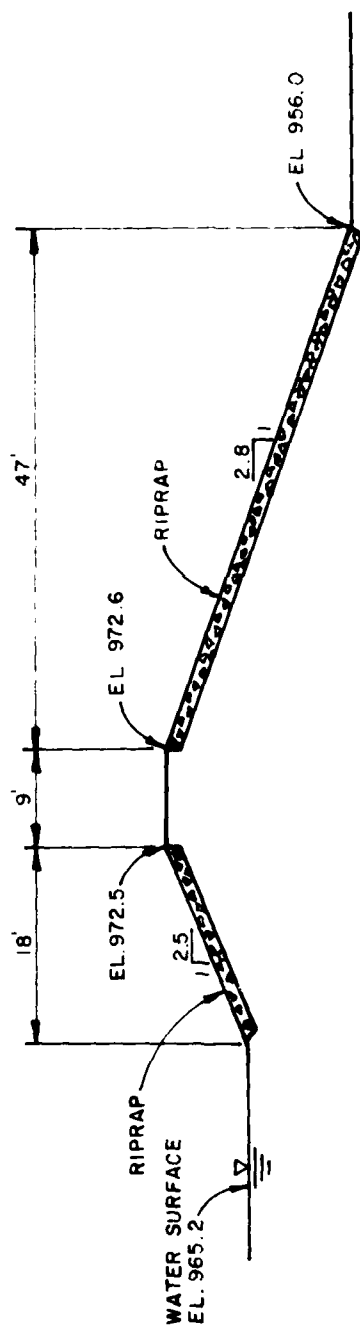
WATER TREATMENT PLANT
STRUCTURE

CL ROAD

LAKE

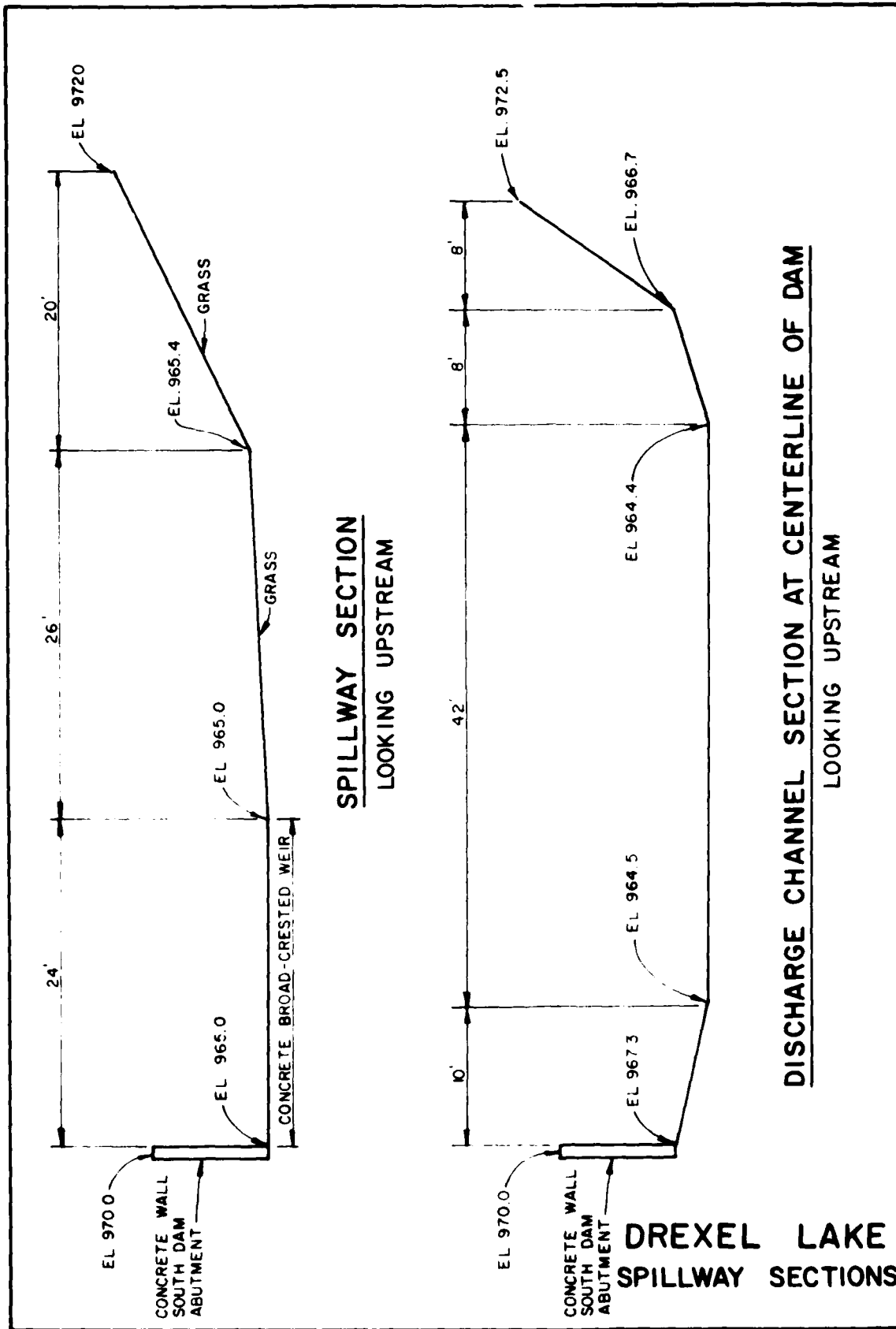


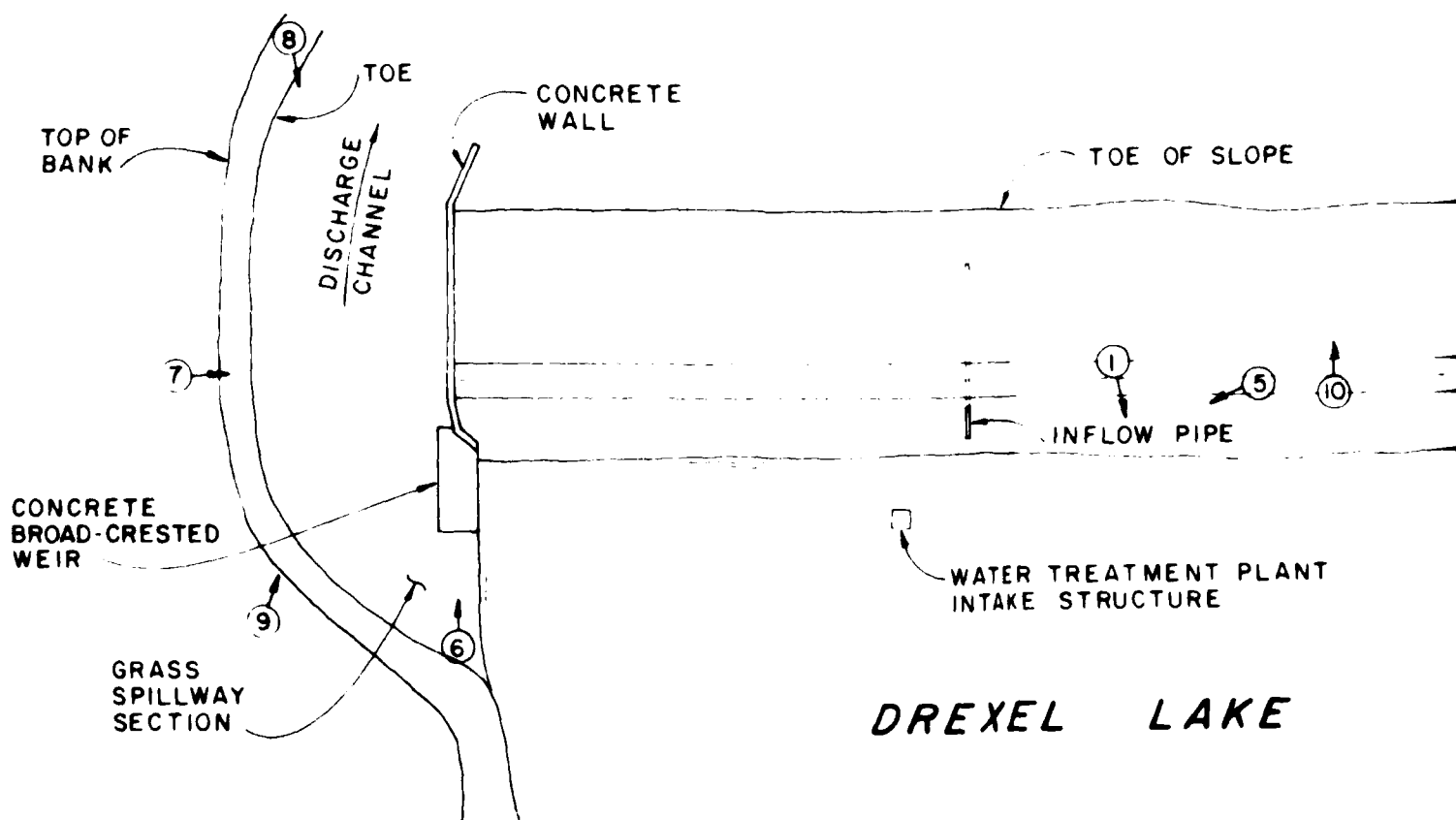
DREXEL LAKE
PLAN



DREXEL LAKE
TYPICAL SECTION

DREXEL LAKE
TYPICAL SECTION

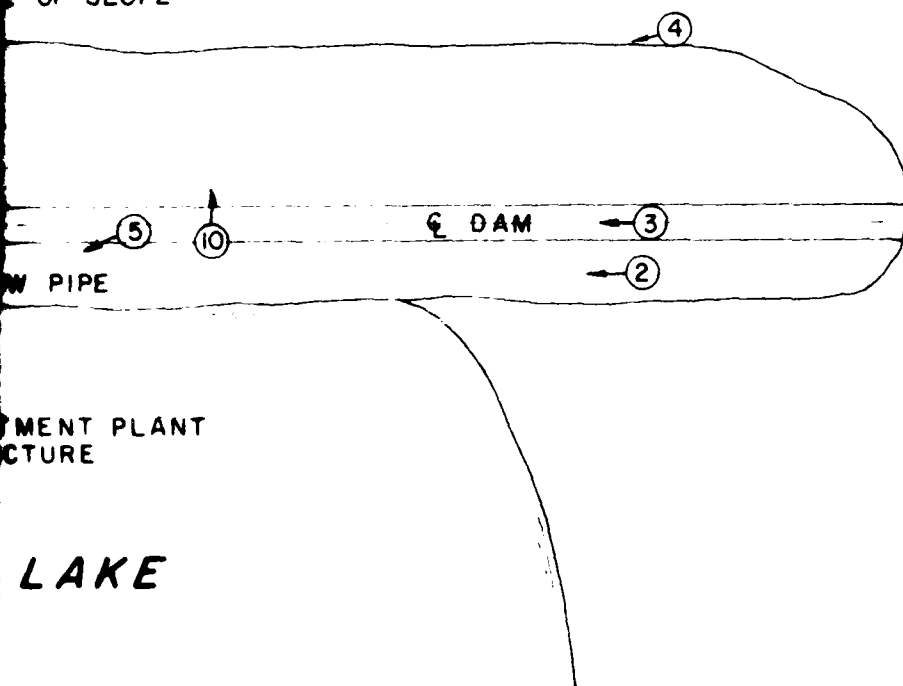






WATER
TREATMENT
PLANT

OF SLOPE



MENT PLANT
CTURE

LAKE

ROAD

LEGEND

← ① PHOTO LOCATION AND
DIRECTION



DREXEL LAKE
PHOTO INDEX



PHOTO 1: VIEW OF LAKE FROM DAM



PHOTO 2: UPSTREAM FACE OF DAM LOOKING SOUTH



PHOTO 3: CREST OF DAM LOOKING SOUTH



PHOTO 4: DOWNSTREAM FACE OF DAM LOOKING SOUTH



PHOTO 5: INTAKE STRUCTURE AND INFLOW PIPE



PHOTO 6: SPILLWAY CREST



PHOTO 7: SOUTH DAM ABUTMENT AND SPILLWAY DISCHARGE CHANNEL



PHOTO 8: SPILLWAY DISCHARGE CHANNEL LOOKING UPSTREAM



PHOTO 9: SPILLWAY DISCHARGE CHANNEL LOOKING DOWNSTREAM



PHOTO 10: DAMAGE ZONE LOOKING DOWNSTREAM FROM DAM

APPENDIX A
HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

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

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

200 square mile, 24 hour rainfall inches	- 25.1
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 101%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 120%
10 square mile, 24 hour percent of 24 hour 200 square mile, rainfall	- 130%
10 square miles, 48 hour percent of 24 hour 200 square mile, rainfall	- 140%

b. Drainage area = 2,920 acres.

