

AD-A106 445

BLACK AND VEATCH KANSAS CITY MO

NATIONAL DAM SAFETY PROGRAM. UNION LAKE DAM

DEC 80 E R BURTON, M L CALLAHAN

F/G 13/13

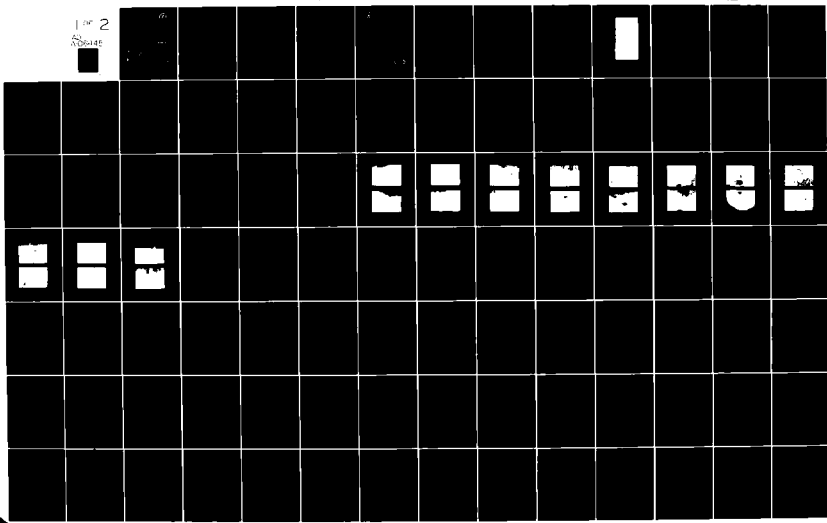
MISSOURI--ETC(U)

DACW43-80-C-0074

NL

UNCLASSIFIED

1 of 2
AD-A106 445



LEVEL II

MISSOURI-KANSAS CITY BASIN

AL A 106445



UNION LAKE DAM

JACKSON COUNTY, MISSOURI

MO 30225

PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

DTIC FILE COPY



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

St. Louis District

**DTIC
ELECTE
NOV 2 1981**
S D

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

FOR: STATE OF MISSOURI

DECEMBER 1980

81 10 26 067

DISTRIBUTION STATEMENT A

**Approved for public release
Distribution Unlimited**

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
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Union Lake Dam (MO 30225) Jackson County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
7. AUTHOR(s) Black & Veatch, Consulting Engineers		6. PERFORMING ORG. REPORT NUMBER
8. CONTRACT OR GRANT NUMBER(s) DACW43-80-C-0074		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (12) 206
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSD-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		12. REPORT DATE December 1980
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSD-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		13. NUMBER OF PAGES Approximately 120
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (10) Edwin R. /Burton Harry L. /Callahan		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. Union Lake Dam (MO 30225), Missouri - Kansas City Basin, Jackson 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.		

058350

UNCLASSIFIED

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 the 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.

MISSOURI-KANSAS CITY BASIN

UNION LAKE DAM

JACKSON COUNTY, MISSOURI

MO 30225

PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



**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

DECEMBER 1980



DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

SUBJECT: Union Lake Dam, Mo. ID No. 30225
Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Union 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:

- a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.
- b. Overtopping of the dam could result in failure of the dam.
- c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY:

SIGNED

Chief, Engineering Division

02 APR 1981

Date

APPROVED BY :

SIGNED

Colonel, CE, District Engineer

03 APR 1981

Date

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or
A	Special

DTIC
ELECTE
S NOV 2 1981 **D**
D

UNION LAKE DAM
JACKSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30225

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

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

DECEMBER 1980

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Union Lake Dam
State Located	Missouri
County Located	Jackson County
Stream	Tributary of Blue River
Date of Inspection	4 December 1980

Union 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 lives and property. The estimated damage zone extends approximately two miles downstream of the dam. Within the estimated damage zone are more than five dwellings, three roads, Interstate Hwy I-435, a railroad yard, and miscellaneous industrial facilities. Contents of the estimated downstream damage zone were verified by the inspection team.

Our inspection and evaluation indicates the spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillways will not pass the probable maximum flood without overtopping but will pass 10 percent of the probable maximum flood. The spillways will not pass the flood which has a one percent chance of occurrence in any given year (100-year flood); but will pass the flood with a 10 percent chance of occurrence (10-year flood). The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. Considering the damage zone, the spillway design flood should be 100 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region.

Based on visual observations, this dam appears to be in less than satisfactory condition. Deficiencies visually observed by the inspection

n

team were dense tree and brush cover, extremely steep upstream and downstream slopes, erosion of the upstream slope at the waterline due to wave action, erosion of the downstream slope from surface runoff and/or overtopping, partially plugged flow conduit, disjointed and displaced primary spillway pipe sections, a small sink hole over the primary spillway pipe, spillway channel erosion, and small animal burrows in the embankment. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

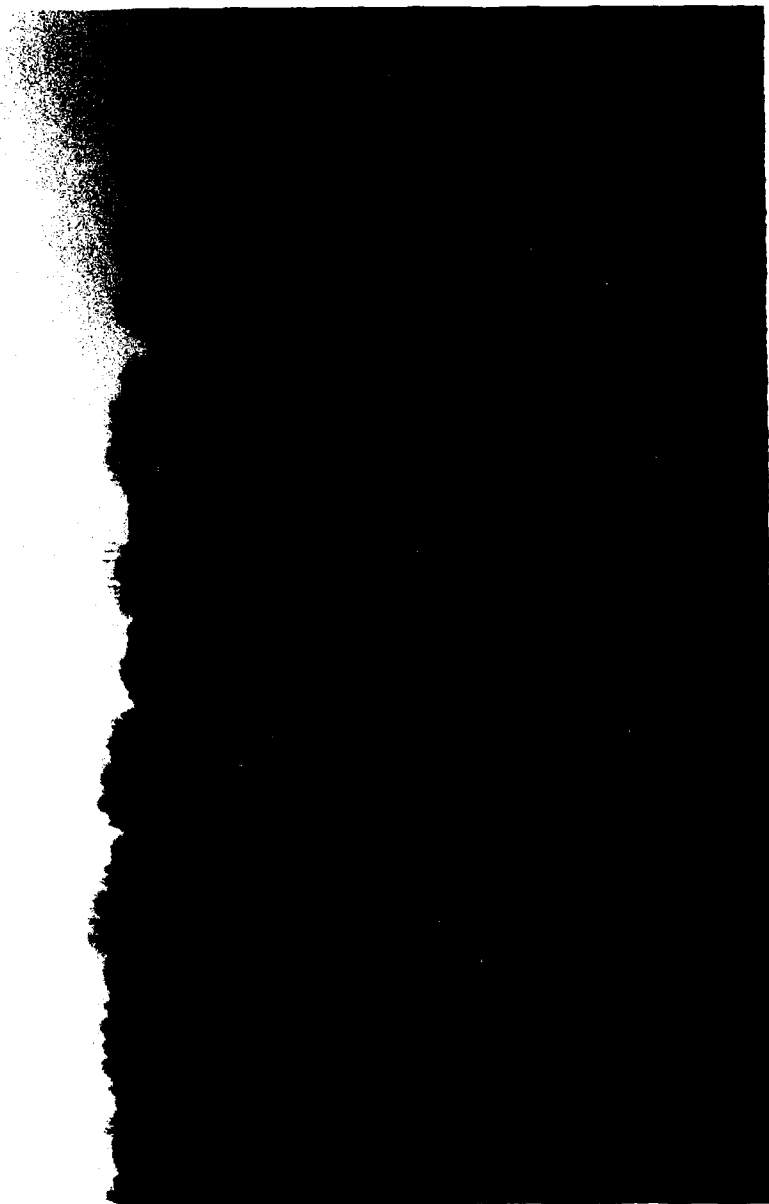
Edwin R. Burton

Edwin R. Burton, PE
Missouri E-10137

Harry L. Callahan

Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF DAM



PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
UNION 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	3
SECTION 2 - ENGINEERING DATA		
2.1	Design	6
2.2	Construction	6
2.3	Operation	6
2.4	Geology	6
2.5	Evaluation	6
SECTION 3 - VISUAL INSPECTION		
3.1	Findings	7
3.2	Evaluation	9
SECTION 4 - OPERATIONAL PROCEDURES		
4.1	Procedures	10
4.2	Maintenance of Dam	10
4.3	Maintenance of Operating Facilities	10
4.4	Description of Any Warning System in Effect	10
4.5	Evaluation	10
SECTION 5 - HYDRAULIC/HYDROLOGIC		
5.1	Evaluation of Features	11
SECTION 6 - STRUCTURAL STABILITY		
6.1	Evaluation of Structural Stability	13
SECTION 7 - ASSESSMENT/REMEDIAL MEASURES		
7.1	Dam Assessment	14
7.2	Remedial Measures	14

LIST OF PLATES

<u>Plate No.</u>	<u>Title</u>
1	Location Map
2	Vicinity Topography
3	Dam Plan
4	Dam Crest Profile and Dam Cross Section
5	Photo Index

LIST OF PHOTOGRAPHS

<u>Photo No.</u>	<u>Title</u>
1	Upstream Face of Dam Looking West
2	Upstream Face of Dam Looking East
3	Upstream Face of Dam, Left Center
4	Crest of Dam Looking West
5	Crest of Dam Looking East
6	Downstream Face of Dam Looking West
7	Downstream Face of Dam Looking East
8	Inlet End of Secondary Spillway Pipes, Right End of Dam
9	Outlet End of Concrete Pipe, Right End of Dam
10	Outlet End of Corrugated Metal Pipe, Right End of Dam
11	Channel Downstream of Corrugated Metal Pipe, Right End of Dam
12	Inlet End of Primary Spillway Pipe at Left End of Dam
13	Sink Hole in Crest at Separated Joint in Primary Spillway Pipe

LIST OF PHOTOGRAPHS
(Cont'd)

<u>Photo No.</u>	<u>Title</u>
14	View Through Primary Spillway Pipe from Downstream End
15	Outlet End of Primary Spillway Pipe at Left End of Dam
16	Channel Downstream of Primary Spillway Pipe
17	Erosion on Downstream Face of Dam, Right Center
18	Erosion on Downstream Face of Dam, Right Center
19	Test Pit on Downstream Embankment Slope, Toe
20	Erosion at Left Side Concrete Primary Spillway Headwall
21	Overview of Upper Lake and Dam
22	Valley Downstream of Dam

APPENDICES

Appendix A - Hydrologic and Hydraulic Analyses
Appendix B - Boring Logs

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 Union Lake Dam, formerly called Joe's Fishing Lake, be made.

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

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

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of a tributary of the Blue River (see Plate 1). The watershed is an area of low hills with fairly steep terrain consisting of about 60 percent urban development, 30 percent timber and 10 percent grassland. Small single family houses are located on large lots on the periphery of the watershed. Immediately upstream of Union Lake's reservoir pool is a small earthen dam and pool. The Union Lake dam is approximately 305 feet long along the crest and 27 feet high. The dam crest is 10 feet wide and is on a curved alinement. The downstream face of the dam has a nonuniform slope from the crest to the valley floor below.

(2) The spillway facilities for this dam consists of three conduits of different diameters. The primary conduit is a 30-inch concrete pipe located near the left abutment which discharges to an eroded channel. The inlet of this spillway includes a 22.6 feet long, 5.3 feet high concrete headwall.

Located near the right abutment are two conduits which also serve as points of discharge for this reservoir. One, a 12-inch diameter concrete pipe is partially plugged with earth, and the second is a 16-inch diameter corrugated metal pipe. Both pipes discharge to an eroded

channel on the right abutment. There is no headwall for these pipes, but there is a small trash screen a short distance upstream from these inlets.

(3) Located immediately upstream of Union Lake is a small earth dam. This dam has an 18-inch diameter corrugated metal pipe conduit spillway located near the right abutment. The dam has a worn gravel road across its crest.

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

b. Location. The dam is located in northeast Jackson County, Kansas City, 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 Independence, Missouri in Section 17 of T49N, R32W.

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. A small size dam is classified as having a height less than 40 feet, but greater than or equal to 25 feet and/or a storage capacity less than 1,000 acre-feet, but greater than or equal to 50 acre-feet.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Union 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 Union Lake Dam the estimated flood damage zone extends approximately two miles downstream of the dam. Within the estimated damage zone are more than five dwellings, three roads, Interstate Hwy I-435, a railroad yard, and miscellaneous industrial facilities. Contents of the estimated downstream damage zone were verified by the inspection team.

e. Ownership. The dam is owned by the Sheet Metal Workers Local No. 2 (contact Mr. Foster), 101 E. Armour, Kansas City, Missouri 64111.

f. Purpose of Dam. The dam forms a 4.0-acre lake used for recreation.

g. Design and Construction History. Data relating to the design and construction were not available.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and flow through the uncontrolled conduit spillways all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 61 acres, 30 acres uncontrolled.

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through the three spillway conduits.

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

(3) Estimated ungated spillway capacity at maximum pool elevation 53 cfs (Probable Maximum Flood Pool El. 913.4).

c. Elevation (Feet above m.s.l., adjusted from Kansas City, Mo. datum).

(1) Top of dam - 911.6 (see Plate 3)

(2) Primary spillway pipe inlet invert - 909.2

(3) Secondary spillway pipe inlet inverts - 909.5 - 16 inch,
910.4 - 12 inch

(4) Streambed at toe of dam - 884.3

(5) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 520 feet $\pm$ (Probable maximum flood pool level)

(2) Length of normal pool - 495 feet $\pm$ (Primary spillway crest)

e. Storage (Acre-feet).

(1) Top of dam - 40

(2) Primary spillway inlet - 30

(3) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 4.4

(2) Primary spillway inlet - 4.0

g. Dam.

(1) Type - Earth embankment

(2) Length - 305 feet

(3) Height - 27 feet $\pm$

(4) Top width - 10 feet

(5) Side slopes - upstream face 1.0 V on 1.8 H, downstream face between 1.0 V on 2.0 H and 1.0 V on 3.3 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. Primary Spillway.

(1) Type - Concrete pipe, 30-inch diameter.

(2) Inlet invert elevation - 909.2 feet m.s.l.

(3) Outlet invert elevation - 906.5 feet m.s.l.

(4) Gates - None.

(5) Upstream channel - None.

(6) Downstream channel - Discharges to an eroded channel leading to the natural stream below the dam.

j. Secondary Spillways.

A.

(1) Type - Concrete pipe, 12-inch diameter. (Blocked with earth)

(2) Inlet invert elevation - 910.4 feet m.s.l.

- (3) Outlet invert elevation - 909.0 feet m.s.l.
- (4) Gates - None.
- (5) Upstream channel - None.
- (6) Downstream channel - Discharges to an eroded channel leading to the natural stream below the dam.

B.

- (1) Type - Corrugated metal pipe, 16-inch diameter.
- (2) Inlet invert elevation - 909.5 feet m.s.l.
- (3) Outlet invert elevation - 909.1 feet m.s.l.
- (4) Gates - None.
- (5) Upstream channel - None.
- (6) Downstream channel - Discharges to an eroded channel leading to the natural stream below the dam.

k. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were not available.

2.2 CONSTRUCTION

Construction records were unavailable.

2.3 OPERATION

Operational records and documentation of past floods were unavailable. The watershed experienced a rainfall of about 12 inches in a 24-hour period in September 1977.

2.4 GEOLOGY

The dam is located across a shallow valley formed by a tributary to the Blue River. The soil of the dam and reservoir area consists of about 9 feet of low to medium plastic silty clay (CL for engineering purposes) developed in modified loess, overlying approximately 4 feet of highly plastic (CH for engineering purposes) residual clay underlain by the Chanute Shale. Bedrock of the general area consists of the Pennsylvanian age Kansas City Group. The formations consist of limestones and shales, with the Chanute Shale being the highest formation in the area, and the Block Limestone the lowest.

The foundation of the dam is on the Wea Shale with the Block Limestone present and outcropping in the middle dam area. The natural bottom of the lake is the Wea Shale with the Westerville Limestone cropping out along the shoreline. The left abutment consists of approximately 2 feet of low plastic silty clay (CL) over about 3 feet of highly plastic clay which overlies the Quivira Shale. The right abutment consists of the Quivira Shale.

2.5 EVALUATION

a. Availability. No engineering data were available.

b. Adequacy. No engineering data were available. Thus, an assessment of the design, construction, and operation could not be made. 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. The validity of the design, construction, and operation could not be determined due to the lack of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Union Lake Dam was made on 4 December 1980. The inspection team consisted of Edwin Burton, team leader; Shannon Casey, geologist; Gary Van Riessen, geotechnical engineer; Paul MacRoberts, civil engineer; Thomas L. Rutherford, hydrologic/hydraulic engineer; and Anthony C. Davis, civil engineer. The dam is in less than satisfactory condition. 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 conditions at the dam. Conditions visually observed by the inspection team included dense tree and brush cover, steep upstream and downstream slopes, erosion of the upstream slope at the waterline due to wave action, erosion of the downstream slope due to surface runoff and apparent overtopping, partially plugged outlet conduit, spillway channel erosion, disjointed and displaced sections of the 30-inch discharge pipe, a small sink hole located over the 30-inch pipe, and small animal burrows. No cracking, sliding, sloughing or other signs of instability or settlement were observed.

The dam crest has a narrow gravel road surface with worn spots caused by apparent overtopping and vehicle/foot traffic. The upstream slope has visible remnants of slope protection, eg. railroad tie retainer wall, and riprap. These deteriorated features might possibly offer some localized protection from wave action. The downstream slope is covered with brush and trees. Trees range in size up to about 10-inches in diameter.

An apparently nonbackfilled inspection pit was observed at the toe of the dam about 50 feet from the right abutment. Some fairly well defined erosion gullies were observed on the downstream slope starting near the dam's crest. Gullies have also been formed at the discharge end of the spillway pipes.

Both the downstream and upstream slopes contain debris, such as cans, and discarded household appliances. The upstream and downstream slopes of the embankment are extremely steep. No instruments to measure the performance of the dam were located. No toe drains or relief wells were observed.

There was no evidence that a maintenance program was in effect. A few animal burrows and mole tunnels were observed on the downstream slope.

c. Appurtenant Structures. The inspection team observed the following items pertaining to the appurtenant structures. The primary spillway is a 30-inch concrete pipe which discharges into a channel cut in the left abutment. There was evidence of erosion in the spillway channel downstream of the pipe. The spillway was considered to be in poor condition. Open and displaced joints observed in the primary spillway pipe are potential locations for internal erosion of the embankment to occur. This is a probable cause of an observed sink hole over the pipe (Photo 13). It should be noted that an abnormally large spillway discharge is likely to damage the embankment due to open joints in the pipes. The secondary spillways, 12-inch concrete pipe (blocked with dirt and debris) and 16-inch corrugated metal pipe located near the right abutment discharge to an eroded channel.

There was no development in the spillway areas which would suffer damage due to flow through the spillways.

d. Geology. The soils in the area of the dam and reservoir consist of low to medium plastic silty clays developed in modified loess. Depth to bedrock, which is interbedded limestone and shale is approximately 13 to 17 feet on the uplands.

The embankment itself consists of stiff, medium to highly plastic (CL to CH) clays.

The abutments are Quivira Shale overlain on the left abutment by 5 feet of low to highly plastic clays, and the foundation of the dam is the Wea Shale, with the Block Limestone present and outcropping in the middle dam area.

Samples of the embankment were taken near the center of the upstream crest using an Oakfield sampler. The materials in the samples consisted of stiff, medium to highly plastic (CL to CH) clays. Based on these samples and visual observations, it is surmised that the embankment consists of silty, sandy clay classified as (CL).

e. Reservoir Area. No slumping or slides of the reservoir banks were observed. The upstream end of lake contains some minor debris and a few trees. The lake was noted to be clean with little or no siltation.

Located immediately upstream of the Union Lake is a small earthen dam. This dam is approximately 240 feet long along the crest. The dam crest is approximately 8 feet wide and has a straight alinement. The elevation at the top of the dam is 926.5 and the dam has a storage volume of 9 ac-ft. No inspection was made except to determine the hydraulic parameters to perform the breaching analysis.

f. Downstream Channel. Each spillway discharges to an eroded channel, then to the natural streambed. The channel immediately downstream of the dam is lined with brush and trees and contains debris.

3.2 EVALUATION

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

The potential for sloughing, erosion, or sliding of embankment material is enhanced by the presence of the relatively steep side slopes and the narrow crest.

The growth of trees and brush, if allowed to go unchecked, could cause deterioration of the embankment. The roots of trees can loosen the embankment material and also can leave voids through which water can pass. Brush on the dam prevents inspection of the embankment and kills the smaller grasses whose roots are more effective in protecting the surface soil of the slope from erosion. The brush provides habitat for burrowing animals which can damage the embankment.

