AD A101287

DELAWARE RIVER BASIN
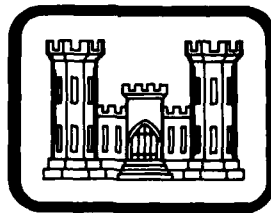BRANCH OF KINNEYVILLE CREEK, WAYNE COUNTY

PENNSYLVANIA

LOWER TWIN LAKE DAM

NDI ID NO. PA-00132
DER ID NO. 64-18

CAMP WAYNE FOR BOYS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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JUL 1 3 1981

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Prepared by
Geo-Technical Services, Inc.
CONSULTING ENGINEERS & GEOLOGISTS
851 S. 19th Street
Harrisburg, Pennsylvania 17104

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

MAY 1981

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DELAWARE RIVER BASIN
BRANCH OF KINNEYVILLE CREEK
WAYNE COUNTY, PENNSYLVANIA

LOWER TWIN LAKE DAM

NDI ID No. PA-00132
DER ID No. 64-18

CAMP WAYNE FOR BOYS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

National Dam Inspection Program. Lower
Twin Lake Dam (NDI ID Number PA-00132,
DER ID Number 64-18) Delaware River Basin,
Branch of Kinneyville Creek, Wayne County,
Pennsylvania. Phase I Inspection Report.

Prepared By

GEO-Technical Services, Inc.
Consulting Engineers & Geologists
851 South 19th Street
Harrisburg, Pennsylvania 17104
Contract DACW31-81-C-0019

For

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
Baltimore, Maryland 21203

May 1981

DTIC
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JUL 13 1981
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PREFACE

This report is prepared under guidance contained in the Recommended Guide-
lines for Safety Inspection of Dams, for Phase I Investigations. Copies
of these guidelines may be obtained from the Office of Chief of Engineers,
Washington, D.C. 20314. The purpose of a Phase I investigation is to ident-
ify expediously those dams which may pose hazards to human life or property.
The assessment of the general condition of the dam is based upon available
data and visual inspections. Detailed investigations, testing, and detail-
ed computational evaluations are beyond the scope of a Phase I investigation;
however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition
of the dam is based on observations of field conditions at the time of in-
spection along with data available to the inspection team. In cases where
the reservoir was lowered or drained prior to inspection, such action, while
improving the stability and safety of the dam, removes the normal load on
the structure and may obscure certain conditions which might otherwise be
detectable if inspected under the normal operating environment of the
structure.

It is important to note that the condition of a dam depends on numerous and
constantly changing internal and external conditions, and is evolutionary in
nature. It would be incorrect to assume that the present condition of the
dam will continue to represent the condition of the dam at some point in the
future. Only through frequent inspections can unsafe conditions be detected
and only through continued care and maintenance can these conditions be
prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and
hydraulic analyses. In accordance with the established Guidelines, the
spillway design flood is based on the estimated "Probable Maximum Flood"
for the region (greatest reasonable possible storm runoff), or fractions
thereof. The spillway design flood provides a measure of relative spill-
way capacity and serves as an aid in determining the need for more detailed
hydrologic and hydraulic studies, considering the size of the dam, its
general condition and the downstream damage potential.

TABLE OF CONTENTS

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam: Lower Twin Lake Dam
                                               NDI ID No. PA-00132
                                               DER ID No. 64-018

Owner: Camp Wayne for Boys

State Located: Pennsylvania

County Located: Wayne

Stream: Branch of Kinneyville Creek

Date of Inspection: December 2, 1980

Based on visual inspection, field survey, and available records, Lower Twin Lake Dam is judged to be in poor conditions. There is no existing spillway to convey flood flows nor means to lower the reservoir level in emergencies.

Based on calculations and according to criteria established for Phase I Dam Inspection Studies, the dam is judged to be unsafe, non-emergency, because of the absence of a spillway. The selected Spillway Design Flood (SDF) for the facility is ½PMF (Probable Maximum Flood). It is judged that the dam could not withstand the depth and duration of overtopping that would occur from a flood magnitude of 0.2 PMF, or greater. Failure of the dam would significantly increase the downstream hazard conditions.

The facility is not properly maintained, as evidenced by the growth of brush and trees on the top of the dam and at the toe.

The following measures are recommended to be undertaken by the owner, in the approximate order of priority, immediately:

(1) Perform additional hydrologic and hydraulic analyses to more accurately determine the required spillway capacity for the Lower Twin Lake Dam. Design and construct a spillway that will pass the required SDF without overtopping the dam.