c. Time of concentration: $T_c = (11.9 \times L^3/H)^{0.385} = 1.37 \text{ hours} = 83 \text{ minutes}$ (L = length of longest watercourse in miles, H = elevation difference in feet) (2)

d. Losses were determined in accordance with SCS methods for determining runoff using a curve number of 89 and antecedent moisture condition III. The hydrologic soil group in the basin was type C.

2. Spillway release rates are based on the broad-crested weir equation.

Broad-crested weir equation:

$$Q = CLH^{1.5} \text{ (for concrete section, } C = 2.64 \text{ to } 2.68, \\ L = 24.0 \text{ feet; for grass section } C = 2.63, L = 26 \text{ to } 46 \text{ feet; } H \text{ is the head on weir).}$$

Discharge rates over the top of the dam are also based on the broad-crested weir equation:

$$Q = CLH^{1.5} \text{ (} C = 2.7, L = 460 \text{ feet).}$$

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. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Modification September 1978, Davis, California.
- (2) U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.

THE UNIVERSITY OF CHICAGO

[illegible]

1953

"

K	0	HEAD	1
0	0	0	0
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	0	0	0
15	0	0	0
16	0	0	0
17	0	0	0
18	0	0	0
19	0	0	0
20	0	0	0
21	0	0	0
22	0	0	0
23	0	0	0
24	0	0	0
25	0	0	0
26	0	0	0
27	0	0	0
28	0	0	0
29	0	0	0
30	0	0	0
31	0	0	0
32	0	0	0
33	0	0	0
34	0	0	0
35	0	0	0
36	0	0	0
37	0	0	0
38	0	0	0
39	0	0	0
40	0	0	0
41	0	0	0
42	0	0	0
43	0	0	0
44	0	0	0
45	0	0	0
46	0	0	0
47	0	0	0
48	0	0	0
49	0	0	0
50	0	0	0
51	0	0	0
52	0	0	0
53	0	0	0
54	0	0	0
55	0	0	0
56	0	0	0
57	0	0	0
58	0	0	0
59	0	0	0
60	0	0	0
61	0	0	0
62	0	0	0
63	0	0	0
64	0	0	0
65	0	0	0
66	0	0	0
67	0	0	0
68	0	0	0
69	0	0	0
70	0	0	0
71	0	0	0
72	0	0	0
73	0	0	0
74	0	0	0
75	0	0	0
76	0	0	0
77	0	0	0
78	0	0	0
79	0	0	0
80	0	0	0
81	0	0	0
82	0	0	0
83	0	0	0
84	0	0	0
85	0	0	0
86	0	0	0
87	0	0	0
88	0	0	0
89	0	0	0
90	0	0	0
91	0	0	0
92	0	0	0
93	0	0	0
94	0	0	0
95	0	0	0
96	0	0	0
97	0	0	0
98	0	0	0
99	0	0	0
100	0	0	0
101	0	0	0
102	0	0	0
103	0	0	0
104	0	0	0
105	0	0	0
106	0	0	0
107	0	0	0
108	0	0	0
109	0	0	0
110	0	0	0
111	0	0	0
112			