The erosion gullies on the downstream face of the embankment should be repaired.

The absence of adequate riprap and slope protection on the upstream slope of the dam has resulted in wave action erosion. If not corrected wave action will continue to erode the embankment and could lead to slope stability problems.

Open and displaced joints observed in the 30-inch primary spillway pipe are areas where potential internal erosion can occur. If this deficiency is not corrected, internal erosion and piping will continue to take place and could lead to spillway and embankment failure.

Burrowing animals will continue to damage the embankment if a program is not undertaken to eliminate them. Piping failure of embankments have resulted from damage caused by burrowing animals.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

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

4.2 MAINTENANCE OF DAM

There is no evidence that a maintenance program is in effect at this dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam.

4.5 EVALUATION

A maintenance program should be developed and initiated. A program should include mowing of the grass cover and controlling tree growth on the embankment in order to discourage animal burrowing and root penetration problems.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data. No design data were available.
- b. Experience Data. The drainage area and lake surface area are developed from USGS Independence Quadrangle Map. The dam layout and topographic maps were provided by the owner and developed by Shafer, Kline, and Warren P.A. of Overland Park, Kansas. These topographic maps were used to develop the storage-elevation curves.
- c. Visual Observations.
 - (1) The primary spillway appears to be in poor condition. The lake level at the time of the inspection (El. 907.3) was below the primary spillway inlet invert level. There were no obstructions to flow in the downstream channel.
 - (2) The secondary spillway conduits appear to be in less than fair condition. The lake level at the time of inspection was below their inlet elevations. The 12-inch concrete pipe spillway was essentially plugged with earth and debris and was not considered a discharge point for purposes of this report. The 16-inch corrugated metal pipe was open. The outlet ends of these pipes are located at an eroded channel at the right abutment.
 - (3) Spillway discharges do not endanger the integrity of the dam.
 - (4) Located immediately upstream from Union Lake's reservoir pool is a small earthen dam. This structure has an 18-inch corrugated metal pipe as its primary spillway.
- d. Overtopping Potential. The spillways 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 spillways will pass 10 percent of the probable maximum flood without overtopping the dam. The spillways will not pass the one percent chance flood (100-year flood) developed from a 24-hour, one percent chance rainfall, but will pass the 10 percent chance flood (10-year flood) developed from a 24-hour, 10 percent chance rainfall. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the downstream hazard, the appropriate spillway design flood should be 100 percent of the probable maximum flood. The portion of the estimated peak discharge of 50 percent of the

probable maximum flood overtopping the dam would be 524 cfs of the total discharge from the reservoir of 571 cfs. The estimated duration of overtopping is 5.2 hours with a maximum height of 1.3 feet. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 1,142 cfs of the total discharge from the reservoir of 1,195 cfs. The estimated duration of overtopping is 7.3 hours with a maximum height of 1.8 feet. The embankment could be jeopardized should overtopping occur for these periods of time.

The hydraulic analysis for Union Lake includes the results of a breach analysis for the upstream impoundment.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately two miles downstream of the dam. More than five dwellings, three roads, Interstate I-435, one railroad yard, and miscellaneous industrial facilities could be severely damaged and lives could be lost should failure of the dam occur. Contents of the estimated downstream damage zone were verified by the inspection team. Union Lake and its downstream damage zone are located in a Zone C (Area of Minimal Flooding) as defined by the National Flood Insurance Program. Applicable flood plain regulations and other constraints are in force as per the flood insurance study effective September 29, 1978.

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. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operational records exist.

d. Postconstruction Changes. It is not known whether or not any repairs have been made to the dam subsequent to its construction.

e. Rehabilitation: The owners of Union Lake have engaged the firm of Shafer, Kline, and Warren, P.A. to prepare engineering documents for the rehabilitation of the dam and appurtenances. An engineering report and construction drawings have been prepared. Subsurface explorations were performed in conjunction with the above engineering study. Boring logs obtained during this effort are presented in Appendix B.

f. 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: embankment and foundation material classifications and shear strengths; abutment materials, conditions, and strengths; 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. Several conditions observed during the visual inspection by the inspection team should be monitored, controlled, and/or repaired. These are erosion on the downstream slope, extremely steep upstream and downstream slopes, erosion of upstream slope due to wave action, partially plugged spillway conduit, disjointed and displaced pipe sections, small sinkhole over the primary spillway pipe, spillway channels erosion, the dense growth of brush, and trees on the embankment, and animal burrows in the embankment. 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.

b. Adequacy of Information. Due to the absence 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. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. The Phase I investigation does not raise any serious enough questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional analyses noted in paragraph 2.5b are necessary for compliance with the guidelines.

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

7.2 REMEDIAL MEASURES

a. Alternatives. The condition of the primary spillway is a serious deficiency and it should be either repaired or replaced. In

addition, the spillway size and/or height of the dam would need to be increased or the lake level would need to be permanently lowered to increase available flood storage to effectively pass the spillway design flood.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended and should be carried out under the direction of a professional engineer experienced in the design, construction, and maintenance of earth dams.

(1) Riprap should be placed on the upstream face of the dam to an elevation above the normal lake level to prevent wave induced erosion of the embankment material. The upstream slope should be cleared of all debris prior to placement of riprap.

(2) A maintenance program to remove and control the growth of brush and trees on the embankment should be developed. Grass/weed cover on the embankments should be cut periodically.

(3) The erosion gullies on the downstream slope of the embankment and the spillway channels should be repaired and protected with suitable materials. Paved ditches or other slope protection may be required to control the concentrated discharge from the spillways.

(4) The animal burrows in the embankment should be corrected since they can lead to piping. Control measures should be implemented to discourage this type of animal activity. The embankment slope should be monitored by a qualified engineer during the repair of the embankment.

(5) All debris and trash discarded on this structure and plugging in the secondary 12-inch diameter concrete pipe should be removed. Such accumulations not only give the appearance of poor maintenance but also can possibly hide potential problem areas.

(6) Seepage and stability analyses should be performed.

(7) A detailed inspection of the dam should be made periodically. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.

(8) The inlet ends of the spillway pipes should have suitable trash racks installed.

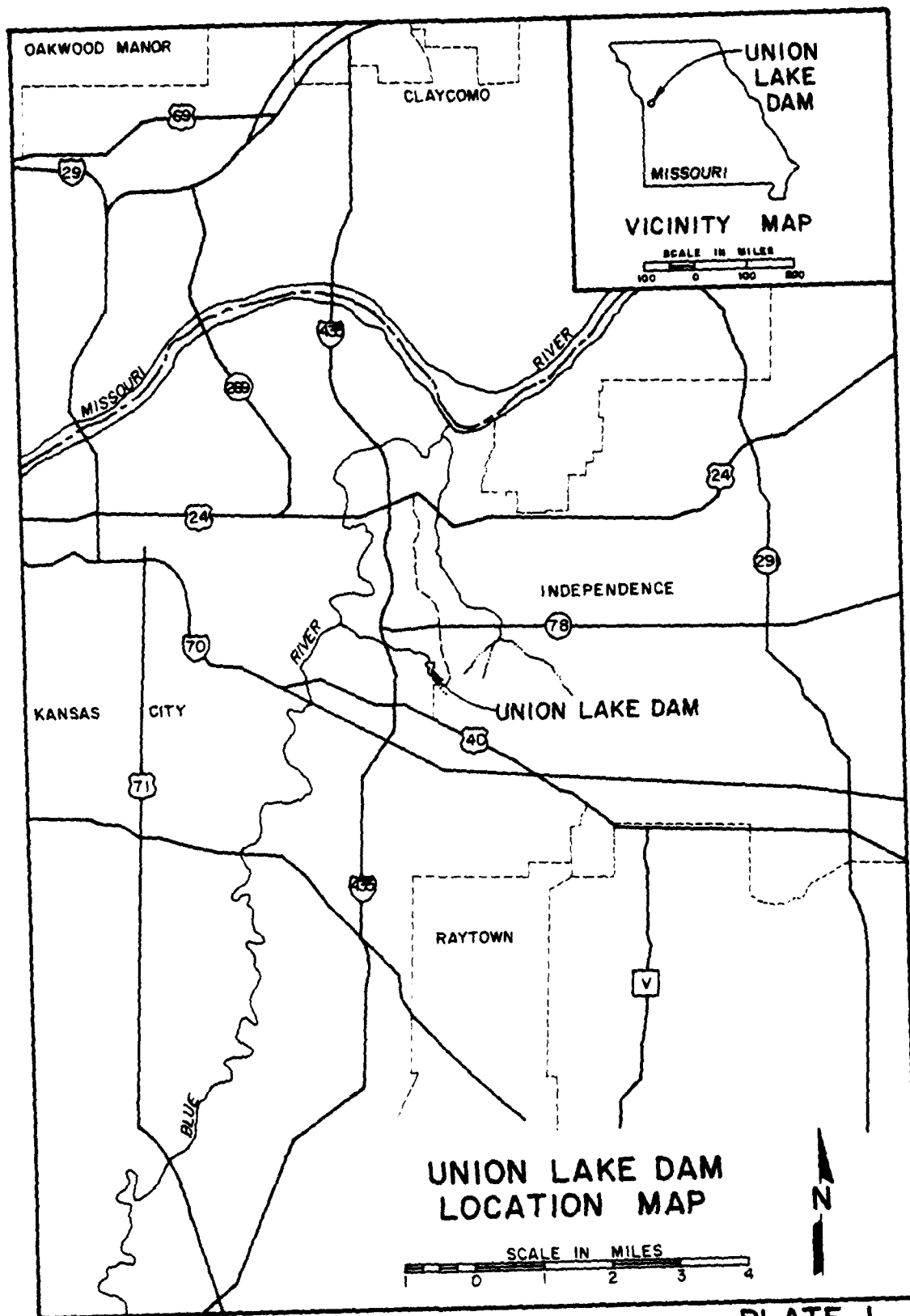


PLATE I

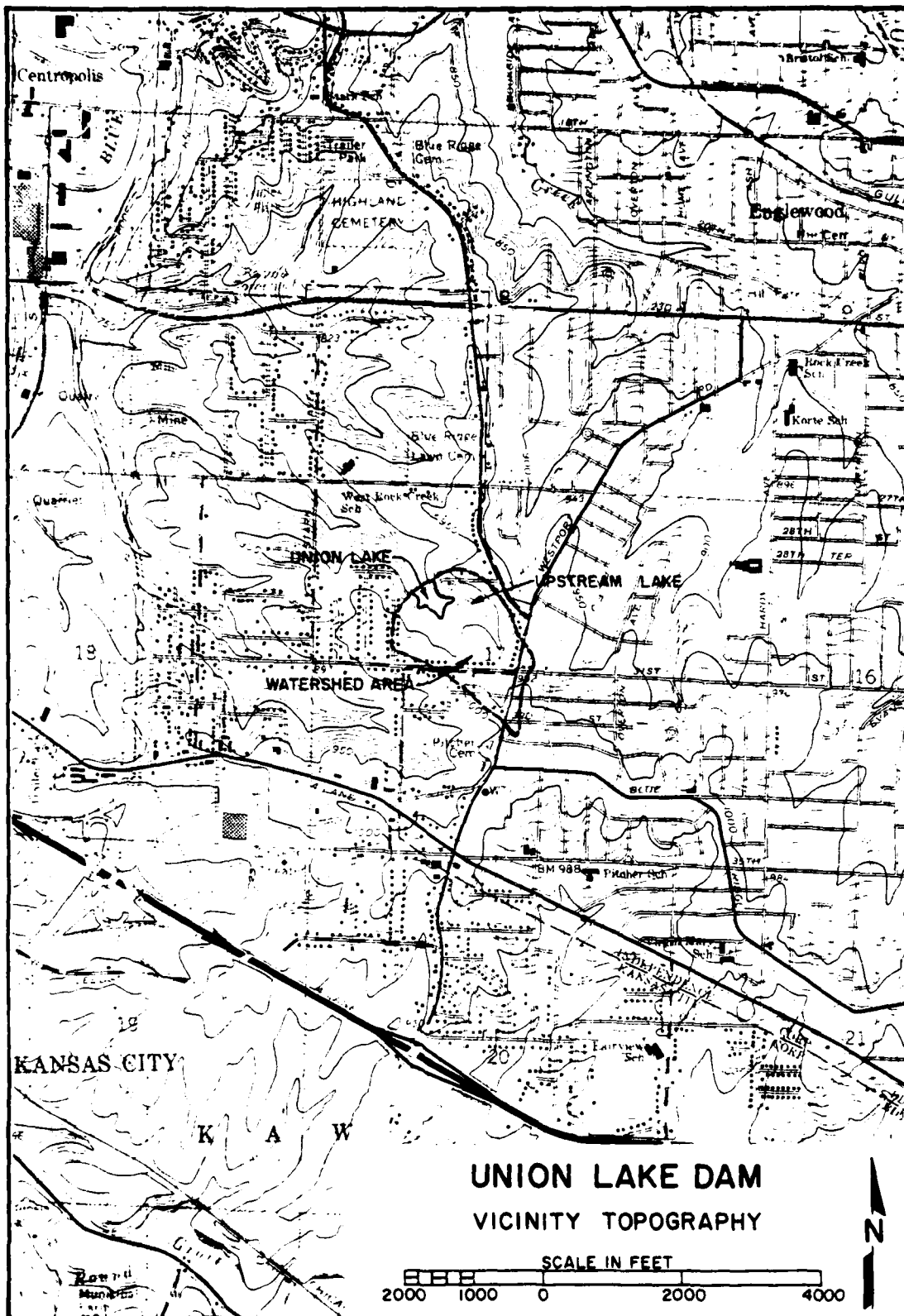
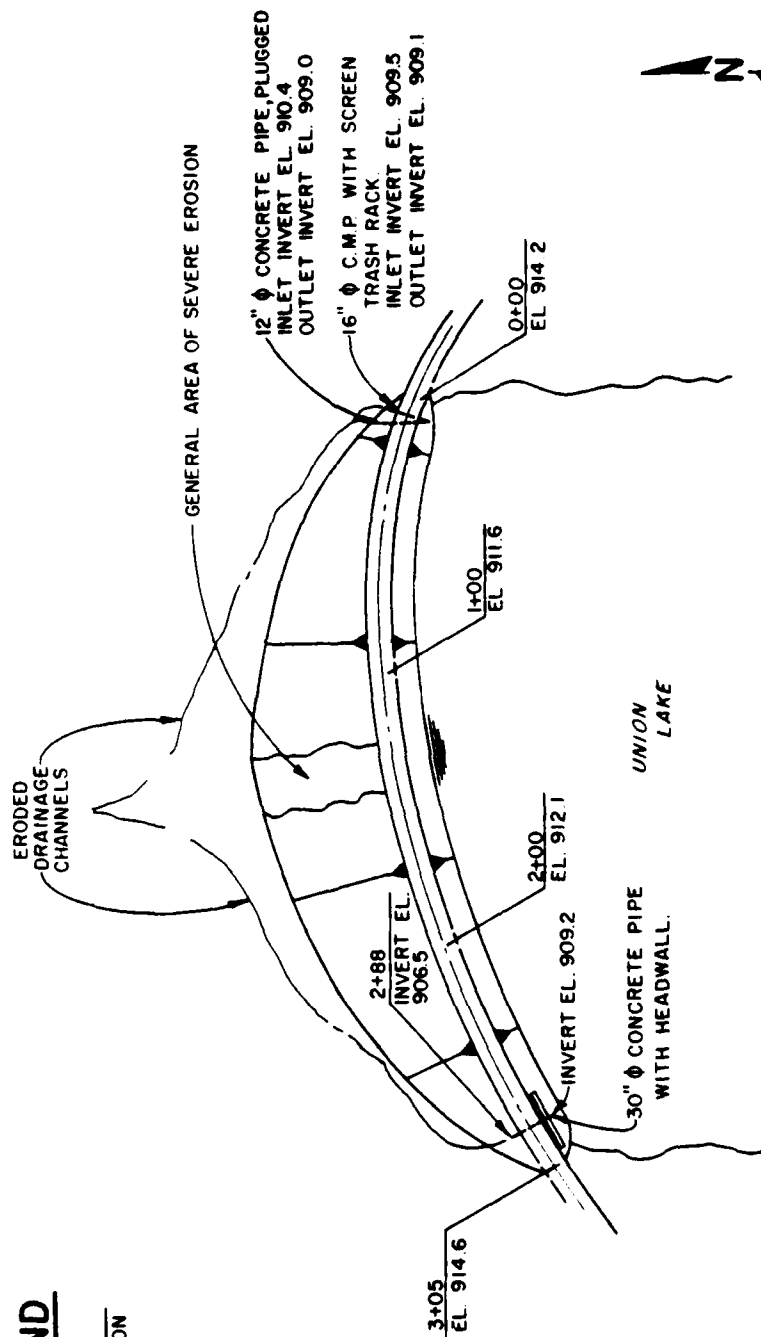


PLATE 2

LEGEND

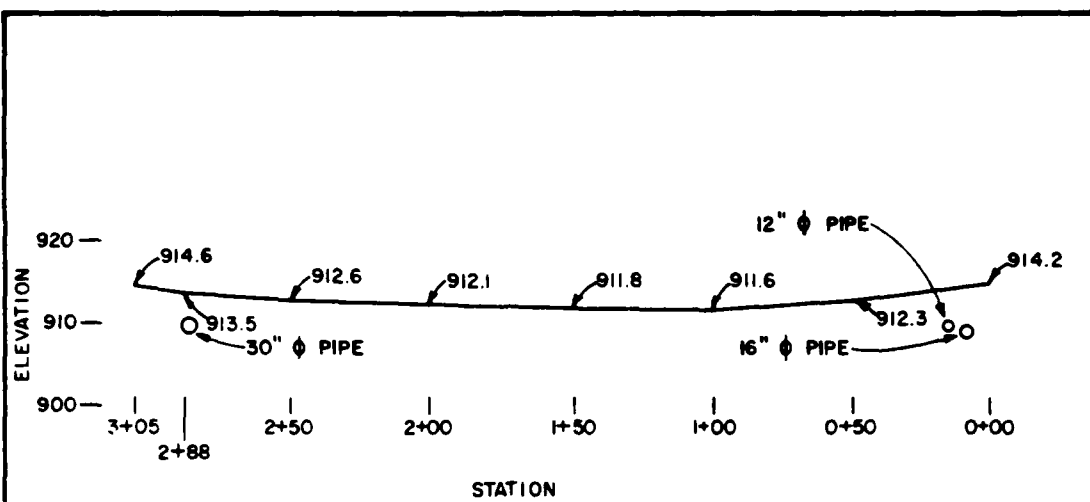
STATION
ELEVATION



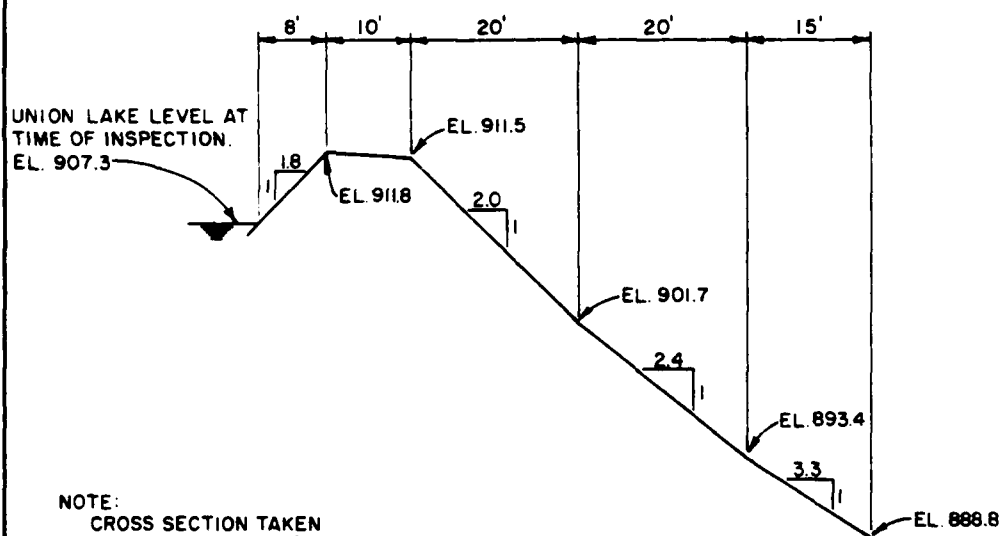
NOTE:
PLAN DATA OBTAINED
FROM FIELD SURVEY.