(2) Remove trees and brush from the top of the earth embankment and the toe of the dam under the supervision of a professional engineer.

(3) Periodically measure the rate and clarity of leakage discharging from the remnant stone culvert. Take appropriate action as necessary.

(4) Develop a method of drawing down the lake in case of emergency.

All investigations, studies, designs, and supervision of construction should be performed by a professional engineer experienced in the design and construction of dams.

In addition, it is recommended that the owner institute operational procedures, as follows:

(1) Develop a detailed emergency operation and warning system.

Lower Twin Lake Dam

     (2) Provide round-the-clock surveillance of the dam during periods of unusually heavy rains

     (3) When warnings of storms of major proportions are given by the National Weather Service, the owner should activate his emergency operation and warning system procedures.

     (4) Institute an inspection program such that the dam is inspected frequently. As presently required by the Commonwealth, the program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the results to determine if remedial measures are necessary.

     (5) Institute a maintenance program to properly maintain all features of the dam.
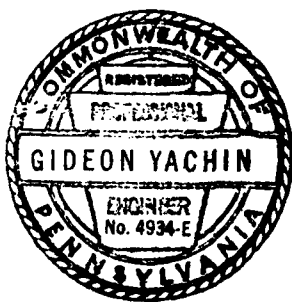
Submitted by:

GEO-TECHNICAL SERVICES, INC.

GIDEON YACHIN, P.E.

Date: May 13, 1981

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF
ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
Commander and District Engineer

Date: 3 JUNE 1981

LOWER TWIN LAKE DAM (PA. 00132)

(UPPER TWIN LAKE IN BACKGROUND)

OVERVIEW

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

LOWER TWIN LAKE DAM

NDI# PA-00132, PENNDER # 64-018

SECTION 1

GENERAL INFORMATION

1.1 General.

a. Authority. The inspection was performed pursuant to the authority granted by the National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances: Lower Twin Lake Dam is a composite earth-fill masonry structure. There is an earthen embankment upstream. The crest and downstream portion of the dam is an earth fill between dry stone walls. The upstream wall forms the top of the dam and is 3' to 4' higher than the earthfill section and the downstream wall. The dam is 157 feet in length along the upstream wall and 10.3 feet high at the low point on the crest. The crest is 14 feet wide including the downstream and upstream walls.

At the present time, the dam does not have a constructed spillway. High flows pass through a 15 feet wide breached section of the upstream wall and overtop the earthfill section and the downstream stone wall.

The dam does not have an operable outlet works. The remnant of a rectangular (1.8' x 1.9') stone culvert is located at the downstream toe of the dam. The location of the inlet end of the conduit is unknown and probably buried under several feet of sediment.

b. Location. -Lower Twin Lake Dam is located on a branch of Kinneyville Creek in Preston Township, Wayne County, Pennsylvania. The dam is situated 0.5 mile north of Lake Como, Pennsylvania, and is shown on the 1978 photo-revised USGS Quadrangle, Lake Como, Pennsylvania, at Latitude N 41°51'16" and Longitude W 75°20'04". A location map is presented in Exhibit E-1.

c. Size Classification. Small (10.3' high, 316 acre-feet maximum storage).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Lower Twin Lake Dam (paragraph 3.1e).

e. Ownership. Camp Wayne for Boys, c/o Michael H. Corpal, 570 Broadway, Lynbrook, New York 11563.

f. Purpose of Dam. Recreation.

1

g. <u>Design and Construction History</u>. Information related to the design and construction of the dam is not available. Data obtained from the Pennsylvania Department of Environmental Resources (PENNDER) indicate that the dam was in existence prior to the 1914 "Survey of Lakes" in Pennsylvania. Inspection reports and photographs indicate the breach in the upstream stone wall occurred prior to 1965. This information is on file with PENNDER.

h. <u>Normal Operating Procedure</u>. The pool is maintained below the dam crest by leakage through the dry stone masonry. Seepage into the upstream wall is passed through the earthfill and into the dry stone culvert.

Flood flows discharge through the breached section of the upstream wall, over the earthfill section and into the natural downstream channel.