IN THESE CASES, THE PROBABLE MAXIMUM

P	25.1	101.	120.	130.	140.
1	100	100	100	100	100
2	100	100	100	100	100
3	100	100	100	100	100
4	100	100	100	100	100
5	100	100	100	100	100
6	100	100	100	100	100
7	100	100	100	100	100
8	100	100	100	100	100
9	100	100	100	100	100
10	100	100	100	100	100
11	100	100	100	100	100
12	100	100	100	100	100
13	100	100	100	100	100
14	100	100	100	100	100
15	100	100	100	100	100
16	100	100	100	100	100
17	100	100	100	100	100
18	100	100	100	100	100
19	100	100	100	100	100
20	100	100	100	100	100
21	100	100	100	100	100
22	100	100	100	100	100
23	100	100	100	100	100
24	100	100	100	100	100
25	100	100	100	100	100
26	100	100	100	100	100
27	100	100	100	100	100
28	100	100	100	100	100
29	100	100	100	100	100
30	100	100	100	100	100
31	100	100	100	100	100
32	100	100	100	100	100
33	100	100	100	100	100
34	100	100	100	100	100
35	100	100	100	100	100
36	100	100	100	100	100
37	100	100	100	100	100
38	100	100	100	100	100
39	100	100	100	100	100
40	100	100	100	100	100
41	100	100	100	100	100
42	100	100	100	100	100
43	100	100	100	100	100
44	100	100	100	100	100
45	100	100	100	100	100
46	100	100	100	100	100
47	100	100	100	100	100
48	100	100	100	100	100
49	100	100	100	100	100
50	100	100	100	100	100
51	100	100	100	100	100
52	100	100	100	100	100
53	100	100	100	100	100
54	100	100	100	100	100
55	100	100	100	100	100
56	100	100	100	100	100
57	100	100	100	100	100
58	100	100	100	100	100
59	100	100	100	100	100
60	100	100	100	100	100
61	100	100	100	100	100
62	100	100	100	100	100
63	100	100	100	100	100
64	100	100	100	100	100
65	100	100	100	100	100
66	100	100	100	100	100
67	100	100	100	100	100
68					

—

K
K
t DAH

t
}

1

—

[illegible]

350. 195. 390. 1365.

0000 000000 0000 000000

SD972.8

“

100

1000 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

Case No.	Year	Age	Sex	Occupation	Duration (yr)	Notes
1	1985	45	M	Farmer	10	First case
2	1986	52	F	Homemaker	15	Second case
3	1987	38	M	Teacher	8	Third case
4	1988	60	F	Retired	20	Fourth case
5	1989	42	M	Engineer	12	Fifth case
6	1990	55	F	Homemaker	18	Sixth case
7	1991	35	M	Student	5	Seventh case
8	1992	65	F	Retired	25	Eighth case
9	1993	48	M	Farmer	14	Ninth case
10	1994	58	F	Homemaker	16	Tenth case
11	1995	32	M	Student	4	Eleventh case
12	1996	62	F	Retired	22	Twelfth case
13	1997	40	M	Farmer	11	Thirteenth case
14	1998	50	F	Homemaker	17	Fourteenth case
15	1999	30	M	Student	3	Fifteenth case
16	2000	60	F	Retired	23	Sixteenth case
17	2001	45	M	Farmer	13	Seventeenth case
18	2002	55	F	Homemaker	19	Eighteenth case
19	2003	35	M	Student	6	Nineteenth case
20	2004	65	F	Retired	24	Twentieth case

[illegible]

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	RATIO 7	RATIO 8	RATIO 9
				.05	.10	.15	.20	.25	.30	.40	.50	1.00
HYDROGRAPH AT	HEAD	4.56 (11.81)	1	1224. (34.66)	2448. (69.31)	3672. (103.97)	4895. (138.62)	6119. (173.28)	7343. (207.94)	9791. (277.25)	12239. (346.56)	24477. (693.12)
	DAM	4.56 (11.81)	1	821. (23.25)	1723. (48.79)	2496. (70.69)	3437. (97.33)	4564. (129.23)	5769. (163.37)	8055. (228.10)	10526. (298.06)	22957. (650.06)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	ELEVATION STORAGE OUTFLOW	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	966.24		965.00	965.00	972.80	126.	821.	0.00	41.17	0.00
.10	970.22		0.	0.	390.	210.	1723.	0.00	41.00	0.00
.15	971.48		0.	0.	3547.	298.	2496.	0.00	41.17	0.00
.20	972.68					382.	3437.	0.00	41.00	0.00
.25	973.30					457.	4564.	1.67	41.00	0.00
.30	973.72					515.	5769.	2.50	40.83	0.00
.40	974.53					624.	8055.	3.50	40.83	0.00
.50	975.23					719.	10526.	4.33	40.83	0.00
1.00	977.37					1009.	22957.	6.67	40.67	0.00