UNION LAKE DAM DAM PLAN



CREST PROFILE



NOTE:
CROSS SECTION TAKEN
NEAR STATION 1+60

CROSS SECTION

UNION LAKE DAM
DAM CREST PROFILE
DAM CROSS SECTION

LEGEND

① PHOTO NUMBER
& DIRECTION

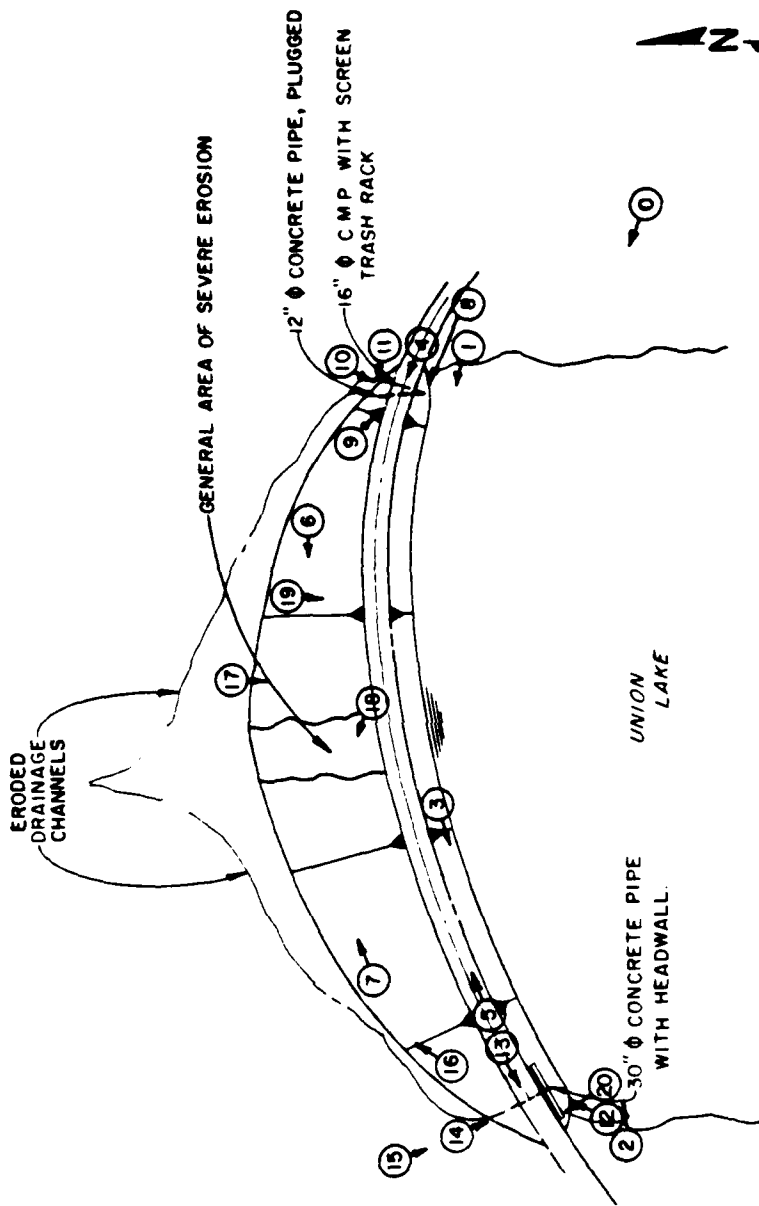


PHOTO 21: VIEW OF UPPER LAKE AND DAM
LOOKING DOWNSTREAM.

PHOTO 22: STREAM AND ROAD CROSSING
APPROXIMATELY 0.7 MILES
DOWNSTREAM OF DAM.

UNION LAKE DAM PHOTO INDEX

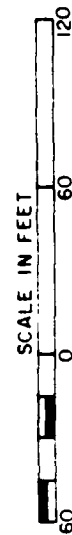




PHOTO 1: UPSTREAM FACE OF DAM LOOKING WEST



PHOTO 2: UPSTREAM FACE OF DAM LOOKING EAST



PHOTO 3: UPSTREAM FACE OF DAM, LEFT CENTER



PHOTO 4: CREST OF DAM LOOKING WEST



PHOTO 5: CREST OF DAM LOOKING EAST



PHOTO 6: DOWNSTREAM FACE OF DAM LOOKING WEST



PHOTO 7: DOWNSTREAM FACE OF DAM LOOKING EAST

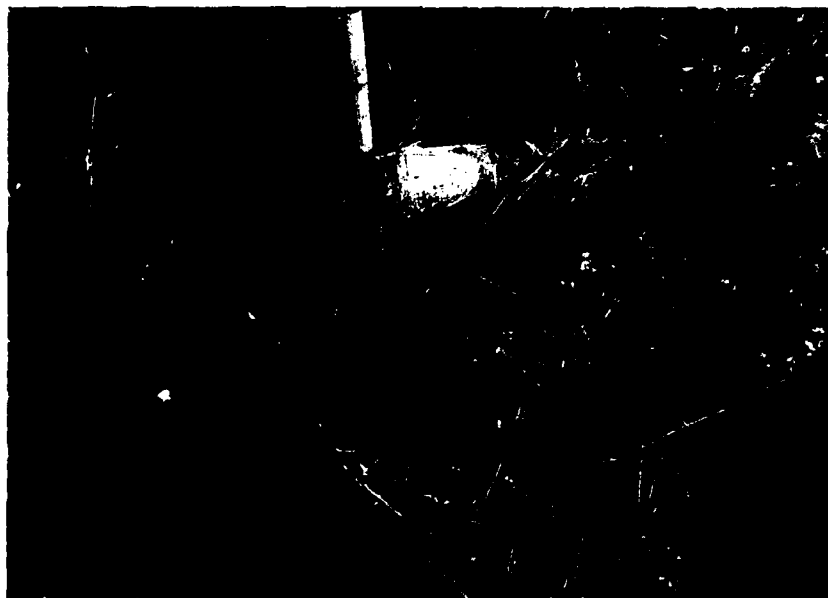


PHOTO 8: INLET END OF SECONDARY SPILLWAY PIPES, RIGHT END OF DAM

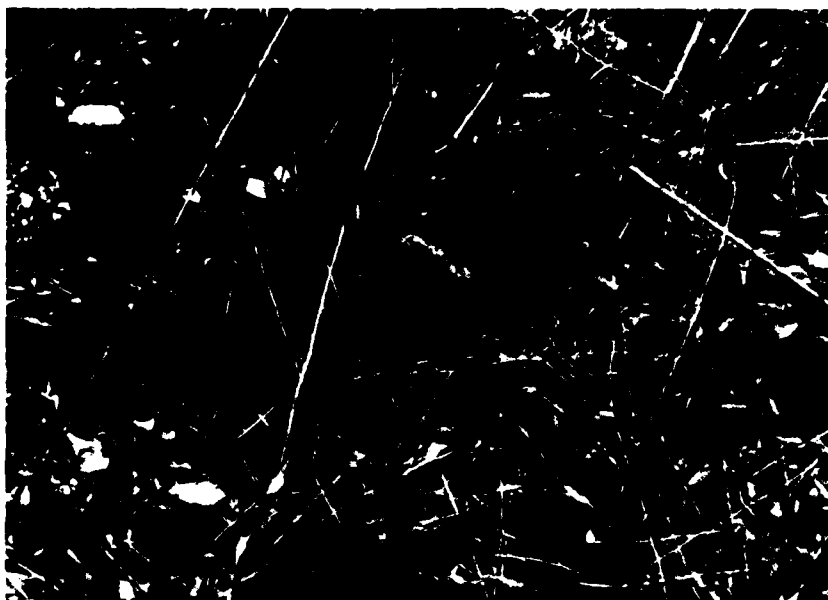


PHOTO 9: OUTLET END OF CONCRETE PIPE, RIGHT END OF DAM



PHOTO 10: OUTLET END OF CORRUGATED METAL PIPE, RIGHT END OF DAM

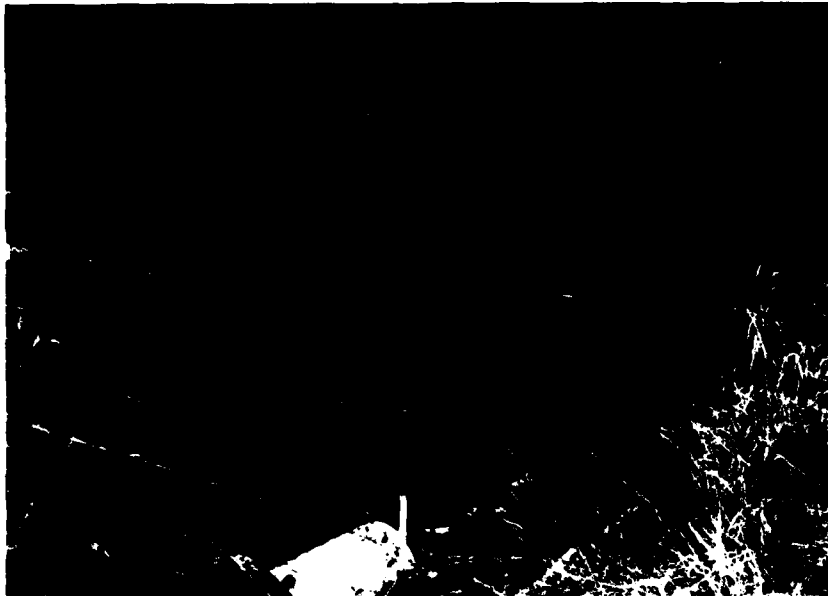


PHOTO 11: CHANNEL DOWNSTREAM OF CORRUGATED METAL PIPE,
RIGHT END OF DAM



PHOTO 12: INLET END OF PRIMARY SPILLWAY PIPE AT LEFT END OF DAM



PHOTO 13: SINK HOLE IN CREST AT SEPARATED JOINT IN PRIMARY SPILLWAY
PIPE

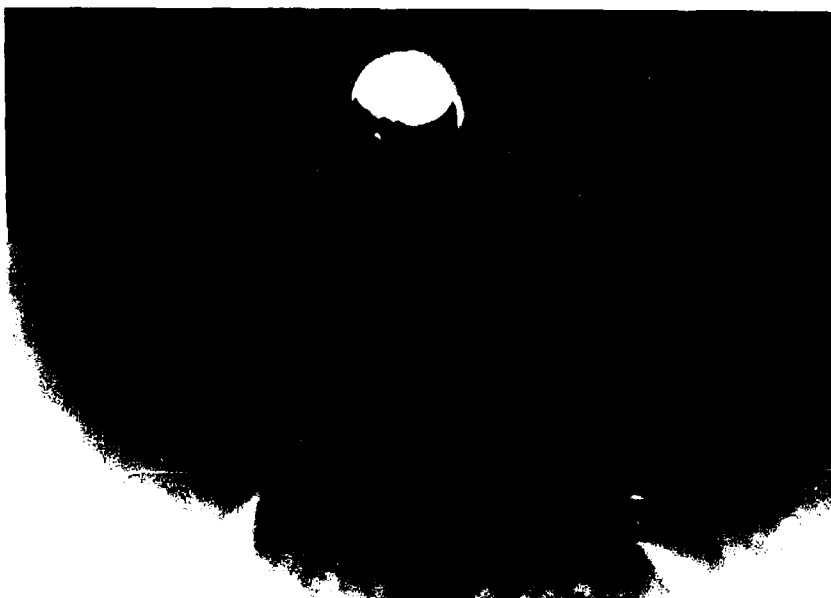


PHOTO 14: VIEW THROUGH PRIMARY SPILLWAY PIPE FROM DOWNSTREAM END



PHOTO 15: OUTLET END OF PRIMARY SPILLWAY PIPE AT LEFT END OF DAM



PHOTO 16: CHANNEL DOWNSTREAM OF PRIMARY SPILLWAY PIPE



PHOTO 17: EROSION ON DOWNSTREAM FACE OF DAM, RIGHT CENTER



PHOTO 18: EROSION ON DOWNSTREAM FACE OF DAM, RIGHT CENTER

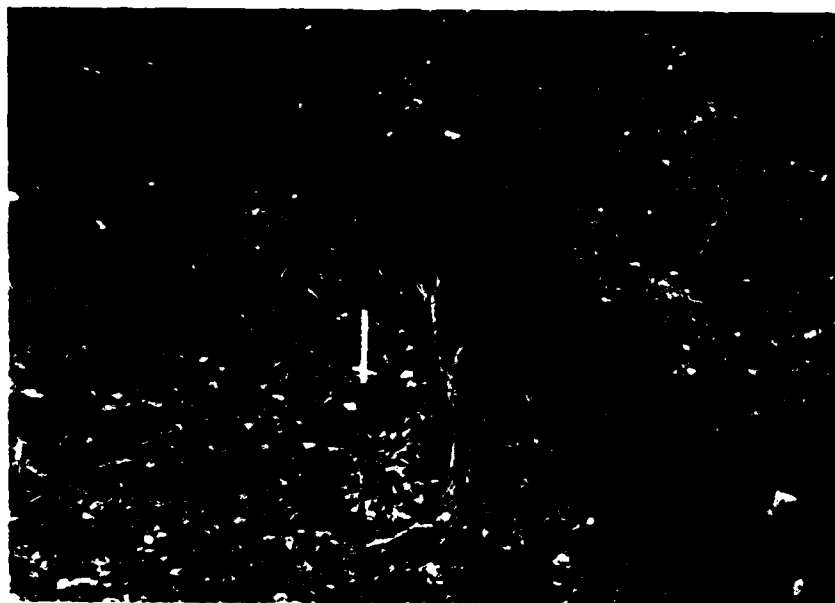


PHOTO 19: TEST PIT ON DOWNSTREAM EMBANKMENT SLOPE, TOE

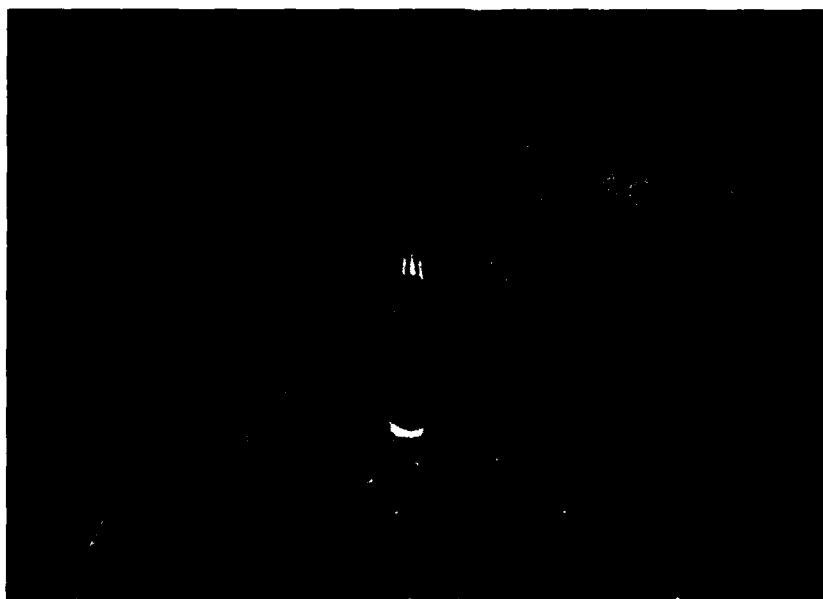


PHOTO 20: EROSION AT LEFT SIDE CONCRETE PRIMARY SPILLWAY HEADWALL



PHOTO 21: OVERVIEW OF UPPER LAKE AND DAM



PHOTO 22: VALLEY DOWNSTREAM OF DAM

APPENDIX A
HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC ANALYSES

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to synthetic unit hydrographs to develop the inflow hydrographs for Union Lake Dam and the upstream reservoir. The inflow hydrographs were then routed through the reservoirs and spillways. The overtopping analysis was determined using the computer program HEC-1 (Dam Safety Version) (1).

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33" (HMR-33) (2). Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm was determined according to the procedures outlined in HMR-33 and EM 1110-2-1411 (3). The Kansas City, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corps of Engineers, was used when the one and 10 percent chance probability floods were routed through the reservoirs and spillways.

The synthetic unit hydrographs for the watersheds were developed by the computer program using the Soil Conservation Service (SCS) method (1, 5). The parameters for the unit hydrographs are shown in Table 1. Lag time and time of concentration was calculated by two different methods. The results used in the analyses was obtained by using the Kerpich formula.

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used and the result from the computer output are shown in Table 2.

Storms were routed through the two reservoirs noted above. Routing through the reservoirs was performed using the modified Puls Method. The initial reservoir pool elevations for the routing of each storm were determined to be equivalent to the invert elevations of the primary spillways in accordance with antecedent storm conditions AMC II and AMC III preceding the one and ten percent probability and probable maximum storms as outlined by the U.S. Army Corps of Engineers, St. Louis District (4). The hydraulic capacity of the spillways and the storage capacities of the reservoirs were defined by the elevation, surface area, storage, and discharge relationships shown in Table 3.

The rating curves for the spillways are shown in Table 4. The flow over the crests of the dams was determined using the nonlevel dam crest option (\$L and \$V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir. The flow through the primary and secondary spillways was determined from nomographs for pipe culverts with inlet control. The 12-inch diameter secondary spillway in the lower lake was blocked with dirt and debris and was not used in the analysis.

Where routings through the upstream reservoir resulted in overtopping of that structure, a breach analysis was performed using HEC-1. The breaching parameters are noted in Table 5.

The results of the routing and breach analyses indicate that a flood equivalent to a maximum of 10 percent of the PMF will not overtop Union Lake Dam.

A summary of the routing analysis for different ratios of the PMF is shown in Table 6.

The computer input data and a summary of the output data are presented at the back of this appendix.

TABLE 1
SYNTHETIC UNIT HYDROGRAPH

<u>Parameters:</u>	Upper Dam	Lower Dam**
Drainage Area (A)	31 acres	30 acres
Lag Time (L_g)	0.085 hours	0.09 hours
Time of Concentration (T_c)	0.14 hours	0.15 hours
Duration (D)	5 minutes	5 minutes

Unit Hydrograph Ordinates
Discharge (cfs)*

<u>Time (Min.)*</u>	Upper Dam	Lower Dam
0	0	0
5	139	120
10	156	152
15	54	58
20	19	21
25	6	8
30	2	3
35	1	1

* From HEC-1 Computer Output.

** Excludes Controlled Drainage Area Upstream.

FORMULAS USED:

$$T_c = (11.9 L^3/H)^{0.385}$$

$$L_g = 0.6 T_c$$

$$D = 0.133 T_c$$

TABLE 2
RAINFALL-RUNOFF VALUES

<u>Selected Storm Event</u>	<u>Storm Duration (Hours)</u>	<u>Rainfall (Inches)</u>	<u>Runoff (Inches)</u>	<u>Loss (Inches)</u>
Upper Dam PMP	24	32.50	30.01	2.49
Lower Dam PMP	24	32.50	30.01	2.49
Upper Dam 100 yr.	24	7.59	3.57	4.02
Lower Dam 100 yr.	24	7.59	3.57	4.02

Additional Data:

- 1) 100 Percent of Drainage Area in Hydrologic Soil Group B(7).
60 Percent of the Land Use was Urban.
30 Percent of the Land Use was Timberland.
10 Percent of the Land Use was Grassland.
- 2) SCS Runoff Curve CN = 82 (AMC III) Lower Lake Dam
82 (AMC III) Upper Lake Dam
for the PMF (5).
- 3) SCS Runoff Curve CN = 65 (AMC II) Lower Lake Dam
65 (AMC II) Upper Lake Dam
for the one and 10 percent probability floods (5).

TABLE 3

ELEVATION, SURFACE AREA, STORAGE, AND DISCHARGE RELATIONSHIPS

<u>Elevation (feet-MSL)</u>	<u>Lake Surface Area (acres)</u>	<u>Lake Storage (acre-ft)</u>	<u>Spillway Discharge (cfs)</u>
Lower Lake Dam			
*909.2	4	30	0
**909.5	4	31	0
***911.6	4.4	40	30
Upper Lake Dam			
*922.3	1	4	0
**926.5	1.3	9	13

*Primary spillway invert elevation
 **Secondary spillway invert elevation
 ***Top of dam elevation

The relationships in Table 3 were developed from the Independence, Missouri. 7.5 minute quadrangle map, field measurements, and engineering documents provided by Shafer, Kline, and Warren, P.A.