1.2 <u>Pertinent Data</u>.

a. <u>Drainage Area</u>.   1.03 Sq. Miles

b. <u>Discharge at Damsite</u> (cfs).
Maximum known flood at damsite   Unknown
Outlet works at maximum pool elevation   Not Applicable
Spillway capacity at maximum pool elevation   Not Applicable

c. <u>Elevation</u> (feet above msl).
Top of Dam
    Design conditions   Unknown
    Existing conditions (lowest point at breach)   1496.5
Maximum Pool
    Design conditions   Unknown
    Existing conditions   1496.5
Normal Pool   1496.5
Upstream Invert Outlet Works   Not Applicable
Downstream Invert   Remnant Stone Culvert
Streambed at Toe of Dam   1486.2

d. <u>Reservoir Length</u>.
Normal Pool   2100 feet
Maximum Pool   2100 feet

e. <u>Storage</u>.
Normal Pool   316 Ac.Ft.
Maximum Pool   316 Ac.Ft.

f. <u>Reservoir Surface</u>.
Normal Pool   34 Acres
Maximum Pool   34 Acres

g. <u>Dam</u>.
Type   Dry stone masonry and earthfill
Length (feet)   157
Height (feet)   10.3
Top Width (feet)   14
Side Slopes   Downstream 5V:1H, Upstream 1V:3.3H
Zoning   Unknown
Cut-off   Unknown
Grout Curtain   Unknown

h.	**Diversion and Regulating Tunnel**.	None
i.	**Spillway**.	None
	Type	Not Applicable
	Length of Weir	Not Applicable
	Crest Elevation	Not Applicable
	Upstream Channel	Not Applicable
	Downstream Channel	Not Applicable
j.	**Regulating Outlets**.	None
	Type	Not Applicable
	Length	Not Applicable
	Closure	Not Applicable
	Access	Not Applicable

SECTION 2

ENGINEERING DATA

2.1 Design.

a. **Data Available.** There is no information available relative to the design of the Lower Twin Lake Dam.

b. **Design Features.** Inspection reports and accompanying photographs from 1924 and 1930 indicate that the upstream wall was originally lined with wood planking. They also imply that the remnant stone culvert, presently visible at the downstream end, served as the outlet works.

2.2 Construction.

No information concerning construction of the dam is available.

2.3 Operation.

There are no records available to indicate the past operational procedures for the dam. The present normal operation of the facility is described in paragraph 1.2h, Section 1.

2.4 Other Information.

On-site inspections were made in July 1924, June 1930, May 1931, June 1934, and April 1965.

2.5 Evaluation.

a. **Availability.** The previously cited inspection reports were provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources (PENNDER), Commonwealth of Pennsylvania. The Owner's representative had no information related to the design, construction or the operation of the dam. Pertinent dam features were obtained by survey on the inspection date (12/02/80). There are no other sources of information available for the evaluation of the facility.

b. **Adequacy.** The available data is very limited and the dam safety assessment must be primarily based on the visual inspection, performance history and the hydrologic and hydraulic analyses, presented in Section 5. The collected data are considered adequate for Phase I report.

c. **Validity.** There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 <u>Observations</u>.

a. <u>General</u>. The overall appearance of the dam is poor. Location of observed deficiencies are shown on the General Plan presented in Exhibit A-1, Appendix A. The profile and typical sections of the dam are presented in Exhibits A-2 and A-3 and are based on field survey made on the day of inspection. The survey datum for this inspection is elevation 1495 feet above mean sea level for the normal water surface of the lake (see Exhibit E-1). On the inspection date (12/02/80), the lake level was approximately at elevation 1495, which is 1.5 feet below the low point on the dam crest (see Exhibit A-3). Deficiencies observed during the field inspection are described below, and are further illustrated in Exhibit A-1, Appendix A. Visible features are depicted in photographs presented in Appendix C.

b. <u>Dam</u>. Observations made during the inspection indicate that the earth and dry stone masonry dam is in poor condition. On the upstream side of the dam, a vertical dry stone wall, about 3.5 feet wide and 157 feet long, extends 3 to 4 feet above the top of the earth embankment (see photographs 1 and 2, Appendix C). The top of the wall is not horizontal and rises on both abutments (see Exhibit A-2). Approximately 15 feet of this wall is breached on the left side to a low point on the dam at elevation 1496.5 (see photograph 4, Appendix C). Upstream of this wall, an earth embankment slopes 1 vertical on 3.3 horizontal to a maximum depth of 3 feet below the lake level. Upstream for a distance of about 300 feet, the original stream channel is filled in with earth to about 3 feet below lake level. The downstream side of the dam is a dry stone masonry wall with a batter of 5 vertical to 1 horizontal. The downstream wall is about 73 feet long and 10.3 feet high at its maximum section. A rectangular opening (1.8'W x 1.9'H) in the low point in the stone wall was discharging water at about 250 GPM (see photograph 3, Appendix C). This flow appears to be entirely leakage, since no intake structure or controls were visible. This is supported by the sound of turbulent flow below the right side of the breach in the upstream wall (see Exhibit A-1). No accumulation of fines was observed in the discharge area. The top of the dam is 14 feet wide and contains earth fill between the dry stone walls (see photograph 2, Appendix C). Except for the low area in the vicinity of the breached upstream wall, the top of the earth fill is essentially horizontal. Brush and trees up to 8" in diameter are located on the dam crest and along the toe of the downstream wall.

c. <u>Appurtenant Structures</u>.