TABLE 4
SPILLWAY RATING CURVES

<u>Reservoir Elevation (ft-msl)</u>	<u>Primary Spillway Discharge (cfs)</u>	<u>Secondary Spillway Discharge (cfs)</u>	<u>Total Spillway Discharge (cfs)</u>
Lower Lake Dam			
*909.2	0	0	0
909.5	0	0	0
910.3	11.3	4.3	15.6
**911.6	24	7.3	30.0
914	49	11	60
916	61	14	75
Upper Lake Dam			
*922.3	0	-	0
924.0	6.8	-	6.8
**926.5	13.2	-	13.2
927.0	14.5	-	14.5
929.0	18.0	-	18.0
931.0	20.0	-	20.0

*Primary Spillway Invert Elevation

**Top of Dam Elevation

METHOD USED:

Primary and Secondary Spillway Release Rates are based on Nomographs for a Pipe Culvert with Inlet Control (6).

TABLE 5

BREACHING PARAMETERS

	Upper Dam
Bottom Width of Breach (BRWID)	10 feet
Side Slope of Breach (z) (In feet horizontal to 1.0 feet vertical)	0.5
Elevation of Breach Bottom at Maximum Size of Breach (ELBM)	913.5 ft. m.s.l.
Time for Breach to Develop to Maximum Size (TFAIL)	1.0 hour
Elevation of Water Surface Which Will Cause Dam to Fail (FAILEL)	926.5 ft. m.s.l.

TABLE 6

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam
-	0	*909.2	30	0	-
0.10	73	910.5	35	17	0
0.15	226	912.3	43	174	0.7
0.50	658	912.9	46	571	1.3
1.00	1,302	913.4	48	1,195	1.8

* Primary Spillway Inlet Elevation

BIBLIOGRAPHY

- (1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Modification April 1980, Davis, California.
- (2) HMR 33, Seasonal Variations of Probable Maximum Precipitation, East of the 105th Meridian for Areas 10 to 1000 Square Miles and Durations from 6 to 48 Hours, U.S. Department of Commerce, NOAA, National Weather Service, 1956.
- (3) EM-1110-2-1411, Standard Project Flood Determinations, U.S. Army Corps of Engineers, 26 March 1952.
- (4) U.S. Army Corps of Engineers, St. Louis District, Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams, 22 August 1980.
- (5) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.
- (6) U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Charts For The Selection Of Highway Culverts, December 1965.
- (7) Mid-America Regional Council, Regional Soils Guide for Kansas City Area, March 1976.

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

Shafer, Kline and Warren, P.A., Design Report for Union Lakes Kansas City, Missouri.

Boring Logs from Woodward-Clyde Consultants, Summary of Laboratory Test Data, November 8, 1979.

National Flood Insurance Program, City of Kansas City, Missouri, U.S. Department of Housing and Urban Development, Community-Panel Number 2901730095A, September 29, 1978.

UNION LAKE
 UNION LAKE DAM - PPE

UNION LAKE DAM INSPECTION PROGRAM
 S. LUDIN DISTRICT US ARMY CORPS OF ENGR.

JOE SPECIFICATION									
NAME	UNIT	IMP	IMP	IMP	IMP	IMP	IMP	IMP	IMP
JOE	1	1	1	1	1	1	1	1	1
JOE	2	2	2	2	2	2	2	2	2
JOE	3	3	3	3	3	3	3	3	3
JOE	4	4	4	4	4	4	4	4	4
JOE	5	5	5	5	5	5	5	5	5

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 1 NPLAN= 9 LPLAN= 1

PTICS= .10 .15 .20 .25 .30 .35 .40 .50 .55 1.00

SUP-AREA RUNOFF COMPUTATION

UNION LAKE INFLOW HYDROGRAPH FOR UPPER DAM

ISTD	ICPP	IECN	ITAP	JFLT	JPRY	ISAP	ISAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME
1	2	3	4	5	6	7	8	9

FEELIP DATA

TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME
1	2	3	4	5	6	7	8	9

LOSS DATA

TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME	TIME
1	2	3	4	5	6	7	8	9

CHANGE NO = 10.00 METHOD = 1.00 EFFECT CN = 12.00

UNIT HYDROGRAPH DATA

TC= .00 LAG= .00

RECESSION DATA

RTION= 1.00

TIME TO RISE TO LAG= (TIME TO LAG/2)

TIME TO RISE TO LAG= (TIME TO LAG/2) 1.00 MOUN. LAG= .00 VOL= 1.00

TIME	DATE	PERIOD	RAIN	LOSS	END-OF-PERIOD FLOW	COMP Q	PERIOD	RAIN	LOSS	COMP Q
1	12-01	1	.01	.00	1.01	0	12-05	.21	.19	.41
2	12-01	2	.01	.00	1.01	0	12-10	.21	.19	.62
3	12-01	3	.01	.00	1.01	0	12-15	.21	.19	.82
4	12-01	4	.01	.00	1.01	0	12-20	.21	.19	.97
5	12-01	5	.01	.00	1.01	0	12-25	.21	.19	1.17
6	12-01	6	.01	.00	1.01	0	12-30	.21	.19	1.37
7	12-01	7	.01	.00	1.01	0	12-35	.21	.19	1.57
8	12-01	8	.01	.00	1.01	0	12-40	.21	.19	1.77
9	12-01	9	.01	.00	1.01	0	12-45	.21	.19	1.97
10	12-01	10	.01	.00	1.01	0	12-50	.21	.19	2.17
11	12-01	11	.01	.00	1.01	0	12-55	.21	.19	2.37
12	12-01	12	.01	.00	1.01	0	13-00	.21	.19	2.57
13	12-01	13	.01	.00	1.01	0	13-05	.21	.19	2.77
14	12-01	14	.01	.00	1.01	0	13-10	.21	.19	2.97
15	12-01	15	.01	.00	1.01	0	13-15	.21	.19	3.17
16	12-01	16	.01	.00	1.01	0	13-20	.21	.19	3.37
17	12-01	17	.01	.00	1.01	0	13-25	.21	.19	3.57
18	12-01	18	.01	.00	1.01	0	13-30	.21	.19	3.77
19	12-01	19	.01	.00	1.01	0	13-35	.21	.19	3.97
20	12-01	20	.01	.00	1.01	0	13-40	.21	.19	4.17
21	12-01	21	.01	.00	1.01	0	13-45	.21	.19	4.37
22	12-01	22	.01	.00	1.01	0	13-50	.21	.19	4.57
23	12-01	23	.01	.00	1.01	0	13-55	.21	.19	4.77
24	12-01	24	.01	.00	1.01	0	14-00	.21	.19	4.97
25	12-01	25	.01	.00	1.01	0	14-05	.21	.19	5.17
26	12-01	26	.01	.00	1.01	0	14-10	.21	.19	5.37
27	12-01	27	.01	.00	1.01	0	14-15	.21	.19	5.57
28	12-01	28	.01	.00	1.01	0	14-20	.21	.19	5.77
29	12-01	29	.01	.00	1.01	0	14-25	.21	.19	5.97
30	12-01	30	.01	.00	1.01	0	14-30	.21	.19	6.17
31	12-01	31	.01	.00	1.01	0	14-35	.21	.19	6.37
32	12-01	32	.01	.00	1.01	0	14-40	.21	.19	6.57
33	12-01	33	.01	.00	1.01	0	14-45	.21	.19	6.77
34	12-01	34	.01	.00	1.01	0	14-50	.21	.19	6.97
35	12-01	35	.01	.00	1.01	0	14-55	.21	.19	7.17
36	12-01	36	.01	.00	1.01	0	15-00	.21	.19	7.37
37	12-01	37	.01	.00	1.01	0	15-05	.21	.19	7.57
38	12-01	38	.01	.00	1.01	0	15-10	.21	.19	7.77
39	12-01	39	.01	.00	1.01	0	15-15	.21	.19	7.97
40	12-01	40	.01	.00	1.01	0	15-20	.21	.19	8.17
41	12-01	41	.01	.00	1.01	0	15-25	.21	.19	8.37
42	12-01	42	.01	.00	1.01	0	15-30	.21	.19	8.57
43	12-01	43	.01	.00	1.01	0	15-35	.21	.19	8.77
44	12-01	44	.01	.00	1.01	0	15-40	.21	.19	8.97
45	12-01	45	.01	.00	1.01	0	15-45	.21	.19	9.17
46	12-01	46	.01	.00	1.01	0	15-50	.21	.19	9.37
47	12-01	47	.01	.00	1.01	0	15-55	.21	.19	9.57
48	12-01	48	.01	.00	1.01	0	16-00	.21	.19	9.77
49	12-01	49	.01	.00	1.01	0	16-05	.21	.19	9.97
50	12-01	50	.01	.00	1.01	0	16-10	.21	.19	10.17
51	12-01	51	.01	.00	1.01	0	16-15	.21	.19	10.37
52	12-01	52	.01	.00	1.01	0	16-20	.21	.19	10.57
53	12-01	53	.01	.00	1.01	0	16-25	.21	.19	10.77

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. 84

1. "FOR PLAN 1. BY 10 6"

[illegible]

HYDROGRAPHIC SURVING

RECEIVED
JAN 10 1964
U.S. DEPT. OF JUSTICE
FEDERAL BUREAU OF INVESTIGATION
WASHINGTON, D.C.

| ITEM | COUP | REF | STAGE | JULY | JUNE | STAGE | ITEM |
|--------------|------|-----|-------|------|------|-------|------|
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| ROUTING DATA | | | | | | | |

DECLASSIFICATION

PROJECT C687 DATE 30 DEC 90 PAGE 9
PROGRAM M21-2-1V TIME 16:20:12 CASE DEF

| CLASS | AVG | TPS | ISME | IOPT | IPPP | LSTR |
|-------|-----|-----|------|------|------|------|
| 0.0 | 0.0 | 1 | 1 | 0 | 0 | 0 |

| | | | | | |
|-------|-------|--------|--------|--------|--------|
| TRAIL | 26.00 | 927.00 | 968.00 | 931.00 | 931.00 |
| FLY | 0.00 | 4.00 | 16.00 | 18.00 | 20.00 |

[illegible]

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | 2055 | 2056 | 2057 | 2058 | 2059 | 2060 | 2061 | 2062 | 2063 | 2064 | 2065 | 2066 | 2067 | 2068 | 2069 | 2070 | 2071 | 2072 | 2073 | 2074 | 2075 | 2076 | 2077 | 2078 | 2079 | 2080 | 2081 | 2082 | 2083 | 2084 | 2085 | 2086 | 2087 | 2088 | 2089 | 2090 | 2091 | 2092 | 2093 | 2094 | 2095 | 2096 | 2097 | 2098 | 2099 | 2100 | 2101 | 2102 | 2103 | 2104 | 2105 | 2106 | 2107 | 2108 | 2109 | 2110 | 2111 | 2112 | 2113 | 2114 | 2115 | 2116 | 2117 | 2118 | 2119 | 2120 | 2121 | 2122 | 2123 | 2124 | 2125 | 2126 | 2127 | 2128 | 2129 | 2130 | 2131 | 2132 | 2133 | 2134 | 2135 | 2136 | 2137 | 2138 | 2139 | 2140 | 2141 | 2142 | 2143 | 2144 | 2145 | 2146 | 2147 | 2148 | 2149 | 2150 | 2151 | 2152 | 2153 | 2154 | 2155 | 2156 | 2157 | 2158 | 2159 | 2160 | 2161 | 2162 | 2163 | 2164 | 2165 | 2166 | 2167 | 2168 | 2169 | 2170 | 2171 | 2172 | 2173 | 2174 | 2175 | 2176 | 2177 | 2178 | 2179 | 2180 | 2181 | 2182 | 2183 | 2184 | 2185 | 2186 | 2187 | 2188 | 2189 | 2190 | 2191 | 2192 | 2193 | 2194 | 2195 | 2196 | 2197 | 2198 | 2199 | 2200 | 2201 | 2202 | 2203 | 2204 | 2205 | 2206 | 2207 | 2208 | 2209 | 2210 | 2211 | 2212 | 2213 | 2214 | 2215 | 2216 | 2217 | 2218 | 2219 | 2220 | 2221 | 2222 | 2223 | 2224 | 2225 | 2226 | 2227 | 2228 | 2229 | 2230 | 2231 | 2232 | 2233 | 2234 | 2235 | 2236 | 2237 | 2238 | 2239 | 2240 | 2241 | 2242 | 2243 | 2244 | 2245 | 2246 | 2247 | 2248 | 2249 | 2250 | 2251 | 2252 | 2253 | 2254 | 2255 | 2256 | 2257 | 2258 | 2259 | 2260 | 2261 | 2262 | 2263 | 2264 | 2265 | 2266 | 2267 | 2268 | 2269 | 2270 | 2271 | 2272 | 2273 | 2274 | 2275 | 2276 | 2277 | 2278 | 2279 | 2280 | 2281 | 2282 | 2283 | 2284 | 2285 | 2286 | 2287 | 2288 | 2289 | 2290 | 2291 | 2292 | 2293 | 2294 | 2295 | 2296 | 2297 | 2298 | 2299 | 2300 | 2301 | 2302 | 2303 | 2304 | 2305 | 2306 | 2307 | 2308 | 2309 | 2310 | 2311 | 2312 | 2313 | 2314 | 2315 | 2316 | 2317 | 2318 | 2319 | 2320 | 2321 | 2322 | 2323 | 2324 | 2325 | 2326 | 2327 | 2328 | 2329 | 2330 | 2331 | 2332 | 2333 | 2334 | 2335 | 2336 | 2337 | 2338 | 2339 | 2340 | 2341 | 2342 | 2343 | 2344 | 2345 | 2346 | 2347 | 2348 | 2349 | 2350 | 2351 | 2352 | 2353 | 2354 | 2355 | 2356 | 2357 | 2358 | 2359 | 2360 | 2361 | 2362 | 2363 | 2364 | 2365 | 2366 | 2367 | 2368 | 2369 | 2370 | 2371 | 2372 | 2373 | 2374 | 2375 | 2376 | 2377 | 2378 | 2379 | 2380 | 2381 | 2382 | 2383 | 2384 | 2385 | 2386 | 2387 | 2388 | 2389 | 2390 | 2391 | 2392 | 2393 | 2394 | 2395 | 2396 | 2397 | 2398 | 2399 | 2400 | 2401 | 2402 | 2403 | 2404 | 2405 | 2406 | 2407 | 2408 | 2409 | 2410 | 2411 | 2412 | 2413 | 2414 | 2415 | 2416 | 2417 | 2418 | 2419 | 2420 | 2421 | 2422 | 2 |
|--|------|---|
|--|------|---|

[illegible]

| | |
|-------|-----------|
| TYPEL | NAME DATA |
| 920.5 | COOL -XPD |
| | DAVID |
| | 0.0 |

[illegible]

| DATE | DESCRIPTION | AMOUNT | BALANCE |
|------|-------------|--------|---------|
| 1950 | | | |
| 10 | PAID | 1.00 | 1.00 |
| 11 | PAID | 1.00 | 2.00 |
| 12 | PAID | 1.00 | 3.00 |
| 13 | PAID | 1.00 | 4.00 |
| 14 | PAID | 1.00 | 5.00 |
| 15 | PAID | 1.00 | 6.00 |
| 16 | PAID | 1.00 | 7.00 |
| 17 | PAID | 1.00 | 8.00 |
| 18 | PAID | 1.00 | 9.00 |
| 19 | PAID | 1.00 | 10.00 |
| 20 | PAID | 1.00 | 11.00 |
| 21 | PAID | 1.00 | 12.00 |
| 22 | PAID | 1.00 | 13.00 |
| 23 | PAID | 1.00 | 14.00 |
| 24 | PAID | 1.00 | 15.00 |
| 25 | PAID | 1.00 | 16.00 |
| 26 | PAID | 1.00 | 17.00 |
| 27 | PAID | 1.00 | 18.00 |
| 28 | PAID | 1.00 | 19.00 |
| 29 | PAID | 1.00 | 20.00 |
| 30 | PAID | 1.00 | 21.00 |
| 31 | PAID | 1.00 | 22.00 |
| 32 | PAID | 1.00 | 23.00 |
| 33 | PAID | 1.00 | 24.00 |
| 34 | PAID | 1.00 | 25.00 |
| 35 | PAID | 1.00 | 26.00 |
| 36 | PAID | 1.00 | 27.00 |
| 37 | PAID | 1.00 | 28.00 |
| 38 | PAID | 1.00 | 29.00 |
| 39 | PAID | 1.00 | 30.00 |
| 40 | PAID | 1.00 | 31.00 |
| 41 | PAID | 1.00 | 32.00 |
| 42 | PAID | 1.00 | 33.00 |
| 43 | PAID | 1.00 | 34.00 |
| 44 | PAID | 1.00 | 35.00 |
| 45 | PAID | 1.00 | 36.00 |
| 46 | PAID | 1.00 | 37.00 |
| 47 | PAID | 1.00 | 38.00 |
| 48 | PAID | 1.00 | 39.00 |
| 49 | PAID | 1.00 | 40.00 |
| 50 | PAID | 1.00 | 41.00 |
| 51 | PAID | 1.00 | 42.00 |
| 52 | PAID | 1.00 | 43.00 |
| 53 | PAID | 1.00 | 44.00 |
| 54 | PAID | 1.00 | 45.00 |
| 55 | PAID | 1.00 | 46.00 |
| 56 | PAID | 1.00 | 47.00 |
| 57 | PAID | 1.00 | 48.00 |
| 58 | PAID | 1.00 | 49.00 |
| 59 | PAID | 1.00 | 50.00 |
| 60 | PAID | 1.00 | 51.00 |
| 61 | PAID | 1.00 | 52.00 |
| 62 | PAID | 1.00 | 53.00 |
| 63 | PAID | 1.00 | 54.00 |
| 64 | PAID | 1.00 | 55.00 |
| 65 | PAID | 1.00 | 56.00 |
| 66 | PAID | 1.00 | 57.00 |
| 67 | PAID | 1.00 | 58.00 |
| 68 | PAID | 1.00 | 59.00 |
| 69 | PAID | 1.00 | 60.00 |
| 70 | PAID | 1.00 | 61.00 |
| 71 | PAID | 1.00 | 62.00 |
| 72 | PAID | 1.00 | 63.00 |
| 73 | PAID | 1.00 | 64.00 |
| 74 | PAID | 1.00 | 65.00 |
| 75 | PAID | 1.00 | 66.00 |
| 76 | PAID | 1.00 | 67.00 |
| 77 | PAID | 1.00 | 68.00 |
| 78 | PAID | 1.00 | 69.00 |
| 79 | PAID | 1.00 | 70.00 |
| 80 | PAID | 1.00 | 71.00 |
| 81 | PAID | 1.00 | 72.00 |
| 82 | PAID | 1.00 | 73.00 |
| 83 | PAID | 1.00 | 74.00 |
| 84 | PAID | 1.00 | 75.00 |
| 85 | PAID | 1.00 | 76.00 |
| 86 | PAID | 1.00 | 77.00 |
| 87 | PAID | 1.00 | 78.00 |
| 88 | PAID | 1.00 | 79.00 |
| 89 | PAID | 1.00 | 80.00 |
| 90 | PAID | 1.00 | 81.00 |
| 91 | PAID | 1.00 | 82.00 |
| 92 | PAID | 1.00 | 83.00 |
| 93 | PAID | 1.00 | 84.00 |
| 94 | PAID | 1.00 | 85.00 |
| 95 | PAID | 1.00 | 86.00 |
| 96 | PAID | 1.00 | 87.00 |
| 97 | PAID | 1.00 | 88.00 |
| 98 | PAID | 1.00 | 89.00 |
| 99 | PAID | 1.00 | 90.00 |
| 100 | PAID | 1.00 | 91.00 |
| 101 | PA | | |

| | | | | | | |
|------|-------|-----|-----|-----|-----|-----|
| 1.01 | 17.15 | 211 | .23 | .02 | .00 | 84. |
| 1.01 | 17.40 | 212 | .23 | .02 | .00 | 84. |
| 1.01 | 17.45 | 213 | .23 | .02 | .00 | 84. |
| 1.01 | 17.50 | 214 | .23 | .02 | .00 | 84. |
| 1.01 | 17.55 | 215 | .23 | .02 | .00 | 84. |
| 1.01 | 18.00 | 216 | .23 | .02 | .00 | 84. |
| 1.01 | 18.05 | 217 | .23 | .02 | .00 | 84. |
| 1.01 | 18.10 | 218 | .23 | .02 | .00 | 84. |
| 1.01 | 18.15 | 219 | .23 | .02 | .00 | 84. |
| 1.01 | 18.20 | 220 | .23 | .02 | .00 | 84. |
| 1.01 | 18.25 | 221 | .23 | .02 | .00 | 84. |
| 1.01 | 18.30 | 222 | .23 | .02 | .00 | 84. |
| 1.01 | 18.35 | 223 | .23 | .02 | .00 | 84. |
| 1.01 | 18.40 | 224 | .23 | .02 | .00 | 84. |
| 1.01 | 18.45 | 225 | .23 | .02 | .00 | 84. |
| 1.01 | 18.50 | 226 | .23 | .02 | .00 | 84. |
| 1.01 | 18.55 | 227 | .23 | .02 | .00 | 84. |
| 1.01 | 19.00 | 228 | .23 | .02 | .00 | 84. |
| 1.01 | 19.05 | 229 | .23 | .02 | .00 | 84. |
| 1.01 | 19.10 | 230 | .23 | .02 | .00 | 84. |
| 1.01 | 19.15 | 231 | .23 | .02 | .00 | 84. |
| 1.01 | 19.20 | 232 | .23 | .02 | .00 | 84. |
| 1.01 | 19.25 | 233 | .23 | .02 | .00 | 84. |
| 1.01 | 19.30 | 234 | .23 | .02 | .00 | 84. |
| 1.01 | 19.35 | 235 | .23 | .02 | .00 | 84. |
| 1.01 | 19.40 | 236 | .23 | .02 | .00 | 84. |
| 1.01 | 19.45 | 237 | .23 | .02 | .00 | 84. |
| 1.01 | 19.50 | 238 | .23 | .02 | .00 | 84. |
| 1.01 | 19.55 | 239 | .23 | .02 | .00 | 84. |
| 1.01 | 20.00 | 240 | .23 | .02 | .00 | 84. |
| 1.01 | 20.05 | 241 | .23 | .02 | .00 | 84. |
| 1.01 | 20.10 | 242 | .23 | .02 | .00 | 84. |
| 1.01 | 20.15 | 243 | .23 | .02 | .00 | 84. |
| 1.01 | 20.20 | 244 | .23 | .02 | .00 | 84. |
| 1.01 | 20.25 | 245 | .23 | .02 | .00 | 84. |
| 1.01 | 20.30 | 246 | .23 | .02 | .00 | 84. |
| 1.01 | 20.35 | 247 | .23 | .02 | .00 | 84. |
| 1.01 | 20.40 | 248 | .23 | .02 | .00 | 84. |
| 1.01 | 20.45 | 249 | .23 | .02 | .00 | 84. |
| 1.01 | 20.50 | 250 | .23 | .02 | .00 | 84. |
| 1.01 | 20.55 | 251 | .23 | .02 | .00 | 84. |
| 1.01 | 21.00 | 252 | .23 | .02 | .00 | 84. |
| 1.01 | 21.05 | 253 | .23 | .02 | .00 | 84. |
| 1.01 | 21.10 | 254 | .23 | .02 | .00 | 84. |
| 1.01 | 21.15 | 255 | .23 | .02 | .00 | 84. |
| 1.01 | 21.20 | 256 | .23 | .02 | .00 | 84. |
| 1.01 | 21.25 | 257 | .23 | .02 | .00 | 84. |
| 1.01 | 21.30 | 258 | .23 | .02 | .00 | 84. |
| 1.01 | 21.35 | 259 | .23 | .02 | .00 | 84. |
| 1.01 | 21.40 | 260 | .23 | .02 | .00 | 84. |
| 1.01 | 21.45 | 261 | .23 | .02 | .00 | 84. |
| 1.01 | 21.50 | 262 | .23 | .02 | .00 | 84. |
| 1.01 | 21.55 | 263 | .23 | .02 | .00 | 84. |
| 1.01 | 22.00 | 264 | .23 | .02 | .00 | 84. |
| 1.01 | 22.05 | 265 | .23 | .02 | .00 | 84. |
| 1.01 | 22.10 | 266 | .23 | .02 | .00 | 84. |
| 1.01 | 22.15 | 267 | .23 | .02 | .00 | 84. |
| 1.01 | 22.20 | 268 | .23 | .02 | .00 | 84. |
| 1.01 | 22.25 | 269 | .23 | .02 | .00 | 84. |
| 1.01 | 22.30 | 270 | .23 | .02 | .00 | 84. |
| 1.01 | 22.35 | 271 | .23 | .02 | .00 | 84. |
| 1.01 | 22.40 | 272 | .23 | .02 | .00 | 84. |
| 1.01 | 22.45 | 273 | .23 | .02 | .00 | 84. |
| 1.01 | 22.50 | 274 | .23 | .02 | .00 | 84. |
| 1.01 | 22.55 | 275 | .23 | .02 | .00 | 84. |
| 1.01 | 23.00 | 276 | .23 | .02 | .00 | 84. |
| 1.01 | 23.05 | 277 | .23 | .02 | .00 | 84. |
| 1.01 | 23.10 | 278 | .23 | .02 | .00 | 84. |
| 1.01 | 23.15 | 279 | .23 | .02 | .00 | 84. |
| 1.01 | 23.20 | 280 | .23 | .02 | .00 | 84. |
| 1.01 | 23.25 | 281 | .23 | .02 | .00 | 84. |
| 1.01 | 23.30 | 282 | .23 | .02 | .00 | 84. |
| 1.01 | 23.35 | 283 | .23 | .02 | .00 | 84. |
| 1.01 | 23.40 | 284 | .23 | .02 | .00 | 84. |
| 1.01 | 23.45 | 285 | .23 | .02 | .00 | 84. |
| 1.01 | 23.50 | 286 | .23 | .02 | .00 | 84. |
| 1.01 | 23.55 | 287 | .23 | .02 | .00 | 84. |
| 1.01 | 24.00 | 288 | .23 | .02 | .00 | 84. |
| 1.01 | 24.05 | 289 | .23 | .02 | .00 | 84. |
| 1.01 | 24.10 | 290 | .23 | .02 | .00 | 84. |
| 1.01 | 24.15 | 291 | .23 | .02 | .00 | 84. |
| 1.01 | 24.20 | 292 | .23 | .02 | .00 | 84. |
| 1.01 | 24.25 | 293 | .23 | .02 | .00 | 84. |
| 1.01 | 24.30 | 294 | .23 | .02 | .00 | 84. |
| 1.01 | 24.35 | 295 | .23 | .02 | .00 | 84. |
| 1.01 | 24.40 | 296 | .23 | .02 | .00 | 84. |
| 1.01 | 24.45 | 297 | .23 | .02 | .00 | 84. |
| 1.01 | 24.50 | 298 | .23 | .02 | .00 | 84. |
| 1.01 | 24.55 | 299 | .23 | .02 | .00 | 84. |
| 1.01 | 25.00 | 300 | .23 | .02 | .00 | 84. |

PLAN 1 V E A T I O N
FLOOD HYDROGRAPH PACKAGE - MICH-1

| TIME | 12.45 | 13.00 | 13.15 | 13.30 | 13.45 | 14.00 | 14.15 | 14.30 | 14.45 | 15.00 | 15.15 | 15.30 | 15.45 | 16.00 | 16.15 | 16.30 | 16.45 | 17.00 | 17.15 | 17.30 | 17.45 | 18.00 | 18.15 | 18.30 | 18.45 | 19.00 | 19.15 | 19.30 | 19.45 | 20.00 | 20.15 | 20.30 | 20.45 | 21.00 | 21.15 | 21.30 | 21.45 | 22.00 | 22.15 | 22.30 | 22.45 | 23.00 | 23.15 | 23.30 | 23.45 | 24.00 | 24.15 | 24.30 | 24.45 | 25.00 | 25.15 | 25.30 | 25.45 | 26.00 | 26.15 | 26.30 | 26.45 | 27.00 | 27.15 | 27.30 | 27.45 | 28.00 | 28.15 | 28.30 | 28.45 | 29.00 | 29.15 | 29.30 | 29.45 | 30.00 | 30.15 | 30.30 | 30.45 | 31.00 | 31.15 | 31.30 | 31.45 | 32.00 | 32.15 | 32.30 | 32.45 | 33.00 | 33.15 | 33.30 | 33.45 | 34.00 | 34.15 | 34.30 | 34.45 | 35.00 | 35.15 | 35.30 | 35.45 | 36.00 | 36.15 | 36.30 | 36.45 | 37.00 | 37.15 | 37.30 | 37.45 | 38.00 | 38.15 | 38.30 | 38.45 | 39.00 | 39.15 | 39.30 | 39.45 | 40.00 | 40.15 | 40.30 | 40.45 | 41.00 | 41.15 | 41.30 | 41.45 | 42.00 | 42.15 | 42.30 | 42.45 | 43.00 | 43.15 | 43.30 | 43.45 | 44.00 | 44.15 | 44.30 | 44.45 | 45.00 | 45.15 | 45.30 | 45.45 | 46.00 | 46.15 | 46.30 | 46.45 | 47.00 | 47.15 | 47.30 | 47.45 | 48.00 | 48.15 | 48.30 | 48.45 | 49.00 | 49.15 | 49.30 | 49.45 | 50.00 | 50.15 | 50.30 | 50.45 | 51.00 | 51.15 | 51.30 | 51.45 | 52.00 | 52.15 | 52.30 | 52.45 | 53.00 | 53.15 | 53.30 | 53.45 | 54.00 | 54.15 | 54.30 | 54.45 | 55.00 | 55.15 | 55.30 | 55.45 | 56.00 | 56.15 | 56.30 | 56.45 | 57.00 | 57.15 | 57.30 | 57.45 | 58.00 | 58.15 | 58.30 | 58.45 | 59.00 | 59.15 | 59.30 | 59.45 | 60.00 | 60.15 | 60.30 | 60.45 | 61.00 | 61.15 | 61.30 | 61.45 | 62.00 | 62.15 | 62.30 | 62.45 | 63.00 | 63.15 | 63.30 | 63.45 | 64.00 | 64.15 | 64.30 | 64.45 | 65.00 | 65.15 | 65.30 | 65.45 | 66.00 | 66.15 | 66.30 | 66.45 | 67.00 | 67.15 | 67.30 | 67.45 | 68.00 | 68.15 | 68.30 | 68.45 | 69.00 | 69.15 | 69.30 | 69.45 | 70.00 | 70.15 | 70.30 | 70.45 | 71.00 | 71.15 | 71.30 | 71.45 | 72.00 | 72.15 | 72.30 | 72.45 | 73.00 | 73.15 | 73.30 | 73.45 | 74.00 | 74.15 | 74.30 | 74.45 | 75.00 | 75.15 | 75.30 | 75.45 | 76.00 | 76.15 | 76.30 | 76.45 | 77.00 | 77.15 | 77.30 | 77.45 | 78.00 | 78.15 | 78.30 | 78.45 | 79.00 | 79.15 | 79.30 | 79.45 | 80.00 | 80.15 | 80.30 | 80.45 | 81.00 | 81.15 | 81.30 | 81.45 | 82.00 | 82.15 | 82.30 | 82.45 | 83.00 | 83.15 | 83.30 | 83.45 | 84.00 | 84.15 | 84.30 | 84.45 | 85.00 | 85.15 | 85.30 | 85.45 | 86.00 | 86.15 | 86.30 | 86.45 | 87.00 | 87.15 | 87.30 | 87.45 | 88.00 | 88.15 | 88.30 | 88.45 | 89.00 | 89.15 | 89.30 | 89.45 | 90.00 | 90.15 | 90.30 | 90.45 | 91.00 | 91.15 | 91.30 | 91.45 | 92.00 | 92.15 | 92.30 | 92.45 | 93.00 | 93.15 | 93.30 | 93.45 | 94.00 | 94.15 | 94.30 | 94.45 | 95.00 | 95.15 | 95.30 | 95.45 | 96.00 | 96.15 | 96.30 | 96.45 | 97.00 | 97.15 | 97.30 | 97.45 | 98.00 | 98.15 | 98.30 | 98.45 | 99.00 | 99.15 | 99.30 | 99.45 | 100.00 | 100.15 | 100.30 | 100.45 | 101.00 | 101.15 | 101.30 | 101.45 | 102.00 | 102.15 | 102.30 | 102.45 | 103.00 | 103.15 | 103.30 | 103.45 | 104.00 | 104.15 | 104.30 | 104.45 | 105.00 | 105.15 | 105.30 | 105.45 | 106.00 | 106.15 | 106.30 | 106.45 | 107.00 | 107.15 | 107.30 | 107.45 | 108.00 | 108.15 | 108.30 | 108.45 | 109.00 | 109.15 | 109.30 | 109.45 | 110.00 | 110.15 | 110.30 | 110.45 | 111.00 | 111.15 | 111.30 | 111.45 | 112.00 | 112.15 | 112.30 | 112.45 | 113.00 | 113.15 | 113.30 | 113.45 | 114.00 | 114.15 | 114.30 | 114.45 | 115.00 | 115.15 | 115.30 | 115.45 | 116.00 | 116.15 | 116.30 | 116.45 | 117.00 | 117.15 | 117.30 | 117.45 | 118.00 | 118.15 | 118.30 | 118.45 | 119.00 | 119.15 | 119.30 | 119.45 | 120.00 | 120.15 | 120.30 | 120.45 | 121.00 | 121.15 | 121.30 | 121.45 | 122.00 | 122.15 | 122.30 | 122.45 | 123.00 | 123.15 | 123.30 | 123.45 | 124.00 | 124.15 | 124.30 | 124.45 | 125.00 | 125.15 | 125.30 | 125.45 | 126.00 | 126.15 | 126.30 | 126.45 | 127.00 | 127.15 | 127.30 | 127.45 | 128.00 | 128.15 | 128.30 | 128.45 | 129.00 | 129.15 | 129.30 | 129.45 | 130.00 | 130.15 | 130.30 | 130.45 | 131.00 | 131.15 | 131.30 | 131.45 | 132.00 | 132.15 | 132.30 | 132.45 | 133.00 | 133.15 | 133.30 | 133.45 | 134.00 | 134.15 | 134.30 | 134.45 | 135.00 | 135.15 | 135.30 | 135.45 | 136.00 | 136.15 | 136.30 | 136.45 | 137.00 | 137.15 | 137.30 | 137.45 | 138.00 | 138.15 | 138.30 | 138.45 | 139.00 | 139.15 | 139.30 | 139.45 | 140.00 | 140.15 | 140.30 | 140.45 | 141.00 | 141.15 | 141.30 | 141.45 | 142.00 | 142.15 | 142.30 | 142.45 | 143.00 | 143.15 | 143.30 | 143.45 | 144.00 | 144.15 | 144.30 | 144.45 | 145.00 | 145.15 | 145.30 | 145.45 | 146.00 | 146.15 | 146.30 | 146.45 | 147.00 | 147.15 | 147.30 | 147.45 | 148.00 | 148.15 | 148.30 | 148.45 | 149.00 | 149.15 | 149.30 | 149.45 | 150.00 | 150.15 | 150.30 | 150.45 | 151.00 | 151.15 | 151.30 | 151.45 | 152.00 | 152.15 | 152.30 | 152.45 | 153.00 | 153.15 | 153.30 | 153.45 | 154.00 | 154.15 | 154.30 | 154.45 | 155.00 | 155.15 | 155.30 | 155.45 | 156.00 | 156.15 | 156.30 | 156.45 | 157.00 | 157.15 | 157.30 | 157.45 | 158.00 | 158.15 | 158.30 | 158.45 | 159.00 | 159.15 | 159.30 | 159.45 | 160.00 | 160.15 | 160.30 | 160.45 | 161.00 | 161.15 | 161.30 | 161.45 | 162.00 | 162.15 | 162.30 | 162.45 | 163.00 | 163.15 | 163.30 | 163.45 | 164.00 | 164.15 | 164.30 | 164.45 | 165.00 | 165.15 | 165.30 | 165.45 | 166.00 | 166.15 | 166.30 | 166.45 | 167.00 | 167.15 | 167.30 | 167.45 | 168.00 | 168.15 | 168.30 | 168.45 | 169.00 | 169.15 | 169.30 | 169.45 | 170.00 | 170.15 | 170.30 | 170.45 | 171.00 | 171.15 | 171.30 | 171.45 | 172.00 | 172.15 | 172.30 | 172.45 | 173.00 | 173.15 | 173.30 | 173.45 | 174.00 | 174.15 | 174.30 | 174.45 | 175.00 | 175.15 | 175.30 | 175.45 | 176.00 | 176.15 | 176.30 | 176.45 | 177.00 | 177.15 | 177.30 | 177.45 | 178.00 | 178.15 | 178.30 | 178.45 | 179.00 | 179.15 | 179.30 | 179.45 | 180.00 | 180.15 | 180.30 | 180.45 | 181.00 | 181.15 | 181.30 | 181.45 | 182.00 | 182.15 | 182.30 | 182.45 | 183.00 | 183.15 | 183.30 | 183.45 | 184.00 | 184.15 | 184.30 | 184.45 | 185.00 | 185.15 | 185.30 | 185.45 | 186.00 | 186.15 | 186.30 | 186.45 | 187.00 | 187.15 | 187.30 | 187.45 | 188.00 | 188.15 | 188.30 | 188.45 | 189.00 | 189.15 | 189.30 | 189.45 | 190.00 | 190.15 | 190.30 | 190.45 | 191.00 | 191.15 | 191.30 | 191.45 | 192.00 | 192.15 | 192.30 | 192.45 | 193.00 | 193.15 | 193.30 | 193.45 | 194.00 | 194.15 | 194.30 | 194.45 | 195.00 | 195.15 | 195.30 | 195.45 | 196.00 | 196.15 | 196.30 | 196.45 | 197.00 | 197.15 | 197.30 | 197.45 | 198.00 | 198.15 | 198.30 | 198.45 | 199.00 | 199.15 | 199.30 | 199.45 | 200.00 | 200.15 | 200.30 | 200.45 | 201.00 | 201.15 | 201.30 | 201.45 | 202.00 | 202.15 | 202.30 | 202.45 | 203.00 | 203.15 | 203.30 | 203.45 | 204.00 | 204.15 | 204.30 | 204.45 | 205.00 | 205.15 | 205.30 | 205.45 | 206.00 | 206.15 | 206.30 | 206.45 | 207.00 | 207.15 | 207.30 | 207.45 | 208.00 | 208.15 | 208.30 | 208.45 | 209.00 | 209.15 | 209.30 | 209.45 | 210.00 | 210.15 | 210.30 | 210.45 | 211.00 | 211.15 | 211.30 | 211.45 | 212.00 | 212.15 | 212.30 | 212.45 | 213.00 | 213.15 | 213.30 | 213.45 | 214.00 | 214.15 | 214.30 | 214.45 | 215.00 | 215.15 | 215.30 | 215.45 | 216.00 | 216.15 | 216.30 | 216.45 | 217.00 | 217.15 | 217.30 | 217.45 | 218.00 | 218.15 | 218.30 | 218.45 | 219.00 | 219.15 | 219.30 | 219.45 | 220.00 | 220.15 | 220.30 | 220.45 | 221.00 | 221.15 | 221.30 | 221.45 | 222.00 | 222.15 | 222.30 | 222.45 | 223.00 | 223.15 | 223.30 | 223.45 | 224.00 | 224.15 | 224.30 | 224.45 | 225.00 | 225.15 | 225.30 | 225.45 | 226.00 | 226.15 | 226.30 | 226.45 | 227.00 | 227.15 | 227.30 | 227.45 | 228.00 | 228.15 | 228.30 | 228.45 | 229.00 | 229.15 | 229.30 | 229.45 | 230.00 | 230.15 | 230.30 | 230.45 | 231.00 | 231.15 | 231.30 | 231.45 | 232.00 | 232.15 | 232.30 | 232.45 | 233.00 | 233.15 | 233.30 | 233.45 | 234.00 | 234.15 | 234.30 | 234.45 | 235.00 | 235.15 | 235.30 | 235.45 | 236.00 | 236.15 | 236.30 | 236.45 | 237.00 | 237.15 | 237.30 | 237.45 | 238.00 | 238.15 | 238.30 | 238.45 | 239.00 | 239.15 | 239.30 | 239.45 | 240.00 | 240.15 | 240.30 | 240.45 | 241.00 | 241.15 | 241.30 | 241.45 | 242.00 | 242.15 | 242.30 | 242.45 | 243.00 | 243.15 | 243.30 | 243.45 | 244.00 | 244.15 | 244.30 | 244.45 | 245.00 | 245.15 | 245.30 | 245.45 | 246.00 | 246.15 | 246.30 | 246.45 | 247.00 | 247.15 | 247.30 | 247.45 | 248.00 | 248.15 | 248.30 | 248.45 | 249.00 | 249.15 | 249.30 | 249.45 | 250.00 | 250.15 | 250.30 | 250.45 | 251.00 | 251.15 | 251.30 | 251.45 | 252.00 | 252.15 | 252.30 | 252.45 | 253.00 | 253.15 | 253.30 | 253.45 | 254.00 | 254.15 | 254.30 | 254.45 | 255.00 | 255.15 | 255.30 | 255.45 | 256.00 | 256.15 | 256.30 | 256.45 | 257.00 | 257.15 | 257.30 | 257.45 | 258.00 | 258.15 | 258.30 | 258.45 | 259.00 | 259.15 | 259.30 | 259.45 | 260.00 | 260.15 | 260.30 | 260.45 | 261.00 | 261.15 | 261.30 | 261.45 | 262.00 | 262.15 | 262.30 | 262.45 | 263.00 | 263.15 | 263.30 | 263.45 | 264.00 | 264.15 | 264.30 | 264.45 | 265.00 | 265.15 | 265.30 | 265.45 | 266.00 | 266.15 | 266.30 | 266.45 | 267.00 | 267.15 | 267.30 | 267.45 | 268.00 | 268.15 | 268.30 | 268.45 | 269.00 | 269.15 | 269.30 | 269.45 | 270.00 | 270.15 | 270.30 | 270.45 | 271.00 | 271.15 | 271.30 | 271.45 | 272.00 | 272.15 | 272.30 | 272.45 | 273.00 | 273.15 | 273.30 | 273.45 | 274.00 | 274.15 | 274.30 | 274.45 | 275.00 | 275.15 | 275.30 | 275.45 | 276.00 | 276.15 | 276.30 | 276.45 | 277.00 | 277.15 | 277.30 | 277.45 | 278.00 | 278.15 | 278.30 | 278.45 | 279.00 | 279.15 | 279.30 | 279.45 | 280.00 | 280.15 | 280.30 | 280.45 | 281.00 | 281.15 | 281.30 | 281.45 | 282.00 | 282.15 | 282.30 | 282.45 | 283.00 | 283.15 | 283.30 | 283.45 | 284.00 | 284.15 | 284.30 | 284.45 | 285.00 | 285.15 | 285.30 | 285.45 | 286.00 | 286.15 | 286.30 | 286.45 | 287.00 | 287.15 | 287.30 | 287.45 | 288.00 | 288.15 | 288.30 | 288.45 | 289.00 | 289.15 | 289.30 | 289.45 | 290.00 | 290.15 | 290.30 | 290.45 | 291.00 | 291.15 | 291.30 | 291.45 | 292.00 | 292.15 | 292.30 | 292.45 | 293.00 | 293.15 | 293.30 | 293.45 | 294.00 | 294.15 | 294.30 | 294.45 | 295.00 | 295.15 | 295.30 | 295.45 | 296.00 | 296.15 | 296.30 | 296.45 | 297.00 | 297.15 | 297.30 | 297.4 |
|------|--------|-------|
|------|--------|-------|