(1) <u>Spillway</u>: There is no visible evidence of a constructed spillway. When inflow into the lake exceeds leakage through the dam, excess flow is discharged through the 15 feet wide breached section in the upstream wall.

(2) <u>Outlet Works</u>: The rectangular opening (1.8'W x 1.9'H) at the low point in the downstream wall appears to be a remnant drain outlet (see photograph No. 3). There was no visible evidence of an intake or con-

trol facilities. On the day of the field inspection, the outlet was discharging about 250 GPM. This flow represents the entire inflow into the lake and appears to be controlled seepage and leakage through the dam.

d. <u>Reservoir Area</u>. With the exception of about 7 acres of farmland on the left abutment, the watershed is predominantly undeveloped woodland. The left abutment slopes vary from 15 to 30 percent and contain many large, slabby, sandstone boulders. The right abutment slopes vary from 5 to 15 percent. There is no evidence of unstable slope conditions or features that could affect the safety of the dam. Approximately 800 feet upstream of Lower Twin Lake is Upper Twin Lake. The impact of this lake on Lower Twin Lake is described in Section 5, Hydrology and Hydraulics. Other pertinent watershed features are shown in Exhibit E-1, Appendix E. The geologic conditions in the area are described in Appendix F.

e. <u>Downstream Channel</u>. The channel downstream of the dam is a natural wooded channel with an average slope of about 5 percent (see photograph No. 5, Appendix C). About 300 feet downstream of the dam, the stream flow is diverted into a man-made earth channel (see photograph No. 6, Appendix C). The channel varies from 8 to 10 feet wide and has a 3-foot high embankment with 1 on 2 slopes on the downhill side. This channel is diverted left of the natural stream valley and discharges into an adjacent stream about 500 feet east. Large flows exceeding the capacity of the man-made channel flow down the original stream valley. After crossing the highway 900 feet downstream, the stream valley widens and combines with the flat flood plain of Kinneyville Creek. There are six occupied homes 650 to 1300 feet downstream that would be extensively damaged and more than a few lives could be lost should the dam fail (see photograph Nos. 7 and 8, Appendix C). Consequently, Lower Twin Lake Dam is classified as a high hazard structure.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

The reservoir is maintained at normal pool level with the excess inflow discharging as leakage through the dam which flows out of the rectangular opening at the toe of the downstream dry stone wall. Previous inspection reports on the dam revealed that this condition existed prior to 1940.

4.2 Maintenance of Dam.

Maintenance activities by the present owner could not be ascertained during the inspection and appear to be minimal. Visual inspection of the dam indicates that there has been little or no maintenance of the dam. Several trees on the dam have grown to 8-inches in diameter.

4.3 Maintenance of Operating Facilities.

There are no visible operable outlet facilities at the dam. The flow in the remnant stone culvert drain is uncontrolled leakage and seepage through the dam.

4.4 Warning System.

There is no emergency operation and warning system in effect at the present time.

4.5 Evaluation.

There is no formal inspection and maintenance program in effect. Frequent inspections are necessary to detect hazardous conditions at the dam.

An emergency warning system and evacuation plan for the downstream residents is necessary to prevent loss of life should the dam fail.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Design Data.

There is no design information available for Lower Twin Lake Dam.

5.2 Experience Data.

No records of prior flood stages or flows are available for Lower Twin Lake Dam, the upstream Upper Twin Lake Dam, or Kinneyville Creek, downstream of the facility.

5.3 Visual Observations.

Based on the visual inspection reported in Section 3, the observations relevent to hydrology and hydraulics are evaluated below:

a. Dam. In the absence of a spillway, the breached portion of the upstream wall conveys flood water over the dam into the downstream channel. A profile of the upstream stone wall is presented in Exhibit A-2.