| PEAK | 6-M-CPD | 2,6-M-CPD | 7,8-M-CPD | TOTAL |
|------|---------|-----------|-----------|-------|
| 1 | 2.0 | 2.0 | 70 | 22.60 |
| 2 | 1.0 | 7 | 2 | 6.40 |
| 3 | 1.0 | 1 | 2 | 6.40 |
| 4 | 1.0 | 1.5 | 2.0 | 3.72 |
| 5 | 1.0 | 1.0 | 7.0 | 26.01 |
| 6 | 1.0 | 1.0 | 157 | 157 |
| 7 | 1.0 | 1.0 | 104 | 104 |

.....

.....

.....

.....

.....

ADJUTANT GENERAL'S OFFICE
WASHINGTON, D. C.

| EXTAS | ECOP | RECOY | TRAPE | SPLIT | JDDY | IMAGE | ISTAGE | IAUTO |
|--------------|------|-------|-------|-------|------|-------|--------|-------|
| 5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| ROUTING DATA | | | | | | | | |
| CO'S | AVG | RES | ECOE | ECOP | IPDP | | ISIA | |
| .. | .. | | 1 | 0 | 0 | | 0 | |

214

```
PROJECT 09457      DATE 30 DEC 80      PAGE 30
=====
PROJECT 02470-1V    TIME 14:26:10    CASE 001
```

| DATE | TIME | LOCATION | WIND | WAVE | SEA | TEMP | WIND | WAVE | SEA | TEMP |
|----------|------|----------|------|------|-----|------|------|------|-----|------|
| 10/10/50 | 0800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 0900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 1000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 1100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 1200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 1300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 1400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 1500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 1600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 1700 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 1900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 2100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 2200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 2300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 2400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 2500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 2600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 2700 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 2800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 2900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 3000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 3100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 3200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 3300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 3400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 3500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 3600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 3700 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 3800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 3900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 4000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 4100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 4200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 4300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 4400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 4500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 4600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 4700 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 4800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 4900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/10/50 | 5000 | 0 | 0 | 0 | | | | | | |

[illegible]

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | 2055 | 2056 | 2057 | 2058 | 2059 | 2060 | 2061 | 2062 | 2063 | 2064 | 2065 | 2066 | 2067 | 2068 | 2069 | 2070 | 2071 | 2072 | 2073 | 2074 | 2075 | 2076 | 2077 | 2078 | 2079 | 2080 | 2081 | 2082 | 2083 | 2084 | 2085 | 2086 | 2087 | 2088 | 2089 | 2090 | 2091 | 2092 | 2093 | 2094 | 2095 | 2096 | 2097 | 2098 | 2099 | 2100 | 2101 | 2102 | 2103 | 2104 | 2105 | 2106 | 2107 | 2108 | 2109 | 2110 | 2111 | 2112 | 2113 | 2114 | 2115 | 2116 | 2117 | 2118 | 2119 | 2120 | 2121 | 2122 | 2123 | 2124 | 2125 | 2126 | 2127 | 2128 | 2129 | 2130 | 2131 | 2132 | 2133 | 2134 | 2135 | 2136 | 2137 | 2138 | 2139 | 2140 | 2141 | 2142 | 2143 | 2144 | 2145 | 2146 | 2147 | 2148 | 2149 | 2150 | 2151 | 2152 | 2153 | 2154 | 2155 | 2156 | 2157 | 2158 | 2159 | 2160 | 2161 | 2162 | 2163 | 2164 | 2165 | 2166 | 2167 | 2168 | 2169 | 2170 | 2171 | 2172 | 2173 | 2174 | 2175 | 2176 | 2177 | 2178 | 2179 | 2180 | 2181 | 2182 | 2183 | 2184 | 2185 | 2186 | 2187 | 2188 | 2189 | 2190 | 2191 | 2192 | 2193 | 2194 | 2195 | 2196 | 2197 | 2198 | 2199 | 2200 | 2201 | 2202 | 2203 | 2204 | 2205 | 2206 | 2207 | 2208 | 2209 | 2210 | 2211 | 2212 | 2213 | 2214 | 2215 | 2216 | 2217 | 2218 | 2219 | 2220 | 2221 | 2222 | 2223 | 2224 | 2225 | 2226 | 2227 | 2228 | 2229 | 2230 | 2231 | 2232 | 2233 | 2234 | 2235 | 2236 | 2237 | 2238 | 2239 | 2240 | 2241 | 2242 | 2243 | 2244 | 2245 | 2246 | 2247 | 2248 | 2249 | 2250 | 2251 | 2252 | 2253 | 2254 | 2255 | 2256 | 2257 | 2258 | 2259 | 2260 | 2261 | 2262 | 2263 | 2264 | 2265 | 2266 | 2267 | 2268 | 2269 | 2270 | 2271 | 2272 | 2273 | 2274 | 2275 | 2276 | 2277 | 2278 | 2279 | 2280 | 2281 | 2282 | 2283 | 2284 | 2285 | 2286 | 2287 | 2288 | 2289 | 2290 | 2291 | 2292 | 2293 | 2294 | 2295 | 2296 | 2297 | 2298 | 2299 | 2300 | 2301 | 2302 | 2303 | 2304 | 2305 | 2306 | 2307 | 2308 | 2309 | 2310 | 2311 | 2312 | 2313 | 2314 | 2315 | 2316 | 2317 | 2318 | 2319 | 2320 | 2321 | 2322 | 2323 | 2324 | 2325 | 2326 | 2327 | 2328 | 2329 | 2330 | 2331 | 2332 | 2333 | 2334 | 2335 | 2336 | 2337 | 2338 | 2339 | 2340 | 2341 | 2342 | 2343 | 2344 | 2345 | 2346 | 2347 | 2348 | 2349 | 2350 | 2351 | 2352 | 2353 | 2354 | 2355 | 2356 | 2357 | 2358 | 2359 | 2360 | 2361 | 2362 | 2363 | 2364 | 2365 | 2366 | 2367 | 2368 | 2369 | 2370 | 2371 | 2372 | 2373 | 2374 | 2375 | 2376 | 2377 | 2378 | 2379 | 2380 | 2381 | 2382 | 2383 | 2384 | 2385 | 2386 | 2387 | 2388 | 2389 | 2390 | 2391 | 2392 | 2393 | 2394 | 2395 | 2396 | 2397 | 2398 | 2399 | 2400 | 2401 | 2402 | 2403 | 2404 | 2405 | 2406 | 2407 | 2408 | 2409 | 2410 | 2411 | 2412 | 2413 | 2414 | 2415 | 2416 | 2417 | 2418 | 2419 | 2420 | 2421 | 2422 | 2 |
|--|------|---|
|--|------|---|

| DATE | TIME | LOCATION | WIND | SEA | WAVE | TEMP | WIND | SEA | WAVE | TEMP |
|------|------|----------|------|-----|------|------|------|-------|------|------|
| 1963 | 1000 | 71N13 | 40K | 500 | 01M5 | 20.0 | 1000 | 71N13 | 40K | 500 |

W. A. C. 327A

| TOREL | CSD | EXPD | DAWID |
|-------|-----|------|-------|
| 191.0 | 1.0 | 1.0 | 1.0 |

[illegible]

STATION
S. F. L. A. T. 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, 83

STANDARD FORM NO. 64

U.S. GOVERNMENT PRINTING OFFICE : 1970 O - 380-000

2000

Upper Dam

SUMMARY OF EDA SAFETY ANALYSIS

| | ELEVATION
STATION
OUTFLOW | INITIAL VALUE
922.10
7.0
0.0 | SPILLWAY CHEST
922.10
4.0
0.0 | TOP OF DAM
926.50
6.0
13.0 | | |
|--------------------|-----------------------------------|---------------------------------------|--|-------------------------------------|---------------------------------|-----------------------------|
| RATIO
OF
PM1 | PERCENT
REDUCTION
WAS-EL-19 | PERCENT
REDUCTION
OVER LIP | MAXIMUM
OUTFLOW
CMS | DURATION
OVER TOP
HOURS | TIME OF
MAX OUTFLOW
HOURS | TIME OF
FAILURE
HOURS |
| 1.0 | 0.0000 | 0.0 | 31.0 | 0.3 | 17.09 | 0.00 |
| 1.1 | 0.0000 | 0.0 | 31.0 | 0.3 | 16.46 | 15.23 |
| 1.2 | 0.0000 | 0.0 | 31.0 | 0.3 | 16.17 | 15.58 |
| 1.3 | 0.0000 | 0.0 | 31.0 | 0.3 | 15.84 | 15.88 |
| 1.4 | 0.0000 | 0.0 | 31.0 | 0.3 | 15.52 | 16.17 |
| 1.5 | 0.0000 | 0.0 | 31.0 | 0.3 | 15.27 | 16.46 |
| 1.6 | 0.0000 | 0.0 | 31.0 | 0.3 | 15.07 | 16.75 |
| 1.7 | 0.0000 | 0.0 | 31.0 | 0.3 | 14.87 | 17.04 |
| 1.8 | 0.0000 | 0.0 | 31.0 | 0.3 | 14.67 | 17.33 |
| 1.9 | 0.0000 | 0.0 | 31.0 | 0.3 | 14.47 | 17.62 |
| 2.0 | 0.0000 | 0.0 | 31.0 | 0.3 | 14.27 | 17.91 |
| 2.1 | 0.0000 | 0.0 | 31.0 | 0.3 | 14.07 | 18.20 |
| 2.2 | 0.0000 | 0.0 | 31.0 | 0.3 | 13.87 | 18.49 |
| 2.3 | 0.0000 | 0.0 | 31.0 | 0.3 | 13.67 | 18.78 |
| 2.4 | 0.0000 | 0.0 | 31.0 | 0.3 | 13.47 | 19.07 |
| 2.5 | 0.0000 | 0.0 | 31.0 | 0.3 | 13.27 | 19.36 |
| 2.6 | 0.0000 | 0.0 | 31.0 | 0.3 | 13.07 | 19.65 |
| 2.7 | 0.0000 | 0.0 | 31.0 | 0.3 | 12.87 | 19.94 |
| 2.8 | 0.0000 | 0.0 | 31.0 | 0.3 | 12.67 | 20.23 |
| 2.9 | 0.0000 | 0.0 | 31.0 | 0.3 | 12.47 | 20.52 |
| 3.0 | 0.0000 | 0.0 | 31.0 | 0.3 | 12.27 | 20.81 |
| 3.1 | 0.0000 | 0.0 | 31.0 | 0.3 | 12.07 | 21.10 |
| 3.2 | 0.0000 | 0.0 | 31.0 | 0.3 | 11.87 | 21.39 |
| 3.3 | 0.0000 | 0.0 | 31.0 | 0.3 | 11.67 | 21.68 |
| 3.4 | 0.0000 | 0.0 | 31.0 | 0.3 | 11.47 | 21.97 |
| 3.5 | 0.0000 | 0.0 | 31.0 | 0.3 | 11.27 | 22.26 |
| 3.6 | 0.0000 | 0.0 | 31.0 | 0.3 | 11.07 | 22.55 |
| 3.7 | 0.0000 | 0.0 | 31.0 | 0.3 | 10.87 | 22.84 |
| 3.8 | 0.0000 | 0.0 | 31.0 | 0.3 | 10.67 | 23.13 |
| 3.9 | 0.0000 | 0.0 | 31.0 | 0.3 | 10.47 | 23.42 |
| 4.0 | 0.0000 | 0.0 | 31.0 | 0.3 | 10.27 | 23.71 |
| 4.1 | 0.0000 | 0.0 | 31.0 | 0.3 | 10.07 | 24.00 |
| 4.2 | 0.0000 | 0.0 | 31.0 | 0.3 | 9.87 | 24.29 |
| 4.3 | 0.0000 | 0.0 | 31.0 | 0.3 | 9.67 | 24.58 |
| 4.4 | 0.0000 | 0.0 | 31.0 | 0.3 | 9.47 | 24.87 |
| 4.5 | 0.0000 | 0.0 | 31.0 | 0.3 | 9.27 | 25.16 |
| 4.6 | 0.0000 | 0.0 | 31.0 | 0.3 | 9.07 | 25.45 |
| 4.7 | 0.0000 | 0.0 | 31.0 | 0.3 | 8.87 | 25.74 |
| 4.8 | 0.0000 | 0.0 | 31.0 | 0.3 | 8.67 | 26.03 |
| 4.9 | 0.0000 | 0.0 | 31.0 | 0.3 | 8.47 | 26.32 |
| 5.0 | 0.0000 | 0.0 | 31.0 | 0.3 | 8.27 | 26.61 |
| 5.1 | 0.0000 | 0.0 | 31.0 | 0.3 | 8.07 | 26.90 |
| 5.2 | 0.0000 | 0.0 | 31.0 | 0.3 | 7.87 | 27.19 |
| 5.3 | 0.0000 | 0.0 | 31.0 | 0.3 | 7.67 | 27.48 |
| 5.4 | 0.0000 | 0.0 | 31.0 | 0.3 | 7.47 | 27.77 |
| 5.5 | 0.0000 | 0.0 | 31.0 | 0.3 | 7.27 | 28.06 |
| 5.6 | 0.0000 | 0.0 | 31.0 | 0.3 | 7.07 | 28.35 |
| 5.7 | 0.0000 | 0.0 | 31.0 | 0.3 | 6.87 | 28.64 |
| 5.8 | 0.0000 | 0.0 | 31.0 | 0.3 | 6.67 | 28.93 |
| 5.9 | 0.0000 | 0.0 | 31.0 | 0.3 | 6.47 | 29.22 |
| 6.0 | 0.0000 | 0.0 | 31.0 | 0.3 | 6.27 | 29.51 |
| 6.1 | 0.0000 | 0.0 | 31.0 | 0.3 | 6.07 | 29.80 |
| 6.2 | 0.0000 | 0.0 | 31.0 | 0.3 | 5.87 | 30.09 |
| 6.3 | 0.0000 | 0.0 | 31.0 | 0.3 | 5.67 | 30.38 |
| 6.4 | 0.0000 | 0.0 | 31.0 | 0.3 | 5.47 | 30.67 |
| 6.5 | 0.0000 | 0.0 | 31.0 | 0.3 | 5.27 | 30.96 |
| 6.6 | 0.0000 | 0.0 | 31.0 | 0.3 | 5.07 | 31.25 |
| 6.7 | 0.0000 | 0.0 | 31.0 | 0.3 | 4.87 | 31.54 |
| 6.8 | 0.0000 | 0.0 | 31.0 | 0.3 | 4.67 | 31.83 |
| 6.9 | 0.0000 | 0.0 | 31.0 | 0.3 | 4.47 | 32.12 |
| 7.0 | 0.0000 | 0.0 | 31.0 | 0.3 | 4.27 | 32.41 |
| 7.1 | 0.0000 | 0.0 | 31.0 | 0.3 | 4.07 | 32.70 |
| 7.2 | 0.0000 | 0.0 | 31.0 | 0.3 | 3.87 | 32.99 |
| 7.3 | 0.0000 | 0.0 | 31.0 | 0.3 | 3.67 | 33.28 |
| 7.4 | 0.0000 | 0.0 | 31.0 | 0.3 | 3.47 | 33.57 |
| 7.5 | 0.0000 | 0.0 | 31.0 | 0.3 | 3.27 | 33.86 |
| 7.6 | 0.0000 | 0.0 | 31.0 | 0.3 | 3.07 | 34.15 |
| 7.7 | 0.0000 | 0.0 | 31.0 | 0.3 | 2.87 | 34.44 |
| 7.8 | 0.0000 | 0.0 | 31.0 | 0.3 | 2.67 | 34.73 |
| 7.9 | 0.0000 | 0.0 | 31.0 | 0.3 | 2.47 | 35.02 |
| 8.0 | 0.0000 | 0.0 | 31.0 | 0.3 | 2.27 | 35.31 |
| 8.1 | 0.0000 | 0.0 | 31.0 | 0.3 | 2.07 | 35.60 |
| 8.2 | 0.0000 | 0.0 | 31.0 | 0.3 | 1.87 | 35.89 |
| 8.3 | 0.0000 | 0.0 | 31.0 | 0.3 | 1.67 | 36.18 |
| 8.4 | 0.0000 | 0.0 | 31.0 | 0.3 | 1.47 | 36.47 |
| 8.5 | 0.0000 | 0.0 | 31.0 | 0.3 | 1.27 | 36.76 |
| 8.6 | 0.0000 | 0.0 | 31.0 | 0.3 | 1.07 | 37.05 |
| 8.7 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.87 | 37.34 |
| 8.8 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.67 | 37.63 |
| 8.9 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.47 | 37.92 |
| 9.0 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.27 | 38.21 |
| 9.1 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.07 | 38.50 |
| 9.2 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.00 | 38.79 |
| 9.3 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.00 | 39.08 |
| 9.4 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.00 | 39.37 |
| 9.5 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.00 | 39.66 |
| 9.6 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.00 | 39.95 |
| 9.7 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.00 | 40.24 |
| 9.8 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.00 | 40.53 |
| 9.9 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.00 | 40.82 |
| 10.0 | 0.0000 | 0.0 | 31.0 | 0.3 | 0.00 | 41.11 |

SUMMARY OF EDA SAFETY ANALYSIS


```

=====
U L I M B V E A T C H P L C O M 6/27/02-9 1A0F
=====
LISTING OF INPUT DATA
=====
DATE 02 JUN 02 TIME 00:00:02
=====

```

[illegible]

W21 02-1 06457 -FF10) YR
MISSOURI DAP INFLECTION RECORD
ST. LOUIS DISTRICT IS ADVY CROSS RE ENGR.
UNION LAKE DAP - 100 YR

[illegible]

2000

2

21

REGULATED HYDROGRAPH THROUGH UPPER CAN.

—

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
84

9-776 5-
9-125
9-625
9-1-6
9-1-6

2.9

1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2190 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278 2279 2280 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293 2294 2295 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518 2519 2520 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533 2534 2535 2536 2537 2538 2539 2540 2541 2542 2543 2544 2545 2546 2547 2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560 2561 2562 2563 2564 2565 2566 2567 2568 2569 2570 2571 2572 2573 2574 2575 2576 2577 2578 2579 2580 2581 2582 2583 2584 2585 2586 2587 2588 2589 2590 2591 2592 2593 2594 2595 2596 2597 2598 2599 2600 2601 2602 2603 2604 2605 2606 2607 2608 2609 2610 2611 2612 2613 2614 2615 2616 2617 2618 2619 2620 2621 2622 2623 2624 2625 2626 2627 2628 2629 2630 2631 2632 2633 2634 2635 2636 2637 2638 2639 2640 2641 2642 2643 2644 2645 2646 2647 2648 2649 2650 2651 2652 2653 2654 2655 2656 2657 2658 2659 2660 2661 2662 2663 2664 2665 2666 2667 2668 2669 2670 2671 2672 2673 2674 2675 2676 2677 2678 2679 2680 2681 2682 2683 2684 2685 2686 2687 2688 2689 2690 2691 2692 2693 2694 2695 2696 2697 2698 2699 2700 2701 2702 2703 2704 2705 2706 2707 2708 2709 2710 2711 2712 2713 2714 2715 2716 2717 2718 2719 2720 2721 2722 2723 2724 2725 2726 2727 2728 2729 2730 2731 2732 2733 2734 2735 2736 2737 2738 2739 2740 2741 2742 2743 2744 2745 2746 2747 2748 2749 2750 2751 2752 2753 2754 2755 2756 2757 2758 2759 2760 2761 2762 2763 2764 2765 2766 2767 2768 2769 2770 2771 2772 2773 2774 2775 2776 2777 2778 2779 2780 2781 2782 2783 2784 2785 2786 2787 2788 2789 2790 2791 2792 2793 2794 2795 2796 2797 2798 2799 2800 2801 2802 2803 2804 2805 2806 2807 2808 2809

[illegible]

.....

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
84

[illegible]

三

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

... ..

1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

```

FLACK P V E A T C H      PAGE 2
LISTING OF INPUT DATA
*****
DATE 06 JAN 79 TIME 09:00:22
PROGRAM N01/2-1          PAGE 2
*****

```

[illegible]


```
P A C K   R   V   E   Y   C M      PAGE 1
LISTING OF INPUT DATA
JACOBSON 4-27-69
```

[illegible][illegible]

CASE, A SYSLIP-APP.
 FAC LARVING
 660200106000

WAG, R 3V58IP-007. -60200104200
TAC WASHINGTON

GASG, A SYSLIP, M21. 040200004600
FAC WADNINE

5450, T. 2.

65, 13.

5256, 740

—A56, 17.

6456, 195-

5A56.711.

EASU, T 17.

2AS6, 7 14.

Oct 1956, 15.

—XOF SYSLIF-01/007

1-201122-0124-487515 A41AR0

```
PLACK & LEATON PROJECT '64-7 DATE 02 JAN 64 PAGE 1
=====
FLOO HYDROGRAPH PACKAGE - HEC-1
PAGES 1-9 OF 19 TIME SC:10:40 CAL FOR
```



```

*****
* L A B O R C O N T R O L *
*****
PROJECT 06457          DATE 12 JAN 84    PAGE 1
*****
PROGRAM M2102-1V      TIME 00:13:40
*****
RELION M2102-1V       - YES-
*****

```

BLACK RIVER TCM
FLOOD HYDROGRAPH PACKAGE - MEC-1

PROJECT 05457
PROGRAM 421/22-IV

DATE 02 JAN 84
TIME 09:00:00

| | | | | | | | | | | | |
|------|------|-----|-----|-----|-----|------|-------|-----|-----|-----|-----|
| 1.01 | 7.00 | 85 | .01 | .00 | .01 | 1.01 | 19.75 | 259 | .01 | .00 | .00 |
| 1.01 | 7.10 | 86 | .01 | .00 | .01 | 1.01 | 19.75 | 270 | .01 | .00 | .00 |
| 1.01 | 7.15 | 87 | .01 | .00 | .01 | 1.01 | 19.75 | 281 | .01 | .00 | .00 |
| 1.01 | 7.20 | 88 | .01 | .00 | .01 | 1.01 | 19.75 | 292 | .01 | .00 | .00 |
| 1.01 | 7.25 | 89 | .01 | .00 | .01 | 1.01 | 19.75 | 303 | .01 | .00 | .00 |
| 1.01 | 7.30 | 90 | .01 | .00 | .01 | 1.01 | 19.75 | 314 | .01 | .00 | .00 |
| 1.01 | 7.35 | 91 | .01 | .00 | .01 | 1.01 | 19.75 | 325 | .01 | .00 | .00 |
| 1.01 | 7.40 | 92 | .01 | .00 | .01 | 1.01 | 19.75 | 336 | .01 | .00 | .00 |
| 1.01 | 7.45 | 93 | .01 | .00 | .01 | 1.01 | 19.75 | 347 | .01 | .00 | .00 |
| 1.01 | 7.50 | 94 | .01 | .00 | .01 | 1.01 | 19.75 | 358 | .01 | .00 | .00 |
| 1.01 | 7.55 | 95 | .01 | .00 | .01 | 1.01 | 19.75 | 369 | .01 | .00 | .00 |
| 1.01 | 7.60 | 96 | .01 | .00 | .01 | 1.01 | 19.75 | 380 | .01 | .00 | .00 |
| 1.01 | 7.65 | 97 | .01 | .00 | .01 | 1.01 | 19.75 | 391 | .01 | .00 | .00 |
| 1.01 | 7.70 | 98 | .01 | .00 | .01 | 1.01 | 19.75 | 402 | .01 | .00 | .00 |
| 1.01 | 7.75 | 99 | .01 | .00 | .01 | 1.01 | 19.75 | 413 | .01 | .00 | .00 |
| 1.01 | 7.80 | 100 | .01 | .00 | .01 | 1.01 | 19.75 | 424 | .01 | .00 | .00 |
| 1.01 | 7.85 | 101 | .01 | .00 | .01 | 1.01 | 19.75 | 435 | .01 | .00 | .00 |
| 1.01 | 7.90 | 102 | .01 | .00 | .01 | 1.01 | 19.75 | 446 | .01 | .00 | .00 |
| 1.01 | 7.95 | 103 | .01 | .00 | .01 | 1.01 | 19.75 | 457 | .01 | .00 | .00 |
| 1.01 | 8.00 | 104 | .01 | .00 | .01 | 1.01 | 19.75 | 468 | .01 | .00 | .00 |
| 1.01 | 8.05 | 105 | .01 | .00 | .01 | 1.01 | 19.75 | 479 | .01 | .00 | .00 |
| 1.01 | 8.10 | 106 | .01 | .00 | .01 | 1.01 | 19.75 | 490 | .01 | .00 | .00 |
| 1.01 | 8.15 | 107 | .01 | .00 | .01 | 1.01 | 19.75 | 501 | .01 | .00 | .00 |
| 1.01 | 8.20 | 108 | .01 | .00 | .01 | 1.01 | 19.75 | 512 | .01 | .00 | .00 |
| 1.01 | 8.25 | 109 | .01 | .00 | .01 | 1.01 | 19.75 | 523 | .01 | .00 | .00 |
| 1.01 | 8.30 | 110 | .01 | .00 | .01 | 1.01 | 19.75 | 534 | .01 | .00 | .00 |
| 1.01 | 8.35 | 111 | .01 | .00 | .01 | 1.01 | 19.75 | 545 | .01 | .00 | .00 |
| 1.01 | 8.40 | 112 | .01 | .00 | .01 | 1.01 | 19.75 | 556 | .01 | .00 | .00 |
| 1.01 | 8.45 | 113 | .01 | .00 | .01 | 1.01 | 19.75 | 567 | .01 | .00 | .00 |
| 1.01 | 8.50 | 114 | .01 | .00 | .01 | 1.01 | 19.75 | 578 | .01 | .00 | .00 |
| 1.01 | 8.55 | 115 | .01 | .00 | .01 | 1.01 | 19.75 | 589 | .01 | .00 | .00 |
| 1.01 | 8.60 | 116 | .01 | .00 | .01 | 1.01 | 19.75 | 600 | .01 | .00 | .00 |
| 1.01 | 8.65 | 117 | .01 | .00 | .01 | 1.01 | 19.75 | 611 | .01 | .00 | .00 |
| 1.01 | 8.70 | 118 | .01 | .00 | .01 | 1.01 | 19.75 | 622 | .01 | .00 | .00 |
| 1.01 | 8.75 | 119 | .01 | .00 | .01 | 1.01 | 19.75 | 633 | .01 | .00 | .00 |
| 1.01 | 8.80 | 120 | .01 | .00 | .01 | 1.01 | 19.75 | 644 | .01 | .00 | .00 |
| 1.01 | 8.85 | 121 | .01 | .00 | .01 | 1.01 | 19.75 | 655 | .01 | .00 | .00 |
| 1.01 | 8.90 | 122 | .01 | .00 | .01 | 1.01 | 19.75 | 666 | .01 | .00 | .00 |
| 1.01 | 8.95 | 123 | .01 | .00 | .01 | 1.01 | 19.75 | 677 | .01 | .00 | .00 |
| 1.01 | 9.00 | 124 | .01 | .00 | .01 | 1.01 | 19.75 | 688 | .01 | .00 | .00 |
| 1.01 | 9.05 | 125 | .01 | .00 | .01 | 1.01 | 19.75 | 699 | .01 | .00 | .00 |
| 1.01 | 9.10 | 126 | .01 | .00 | .01 | 1.01 | 19.75 | 710 | .01 | .00 | .00 |
| 1.01 | 9.15 | 127 | .01 | .00 | .01 | 1.01 | 19.75 | 721 | .01 | .00 | .00 |
| 1.01 | 9.20 | 128 | .01 | .00 | .01 | 1.01 | 19.75 | 732 | .01 | .00 | .00 |
| 1.01 | 9.25 | 129 | .01 | .00 | .01 | 1.01 | 19.75 | 743 | .01 | .00 | .00 |
| 1.01 | 9.30 | 130 | .01 | .00 | .01 | 1.01 | 19.75 | 754 | .01 | .00 | .00 |
| 1.01 | 9.35 | 131 | .01 | .00 | .01 | 1.01 | 19.75 | 765 | .01 | .00 | .00 |
| 1.01 | 9.40 | 132 | .01 | .00 | .01 | 1.01 | 19.75 | 776 | .01 | .00 | .00 |
| 1.01 | 9.45 | 133 | .01 | .00 | .01 | 1.01 | 19.75 | 787 | .01 | .00 | .00 |
| 1.01 | 9.50 | 134 | .01 | .00 | .01 | 1.01 | 19.75 | 798 | .01 | .00 | .00 |
| 1.01 | 9.55 | 135 | .01 | .00 | .01 | 1.01 | 19.75 | 809 | .01 | .00 | .00 |
| 1.01 | 9.60 | 136 | .01 | .00 | .01 | 1.01 | 19.75 | 820 | .01 | .00 | .00 |
| 1.01 | 9.65 | 137 | .01 | .00 | .01 | 1.01 | 19.75 | 831 | .01 | .00 | .00 |
| 1.01 | 9.70 | 138 | .01 | .00 | .01 | 1.01 | 19.75 | 842 | .01 | .00 | .00 |
| 1.01 | 9.75 | 139 | .01 | .00 | .01 | 1.01 | 19.75 | 853 | .01 | .00 | .00 |
| 1.01 | 9.80 | 140 | .01 | .00 | .01 | 1.01 | 19.75 | 864 | .01 | .00 | .00 |

BLACK RIVER TCM
FLOOD HYDROGRAPH PACKAGE - MEC-1

PROJECT 05457
PROGRAM 421/22-IV

DATE 02 JAN 84
TIME 09:00:00

| | | | | | | | | | | | |
|------|-------|-----|-----|-----|-----|------|-------|-----|-----|-----|-----|
| 1.01 | 11.45 | 121 | .15 | .05 | .10 | 1.01 | 21.40 | 284 | .01 | .00 | .00 |
|------|-------|-----|-----|-----|-----|------|-------|-----|-----|-----|-----|

BLACK & VEATCH
FLOOD HYDROGRAPH PACKAGE - MEC-1

PROJECT 75657 DATE 12/02/83 PAGE 10
PROGRAM W21/02-1V TYPE US3/06 CASE 444131X8

Upper Dam

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

ELEVATION
STORAGE
OUTFLOW

INITIAL VALUE
522.50
5.
0.

SPILLWAY CREST
522.50
5.
0.

TOP OF DAM
526.50
5.
11.

RATIO
OF
PPE

PARITY
RESERVOIR
W.S. ELEV
526.50

PARITY
STORAGE
AC-FT
5.

DURATION
OVER TOP
HOURS
15.

TYPE OF
PAR CUTFLOW
HOURS
15.75

TYPE OF
FAILURE
15.75

BLACK & VEATCH
FLOOD HYDROGRAPH PACKAGE - MEC-1

PROJECT 75657 DATE 12/02/83 PAGE 10
PROGRAM W21/02-1V TYPE US3/06 CASE 444131X8

2

Lower Dam

SUBJECTS

| PLANT | ELEVATION
FEET | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|-------|-------------------|---------------|----------------|------------|
| 1 | 512.00 | 55.00 | 55.00 | 518.00 |
| 2 | 512.00 | 55.00 | 55.00 | 518.00 |
| 3 | 512.00 | 55.00 | 55.00 | 518.00 |
| 4 | 512.00 | 55.00 | 55.00 | 518.00 |
| 5 | 512.00 | 55.00 | 55.00 | 518.00 |
| 6 | 512.00 | 55.00 | 55.00 | 518.00 |
| 7 | 512.00 | 55.00 | 55.00 | 518.00 |
| 8 | 512.00 | 55.00 | 55.00 | 518.00 |
| 9 | 512.00 | 55.00 | 55.00 | 518.00 |
| 10 | 512.00 | 55.00 | 55.00 | 518.00 |
| 11 | 512.00 | 55.00 | 55.00 | 518.00 |
| 12 | 512.00 | 55.00 | 55.00 | 518.00 |
| 13 | 512.00 | 55.00 | 55.00 | 518.00 |
| 14 | 512.00 | 55.00 | 55.00 | 518.00 |
| 15 | 512.00 | 55.00 | 55.00 | 518.00 |
| 16 | 512.00 | 55.00 | 55.00 | 518.00 |
| 17 | 512.00 | 55.00 | 55.00 | 518.00 |
| 18 | 512.00 | 55.00 | 55.00 | 518.00 |
| 19 | 512.00 | 55.00 | 55.00 | 518.00 |
| 20 | 512.00 | 55.00 | 55.00 | 518.00 |
| 21 | 512.00 | 55.00 | 55.00 | 518.00 |
| 22 | 512.00 | 55.00 | 55.00 | 518.00 |
| 23 | 512.00 | 55.00 | 55.00 | 518.00 |
| 24 | 512.00 | 55.00 | 55.00 | 518.00 |
| 25 | 512.00 | 55.00 | 55.00 | 518.00 |
| 26 | 512.00 | 55.00 | 55.00 | 518.00 |
| 27 | 512.00 | 55.00 | 55.00 | 518.00 |
| 28 | 512.00 | 55.00 | 55.00 | 518.00 |
| 29 | 512.00 | 55.00 | 55.00 | 518.00 |
| 30 | 512.00 | 55.00 | 55.00 | 518.00 |
| 31 | 512.00 | 55.00 | 55.00 | 518.00 |
| 32 | 512.00 | 55.00 | 55.00 | 518.00 |
| 33 | 512.00 | 55.00 | 55.00 | 518.00 |
| 34 | 512.00 | 55.00 | 55.00 | 518.00 |
| 35 | 512.00 | 55.00 | 55.00 | 518.00 |
| 36 | 512.00 | 55.00 | 55.00 | 518.00 |
| 37 | 512.00 | 55.00 | 55.00 | 518.00 |
| 38 | 512.00 | 55.00 | 55.00 | 518.00 |
| 39 | 512.00 | 55.00 | 55.00 | 518.00 |
| 40 | 512.00 | 55.00 | 55.00 | 518.00 |
| 41 | 512.00 | 55.00 | 55.00 | 518.00 |
| 42 | 512.00 | 55.00 | 55.00 | 518.00 |
| 43 | 512.00 | 55.00 | 55.00 | 518.00 |
| 44 | 512.00 | 55.00 | 55.00 | 518.00 |
| 45 | 512.00 | 55.00 | 55.00 | 518.00 |
| 46 | 512.00 | 55.00 | 55.00 | 518.00 |
| 47 | 512.00 | 55.00 | 55.00 | 518.00 |
| 48 | 512.00 | 55.00 | 55.00 | 518.00 |
| 49 | 512.00 | 55.00 | 55.00 | 518.00 |
| 50 | 512.00 | 55.00 | 55.00 | 518.00 |
| 51 | 512.00 | 55.00 | 55.00 | 518.00 |
| 52 | 512.00 | 55.00 | 55.00 | 518.00 |
| 53 | 512.00 | 55.00 | 55.00 | 518.00 |
| 54 | 512.00 | 55.00 | 55.00 | 518.00 |
| 55 | 512.00 | 55.00 | 55.00 | 518.00 |
| 56 | 512.00 | 55.00 | 55.00 | 518.00 |
| 57 | 512.00 | 55.00 | 55.00 | 518.00 |
| 58 | 512.00 | 55.00 | 55.00 | 518.00 |
| 59 | 512.00 | 55.00 | 55.00 | 518.00 |
| 60 | 512.00 | 55.00 | 55.00 | 518.00 |
| 61 | 512.00 | 55.00 | 55.00 | 518.00 |
| 62 | 512.00 | 55.00 | 55.00 | 518.00 |
| 63 | 512.00 | 55.00 | 55.00 | 518.00 |
| 64 | 512.00 | 55.00 | 55.00 | 518.00 |
| 65 | 512.00 | 55.00 | 55.00 | 518.00 |
| 66 | 512.00 | 55.00 | 55.00 | 518.00 |
| 67 | 512.00 | 55.00 | 55.00 | 518.00 |
| 68 | 512.00 | 55.00 | 55.00 | 518.00 |
| 69 | 512.00 | 55.00 | 55.00 | 518.00 |
| 70 | 512.00 | 55.00 | 55.00 | 518.00 |
| 71 | 512.00 | 55.00 | 55.00 | 518.00 |
| 72 | 512.00 | 55.00 | 55.00 | 518.00 |
| 73 | 512.00 | 55.00 | 55.00 | 518.00 |
| 74 | 512.00 | 55.00 | 55.00 | 518.00 |
| 75 | 512.00 | 55.00 | 55.00 | 518.00 |
| 76 | 512.00 | 55.00 | 55.00 | 518.00 |
| 77 | 512.00 | 55.00 | 55.00 | 518.00 |
| 78 | 512.00 | 55.00 | 55.00 | 518.00 |
| 79 | 512.00 | 55.00 | 55.00 | 518.00 |
| 80 | 512.00 | 55.00 | 55.00 | 518.00 |
| 81 | 512.00 | 55.00 | 55.00 | 518.00 |
| 82 | 512.00 | 55.00 | 55.00 | 518.00 |
| 83 | 512.00 | 55.00 | 55.00 | 518.00 |
| 84 | 512.00 | 55.00 | 55.00 | 518.00 |
| 85 | 512.00 | 55.00 | 55.00 | 518.00 |
| 86 | 512.00 | 55.00 | 55.00 | 518.00 |
| 87 | 512.00 | 55.00 | 55.00 | 518.00 |
| 88 | 512.00 | 55.00 | 55.00 | 518.00 |
| 89 | 512.00 | 55.00 | 55.00 | 518.00 |
| 90 | 512.00 | 55.00 | 55.00 | 518.00 |
| 91 | 512.00 | 55.00 | 55.00 | 518.00 |
| 92 | 512.00 | 55.00 | 55.00 | 518.00 |
| 93 | 512.00 | 55.00 | 55.00 | 518.00 |
| 94 | 512.00 | 55.00 | 55.00 | 518.00 |
| 95 | 512.00 | 55.00 | 55.00 | 518.00 |
| 96 | 512.00 | 55.00 | 55.00 | 518.00 |
| 97 | 512.00 | 55.00 | 55.00 | 518.00 |
| 98 | 512.00 | 55.00 | 55.00 | 518.00 |
| 99 | 512.00 | 55.00 | 55.00 | 518.00 |
| 100 | 512.00 | 55.00 | 55.00 | 518.00 |