Photographs from inspection reports and visual observations indicate that the dam was constructed to increase the level of a natural lake. For a distance of about 300 feet upstream of the dam, the original stream channel has been filled in by lake sediments or by man-placed soils to about elevation 1492. Should the dam fail, only the water impounded above elevation 1492 would contribute to downstream flooding conditions.

b. Upstream Conditions. About 800 feet upstream of Lower Twin Lake is Upper Twin Lake Dam, as shown on Exhibit E-1. The effect of this upstream dam and reservoir on the hydrologic and hydraulic characteristics of Lower Twin Lake Dam is described in Appendix D and summarized in paragraph 5.5b.

c. Downstream Conditions. There are no downstream conditions which would affect the hydraulic analysis of the dam. The diversion channel, described in paragraph 3.1e, has no significant effect on downstream conditions during floods.

5.4 Method of Analysis.

Hydrologic and hydraulic evaluation was made in accordance with the procedures and guidelines established by the U.S. Army Corps of Engineers, Baltimore District, Phase I Safety Inspection of Dams. The analysis has been performed utilizing the HEC-1DB program developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California. A brief description of program capabilities, as well as the input and output data used specifically for this analysis , is presented in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). According to criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and the hazard potential (high) of the Lower Twin Lake Dam is between one-half Probable Maximum Flood ($\frac{1}{2}$PMF) and the full PMF. Based on the potential hazard survey and the hydrologic and hydraulic analysis, $\frac{1}{2}$PMF is selected for the SDF for Lower Twin Lake Dam.

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b. <u>Results of Analysis</u>. The analysis indicates that the Lower Twin Lake Dam overtops by 1.5 and 3.1 feet during flood magnitudes of 0.2 PMF and 0.5 PMF respectively. In the absence of a spillway, the duration of overtopping, for all flood magnitudes analyzed, is 48 hours.

It was judged that overtopping depth of one foot over the crest of the earth embankment would breach the dam within a period of 15 minutes. Dam break analysis was performed with a breach width equal to the existing 15 feet wide breach in the upstream stone wall. Since the dam was constructed at the outlet of a natural lake, failure of the dam would only release the impounded water above the outlet of the natural lake (see Appendix D, Sheet D-15).

Comparison between the "overtopping" analysis and the "dam breach" analysis indicates that the maximum flood stage resulting from the breaching of the dam would occur considerably sooner and would be higher that that derived for the "overtopping" analysis. For flood magnitudes of 0.2 PMF, the aforementioned comparison indicates that the difference between the attained maximum flood stages is 2.25 hours. The computed maximum flood stage difference at the first group of dwellings, downstream of the dam, is 3.4 feet. This will increase the hazard to loss of life and property damage.

The analysis indicates that Upper Twin Lake Dam would be overtopped at the ½PMF by a maximum depth of 0.7 feet and that the duration of overtopping would be 5.75 hours. It is judged that the Upper Twin Lake Dam would not fail due to overtopping under these conditions.

A summary of computer analysis is tabulated at the end of Appendix D.

c. <u>Spillway Adequacy</u>. Lower Twin Lake Dam is rated as seriously inadequate because there is no spillway capable of passing floods without overtopping the dam. Failure of the dam would increase downstream flooding conditions above those existing prior to the failure and increase hazard to loss of life.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations.

The visual inspection reported in Section 3 resulted in a number of observations relative to the structural stability of the dam as described below.

a. Embankment. The brush and trees growing on the dam crest and along the toe are undesirable. The trees promote structural deterioration of the dry stone walls and create potential piping paths in the embankment.

b. Spillway. The lack of a spillway causes flood flows to be discharged over the dam crest. A fifteen-foot section of the upstream wall has been breached and the downstream wall has had several stones removed by erosion. Subsequent high discharges will increase this structural deterioration to the point of total failure.

c. Outlet Works. All low flow discharges pass through the embankment and dry stone walls of the sturcture as leakage. While no evidence of piping was observed, the possibility of piping developing in the future cannot be ruled out.

6.2 Past Performance.

The absence of discernible settlement, bulging, and misalignment combined with the lack of any reported distress over a recorded history of 57 years indicates that the structure is stable under conditions other than severe overtopping.

6.3 Seismic Stability.

The dam is located in Seismic Zone 1. Normally, in this zone, it is assumed that if the dam has an adequate safety factor under static conditions, it can be assumed safe for dynamic earthquake loadings. Based on visual inspections, the dam's age, and past performance, the dam is judged to be stable under static conditions.

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SECTION 7

ASSESSMENT, RECOMMENDATIONS AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment.

    a. Safety.

       (1) Based on visual inspection, available records, calculations, and past performance, Lower Twin Lake Dam is judged to be in poor condition. Since the dam has no spillway, it is not capable of passing any portion of the PMF without overtopping. In the absence of a spillway, and based on the type of construction and the condition of the dam, it is judged that the dam could not withstand the depth and duration of overtopping that would occur for the selected SDF ($\frac{1}{2}$PMF). Failure of the dam would cause an increased hazard to loss of life downstream. The facility is rated as seriously inadequate. According to criteria established for these studies, the dam is rated as unsafe, non-emergency, as the facility is seriously inadequate.