APPENDIX B

BORING LOGS

BORING LOG

LEGEND AND NOMENCLATURE

Items shown on boring logs refer to the following:

1. Depth - Depth below reference elevation, ground surface unless otherwise shown.
2. Sample - Types designated by letter
 - D - Disturbed sample, obtained from auger cuttings or wash water for classification purposes only.
 - S - Split-Spoon sample, obtained by driving 2-inch split-spoon to determine penetration resistance and allow classification.
 - C - Liner tube sample, obtained by penetration of thick, wall sampler containing 2-inch diameter liner-tubes (California sampler).
 - U - Undisturbed sample, obtained by penetration of minimum 3 inch diameter, thin-wall tube using an open or, where indicated, fixed-piston sampling head.
- Rec - Recovery is expressed as a ratio of the length recovered to the total length pushed or driven (in inches) i.e. $\frac{8}{12}$
- Resist - Resistance is designated as follows:
 - P - Sample pushed in one continuous movement by hydraulic rig action, maximum hydraulic pressure shown where pertinent.
 - ³⁶₉ - Numbers indicate blows per 6 inches of sampler penetration when driven by a 140-pound hammer falling freely 30 inches. The Standard Penetration Resistance is the number of blows for the last 12 inches of penetration of the split-spoon sampler, e.g. 15. Note that a blow count can be given for the California sampler, but this is not the Standard Penetration Resistance.
3. Description - Description of material according to the Unified Soil Classification: word description gives soil constituents, consistency or density, and other appropriate classification characteristics. Unified Soil Classification symbols are shown on the USC column. Geologic names, where appropriate, are shown under Special Notes. A solid line indicates stratigraphic change; a dashed line indicates approximate location of stratigraphic change.
4. Special Notes and Field Observations - Pertinent observations made by Inspector during drilling including type of boring, free water level, water seepage, fluid loss, hole termination depth, etc.
5. Legend -

| | | |
|---|--|---|
| CFA - Continuous flight auger
ATD - At time of drilling
AD - After drilling
DWL - Drill water loss
DWR - Drill water return | 
 | Water depth at specified time after drilling
Water entry depth at time of drilling |
|---|--|---|

BORING LOG

PROJECT NAME DAMS AND PONDS

B-1

PROJECT LOCATION 29th & Blue Ridge Cut Off

GEOLOGIST M. Robinette DRILLER R. Herber

SURFACE ELEVATION 244

ELEVATION DATUM City

SHEET 1 OF 2

PROJECT NO. K79-88

DATE 9-14-79

RIG CHE 55

WATER ENTERS None

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----|--------|---|--------|---|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Stiff, dark brown, low plastic Silty CLAY | CL | Boring advanced with 4" diameter CFA

WC > PL |
| D | | | | Very stiff, dark brown, medium plastic CLAY | | |
| 5 | | | | | | |
| 10 | D | | | Very stiff, dark brown, highly plastic CLAY | CH | |
| 15 | | | | | | |
| D | | | | SHALE: very stiff to hard, olive to buff, highly plastic, weathered | SH | |
| D | | | | SHALE: very stiff to hard, maroon, highly plastic, weathered | | |
| 20 | | | | SHALE: very stiff to hard, olive to buff, highly plastic, clayey | SH | |
| 25 | | | | LIMESTONE: light gray to light brown, fine grained, crystalline, slightly weathered | LS | |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 6

BORING LOG

SHEET 2 OF 2

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-1

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

RIG CME 55

WATER ENTERS None

SURFACE ELEVATION 244 ELEVATION DATUM City

Detected AID

[illegible]

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 7

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-2

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 3-14-79

RIG CME 55

GEOLOGIST M. Robinette DRILLER R. Herber

WATER ENTERS None

SURFACE ELEVATION 240

ELEVATION DATUM City

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----|--------|---|--------|---|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Stiff, dark brown, low plastic Silty CLAY | CL | Boring advanced with 4" diameter CFA

WC > PL |
| | | | | Very stiff, dark brown, highly plastic CLAY | CH | |
| 5 | | | | | | |
| 10 | D | | | | | |
| 15 | | | | | | |
| | D | | | SHALE: very stiff to hard, olive to maroon, highly plastic | SH | |
| 20 | | | | LIMESTONE: light gray to light brown, fine grained, crystalline, slightly weathered | LS | |
| 25 | | | | | | Bottom of boring
22.5' |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 8

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-3

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST M. Robinette DRILLER R. Herber

RIG CME 55

SURFACE ELEVATION 236

ELEVATION DATUM City

WATER ENTERS None

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----|--------|---|--------|---|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Stiff, dark brown, medium plastic Silty CLAY | | Boring advanced with 4" diameter CFA

WC > PL |
| | | | | Becoming medium brown | CL | |
| 5 | D | | | | | |
| 10 | D | | | Very stiff, medium brown, highly plastic CLAY | CH | |
| 15 | | | | | | |
| | | | | LIMESTONE: light gray to light brown, fine grained, crystalline, slightly weathered | LS | |
| 20 | | | | | | Bottom of boring 18.0' |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 9

BORING LOG

PROJECT NAME DAMS AND PONDS

B-4

PROJECT LOCATION 29th & Blue Ridge Cut Off

GEOLOGIST M. Robinette DRILLER R. Herber

SURFACE ELEVATION 231

ELEVATION DATUM City

SHEET 1 OF 1

PROJECT NO. K79-88

DATE 9-14-79

RIG CME 55

WATER ENTERS None

Detected ATC

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----|--------|--|--------|---|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Stiff, dark brown to black, low plastic, Silty CLAY | CL | Boring advanced with 4" diameter CFA

WC > PL |
| | | | | Stiff, medium brown, medium plastic Silty CLAY | | |
| 5 | D | | | | | |
| 10 | | | | Very stiff, dark brown, highly plastic CLAY | CH | Bottom of boring 17.0' |
| | D | | | | | |
| 15 | | | | LIMESTONE: light gray to light brown, fine grained, crystalline, weathered to slightly weathered | LS | |
| 20 | | | | | | |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 10

BORING LOG

PROJECT NAME DAMS AND PONDS

B-5

PROJECT LOCATION 29th & Blue Ridge Cut Off

GEOLOGIST M. Robinette DRILLER R. Herber

SURFACE ELEVATION 226

ELEVATION DATUM City

SHEET 1 OF 1

PROJECT NO. K79-88

DATE 9-14-79

RIG CME 55

WATER ENTERS None

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----|--------|---|--------|---|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Stiff, medium brown, highly plastic CLAY with trace of silt | CH | Boring advanced with 4" diameter CFA
WC > PL |
| 5 | D | | | | | |
| 10 | | | | Very stiff, dark brown, highly plastic CLAY with trace of silt | | WC > PL |
| | D | | | | | |
| 15 | | | | LIMESTONE: buff to red brown, medium grained, slightly to very weathered | LS | |
| | | | | SHALE: very stiff to hard, mottled black and olive, highly plastic, clayey, weathered | SH | |
| | D | | | | | |
| 20 | | | | | | Bottom of boring
19.0' |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 11

BORING LOG

PROJECT NAME DAMS AND PONDS

SHEET 1 OF 1

PROJECT NO. K70-88

B-6

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-76

GEOLOGIST M. Robinette DRILLER R. Herber

RIG CME 55

SURFACE ELEVATION 212

ELEVATION DATUM City

WATER ENTERS None

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----|--------|--|--------|--------------------------------------|
| | TYPE | REC | RESIST | | | |
| 0 | | | | | | |
| | D | | | Stiff, dark brown, highly plastic CLAY with trace of silt | CH | Boring advanced with 4" diameter CFA |
| 5 | | | | LIMESTONE: highly weathered | LS | |
| | D | | | Stiff, dark brown, highly plastic CLAY with trace of silt | CH | |
| 10 | | | | SHALE: very stiff, olive and light brown highly plastic, clayey, weathered | SH | |
| | D | | | | | |
| 15 | | | | SHALE: hard, blue gray, highly plastic, slightly weathered to weathered | | |
| | D | | | | | |
| 20 | | | | LIMESTONE: buff to brown, medium grained weathered | LS | |
| | D | | | SHALE: hard, light gray, highly plastic, slightly weathered | SH | |
| | D | | | LIMESTONE | LS | |
| 25 | | | | | | Bottom of boring 23.0' |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 12

BORING LOG

PROJECT NAME DAMS AND PONDS

B-7

PROJECT LOCATION 29th & Blue Ridge Cut Off

GEOLOGIST G. K. Hess DRILLER R. Herber

SURFACE ELEVATION 225 ELEVATION DATUM City

SHEET 1 OF 1

PROJECT NO. K79-88

DATE 9-14-79

RIG CME 55

WATER ENTERS None

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----|--------|---|--------|--------------------------------------|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Stiff, medium to light brown, low plastic Silty CLAY | CL | Boring advanced with 4" diameter CFA |
| 5 | D | | | | | WC < PL |
| 10 | D | | | Stiff, medium brown, highly plastic CLAY | CH | |
| 15 | | | | LIMESTONE: gray to light brown, fine to medium grained, weathered | LS | |
| | | | | SHALE: hard, tan to light green, highly plastic, weathered | SH | |
| 20 | D | | | SHALE: dark gray to black, highly plastic, slightly weathered | | |
| | | | | SHALE: medium to light gray, highly plastic, slightly to unweathered, with trace calcareous zones | | |
| 25 | | | | | | Bottom of boring 24.0' |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 13

BORING LOG

PROJECT NAME DAMS AND PONDS

B-8

PROJECT LOCATION 29th & Blue Ridge Cut Off

GEOLOGIST G. K. Hess DRILLER R. Herber

WINFACE ELEVATION 223 ELEVATION DATUM City

SHEET 1 OF 1

PROJECT NO. K70-88

DATE 9-14-79

RIG CME 55

WATER ENTERS None

Detected ATD

| DEPTH
(1) | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND
FIELD OBSERVATIONS |
|--------------|--------|-----|--------|---|--------|--|
| | TYPE | REC | RESIST | | | |
| | | | | Stiff, medium brown, low to medium plastic
Silty CLAY | CL | Boring advanced with
4" diameter CFA
WC < PL |
| 5 | D | | | | | WC > PL |
| 10 | | | | LIMESTONE: light gray to light brown, fine
to medium grained, weathered

Becoming slightly weathered | LS | |
| 15 | | | | SHALE: dark gray to black, highly plastic,
slightly weathered | SH | |
| | | | | | | Bottom of boring
14.0' |

WOODYARD-CLYDE CONSULTANTS

FIGURE NO. 14

BORING LOG

PROJECT NAME DAMS AND PONDS

B-9

PROJECT LOCATION 29th & Blue Ridge Cut Off

GEOLOGIST G. K. Hess DRILLER R. Herber

SURFACE ELEVATION 237

ELEVATION DATUM City

SHEET 1 OF 1

PROJECT NO. K79-88

DATE 9-14-79

RIG CME 55

WATER ENTERS None

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----|--------|--|--------|---|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Stiff to very stiff, medium brown, medium to low plastic Silty CLAY | CL | Boring Advanced with 4" diameter CFA
WC > PL |
| 5 | | | | | | |
| 10 | | | | | | |
| 15 | | | | Stiff, medium brown, highly plastic CLAY with trace of silt | CH | Bottom of boring 19.0' |
| | | | | LIKSTONE: light gray to light brown, fine to medium grained, weathered | LS | |
| 20 | | | | SHALE: very stiff, medium brown, highly plastic, weathered | SH | |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 15

BORING LOG

PROJECT NAME DAMS AND PONDS

SHEET 1 OF 1

PROJECT NO. K79-88

B-10

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER R. Herber

RIG CME 55

SURFACE ELEVATION 244

ELEVATION DATUM City

WATER ENTERS None

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----|--------|---|--------|--------------------------------------|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Stiff, medium brown, medium to low plastic Silty CLAY | CL | Boring advanced with 4" diameter CFA |
| 5 | D | | | | | WC > PL |
| 10 | D | | | | | |
| 15 | | | | | | |
| | D | | | Stiff, medium brown, highly plastic CLAY | CH | |
| | | | | SHALE: very stiff to hard, maroon to medium brown, highly plastic, weathered | SH | |
| 20 | | | | Becoming tan | | |
| | D | | | | | |
| | | | | LIMESTONE: light gray to light brown, fine to medium grained, weathered to slightly weathered | LS | |
| 25 | | | | | | Bottom of boring 24.0' |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 16

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-11

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER C. Meyer

RIG CHE 55

SURFACE ELEVATION 206

ELEVATION DATUM City

WATER ENTERS None

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|---------|--------|--|------------------|---|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Very stiff, medium brown, highly plastic, CLAY FILL with limestone and shale fragments | F
I
L
L | Boring advanced with 4" diameter CFA

WC > PL |
| | C | 4
TZ | P | Becoming predominantly shale | | |
| 5 | | | | Stiff, mottled dark brown, light brown and light green, highly plastic CLAY FILL with some silt and trace of shale fragments | | |
| | C | 7
TZ | P | | CH | |
| | C | 4
TZ | P | Stiff, gray to light green, highly plastic CLAY with limestone cobble at 8' | | |
| 10 | | | | Becoming stiff to very stiff | | |
| | C | 7
TZ | P | | CH
I
SH | |
| | C | 8
TZ | P | Very stiff, mottled gray and light brown, highly plastic CLAY with trace of silt | | |
| 15 | | | | Grading to highly plastic CLAY to weathered Clayey SHALE | | |
| | C | 4/6 | P | | LS | Bottom of boring 18.0' |
| 20 | | | | LIMESTONE: light gray to light brown, fine to medium grained, slightly weathered | | |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 17

BORING LOG

PROJECT NAME DAMS AND PONDS

SHEET 1 OF 2

PROJECT NO. K79-88

DATE 9-14-79

RIG CHE 75

WATER ENTERS @ EI 183

B-12

PROJECT LOCATION 29th & Blue Ridge Cut Off

GEOLOGIST G. K. Hess DRILLER C. Meyer

SURFACE ELEVATION 205± ELEVATION DATUM City

ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----------------|--------|--|--------|--------------------------------------|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Gravel Fill | F | Boring advanced with 4" diameter CFA |
| | | | | Very stiff, dark brown, highly plastic CLAY FILL with trace limonite nodules and shale fragments | L | |
| | C | $\frac{4}{10}$ | P | | | |
| | | | | | | |
| 5 | | | | With some low to medium plastic clay zones | | |
| | C | $\frac{8}{12}$ | P | | | |
| | | | | | | |
| | U | $\frac{12}{12}$ | P | | | |
| | | | | Stiff, gray-green, highly plastic CLAY and SHALE FILL with silt | | |
| | C | $\frac{7}{12}$ | P | | | |
| 10 | | | | | | |
| | | | | | | |
| | U | $\frac{10}{12}$ | P | Firm, mottled gray to light green, medium to highly plastic CLAY FILL with shale fragments | | |
| | | | | | | |
| 15 | | | | Firm, mottled medium to dark brown, low plastic Silty CLAY | CL | |
| | | | | | | |
| | U | $\frac{12}{12}$ | P | | | |
| | | | | | | |
| 20 | | | | With occasional limestone fragments | | |
| | | | | | | |
| | U | $\frac{12}{12}$ | P | | | |
| | | | | SHALE: stiff to very stiff, medium gray, highly plastic, weathered | SH | ← Water detected ATD |
| | | | | | | |
| 25 | | | | | | |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 18

BORING LOG

PROJECT NAME DAMS AND PONDS

SHEET 2 OF 2

PROJECT NO. K79-88

B-12

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER C. Meyer

RIG CME 75

SURFACE ELEVATION 205± ELEVATION DATUM City

WATER ENTERS @ El 183

ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|--------|--------|---|--------|--------------------------------------|
| | TYPE | REC | RESIST | | | |
| 25 | | | | SAME: SHALE, hard, dark to medium gray, highly plastic, weathered | SH | |
| | C | S
S | P | Becoming slightly weathered | | |
| 30 | | | | | | |
| 35 | | | | | | Bottom of boring
32.0' |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 19

BORING LOG

PROJECT NAME DAMS AND PONDS

SHEET 1 OF 1

PROJECT NO. K79-88

B-13

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER C. Meyer

RIS CME 75

SURFACE ELEVATION 206 ELEVATION DATUM City

WATER ENTERS None

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|---------|--------|--|------------------|--------------------------------------|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Very stiff, medium brown, medium plastic, CLAY FILL with limestone and shale fragments | F
I
L
L | Boring advanced with 4" diameter CFA |
| | C | 0
T2 | P | | | |
| | | | | SHALE: stiff, mottled tan to light brown, highly plastic, very weathered | SH | |
| 5 | C | 4
12 | P | | | |
| | | | | With brown layers | | |
| | C | 6
T2 | P | | | |
| | | | | Becoming olive green | | |
| 10 | C | 4
12 | P | | | |
| | | | | Becoming mottled gray and yellow brown with limestone fragments | | |
| | C | 6
T2 | P | | | |
| 15 | | | | | | |
| | | | | Becoming gray and slightly weathered | | |
| 20 | | | | | | |
| | | | | | | Bottom of boring 17.0' |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 20

BORING LOG

SHEET 1 OF 2
 PROJECT NO. K79-88
 DATE 9-14-79
 RIG CME 75
 WATER ENTERS None
 Detected ATD

PROJECT NAME DAMS AND PONDS

B-14

PROJECT LOCATION 29th & Blue Ridge Cut Off

GEOLOGIST G. V. Hess DRILLER C. Mayer

SURFACE ELEVATION 192

ELEVATION DATUM City

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|----------------|--------|---|--------|---|
| | TYPE | REC | RESIST | | | |
| 0 | | | | Very stiff, medium brown, medium plastic gravel and CLAY FILL | FILL | Boring advanced with 4" diameter CFA

WC < PL |
| | | | | Very stiff, medium brown, highly plastic, desiccated CLAY FILL | | |
| | C | $\frac{4}{12}$ | P | | | |
| | | | | | | |
| 5 | C | $\frac{8}{12}$ | P | With some low plastic silty layers | | WC > PL |
| | | | | | | |
| | C | $\frac{4}{12}$ | P | | | |
| | | | | | | |
| 10 | | | | | CL | |
| | C | $\frac{8}{12}$ | P | Stiff, dark gray to dark brown, low plastic Silty CLAY with trace of organic matter | | |
| | | | | | CH | |
| | C | $\frac{6}{12}$ | P | Stiff, mottled medium brown to gray, highly plastic CLAY with some silt | | |
| 15 | | | | | SH | |
| | | | | SHALE: hard, tan, highly plastic, weathered | | |
| | C | $\frac{4}{8}$ | P | | | |
| | | | | | | |
| 20 | | | | | | |
| | | | | Becoming slightly weathered | | |
| | C | $\frac{4}{4}$ | P | | | |
| | | | | | | |
| 25 | | | | | | |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 21

BORING LOG

SHEET 2 OF 2

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

8-14

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-70

RIG CME 75

GEOLOGIST G. K. Hess DRILLER C. Meyer

WATER ENTERS None

SURFACE ELEVATION 192 ELEVATION DATUM City

detected ATD

[illegible]

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 22

BORING LOG

PROJECT NAME DAMS AND PONDS

B-15

PROJECT LOCATION 29th & Blue Ridge Cut Off

GEOLOGIST G. K. Hess DRILLER R. Herber

SURFACE ELEVATION 189 ELEVATION DATUM City

SHEET 1 OF 2

PROJECT NO. K79-88

DATE 9-14-79

RIG CME 55

WATER INTERS None

Detected ATD

| DEPTH | SAMPLE | | | DESCRIPTION | U.S.C. | SPECIAL NOTES AND FIELD OBSERVATIONS |
|-------|--------|-----------------|--------|---|------------------|---|
| | TYPE | REC | RES/ST | | | |
| 0 | | | | Very stiff, medium to light brown, low plastic CLAY FILL with gravel | F
I
L
L | Boring advanced with 4" diameter CFA

WC > PL |
| | | | | Very stiff, medium brown, highly plastic CLAY FILL with some silt | | |
| 5 | C | $\frac{10}{12}$ | P | Becoming medium to highly plastic | | |
| | | | | Becoming very stiff and mottled with gray | | |
| 10 | U | $\frac{18}{18}$ | P | Becoming medium plastic | | |
| 15 | C | $\frac{8}{12}$ | P | Stiff, brown to gray green, medium plastic Silty CLAY FILL with a trace of organic matter | | |
| 20 | U | $\frac{0}{12}$ | P | Stiff, mottled light brown and medium brown, highly plastic CLAY FILL with trace of silt and some low plastic zones | | |
| | U | $\frac{12}{12}$ | P | | | |
| 25 | | | | | | |

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 23