       (2) There is no functional outlet works for the dam.

       (3) A summary of the features and observed deficiencies is listed below:

Feature and Location	Observed Deficiencies
Spillway	Non-existent
Outlet Works	Not Functional
Dry Masonry Structure	Stones missing and displaced; clear seepage at toe.
Embankment	Brush and trees.

       (4) The facility is not properly maintained, as evidenced by the growth of brush and trees on top of the dam and at the toe.

    b. Adequacy of Information. The information available is such that an assessment of the condition of the dam must be based primarily on the visual inspection and computations performed as part of this study.

    c. Urgency. The recommendations in paragraph 7.2 should be implemented immediately.

    d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in paragraph 7.2, further investigations by a professional engineer, experienced in the design and construction of dams, will be necessary.

7.2 Recommendations and Remedial Measures.

    a. The following measures are recommended to be undertaken by the owner, in approximate order of priority, immediately:

       (1) Perform additional hydrologic and hydraulic analyses to more accurately determine the required spillway capacity for the Lower Twin Lake Dam. Design and construct a spillway that will pass the required SDF without overtopping the dam.

(2) Remove trees and brush from the top of the earth embankment and the toe of the dam under the supervision of a professional engineer.

(3) Periodically measure the rate and clarity of the leakage discharging from the remnant stone culvert. Take appropriate action as necessary.

(4) Develop a method of drawing down the lake in case of emergency. All investigations, studies, designs and supervision of construction should be performed by a professional engineer, experienced in the design and construction of dams.

b. In addition, it is recommended that the owner institute operational procedures as follows:

(1) Develop a detailed emergency operation and warning system.

(2) Provide round-the-clock surveillance of the dam during periods of unusually heavy rains.

(3) When warnings of storms of major proportions are given by the National Weather Service, the owner should activate his emergency operation and warning system procedures.

(4) Institute an inspection program such that the dam is inspected frequently. As presently required by the Commonwealth, the program should include a formal annual inspection by a professional engineer, experienced in the design and construction of dams. Utilize the results to determine if remedial measures are necessary.

(5) Institute a maintenance program to properly maintain all features of the dam.

APPENDIX A

VISUAL INSPECTION - CHECKLIST AND FIELD SKETCHES
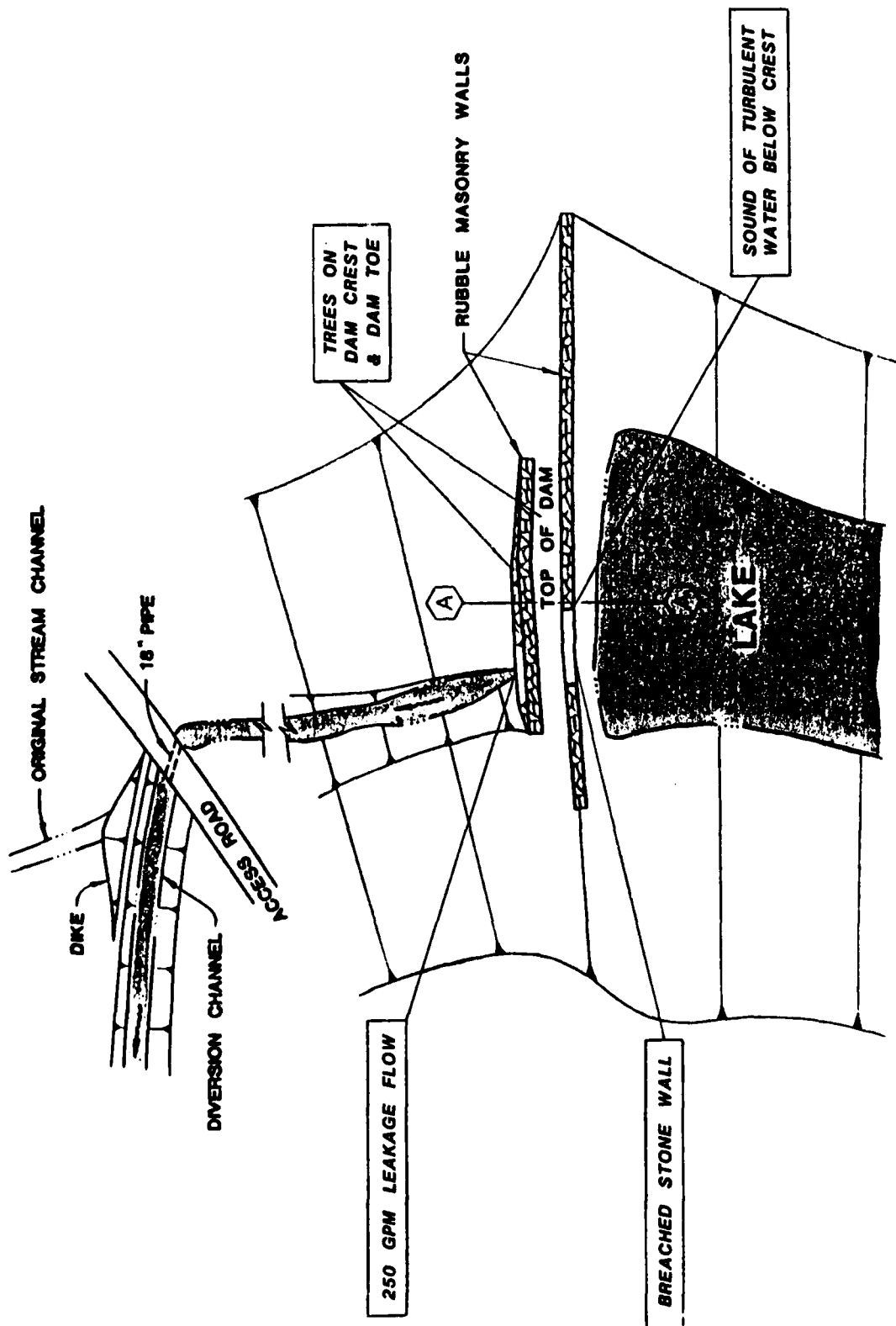
LOWER TWIN LAKE DAM
GENERAL PLAN – FIELD INSPECTION NOTES

EXHIBIT A-1

LOWER TWIN LAKE DAM

TOP OF DAM PROFILE

RIGHT 15 174.EXT
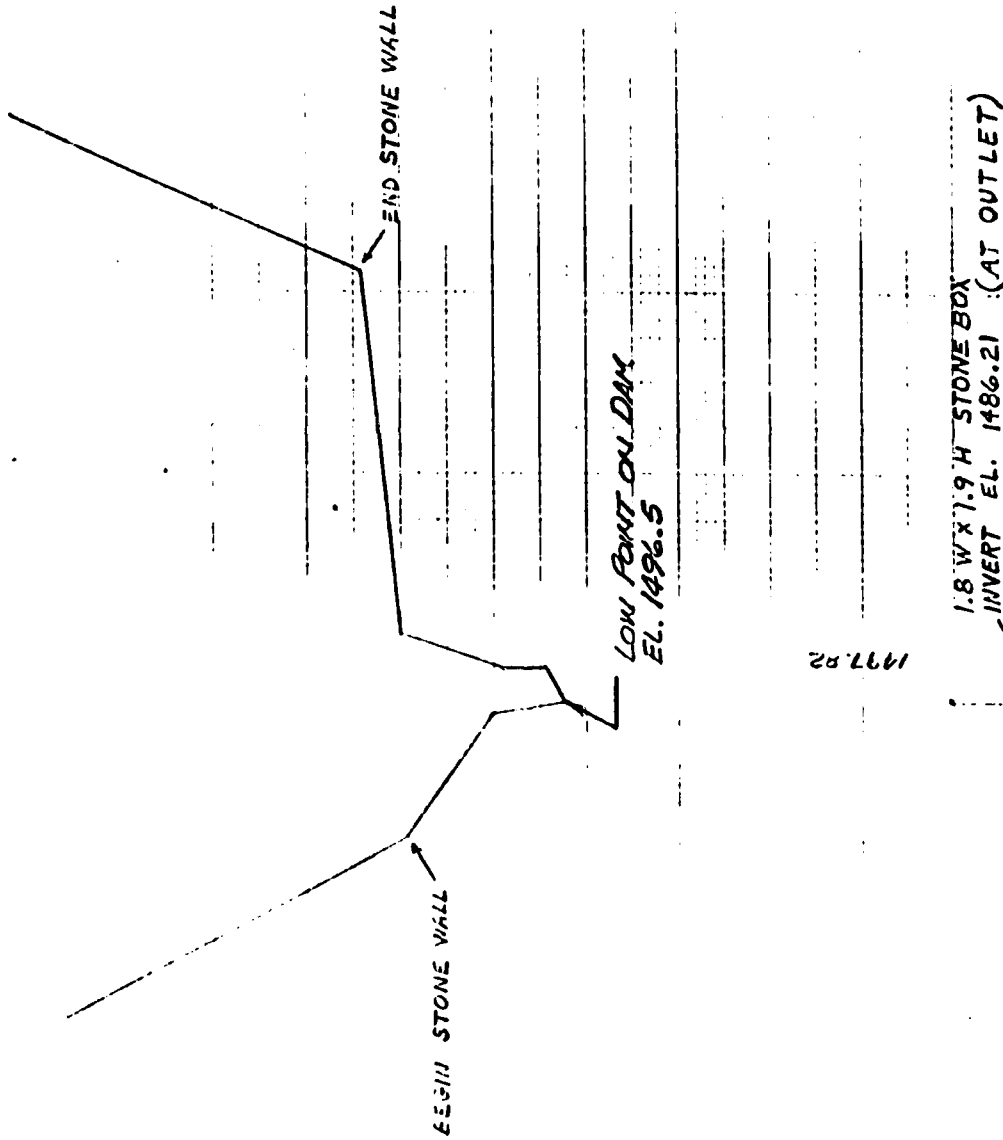
END STONE WALL

LOW POINT ON DAM
EL. 1496.5

BEGIN STONE WALL

1.8'W X 1.9'H STONE BOX
INVERT EL. 1486.21 (AT OUTLET)

1497.82

Station	Elevation
0	1507.17
+51	1499.67
+84	1498.01
+85	1496.57
+97	1496.90
+06	1500.50
+06	1500.57
2	
+49	1508.27
3	

1456
1450

EXHIBIT A-2
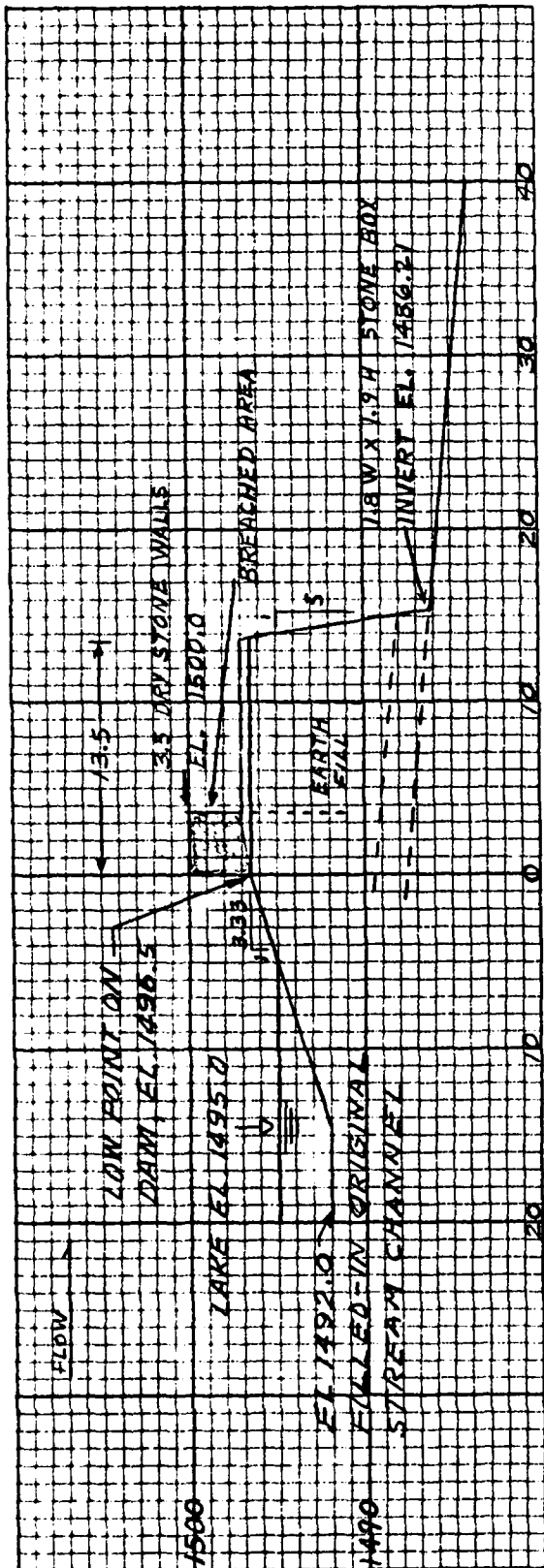
OUTLET SECTION
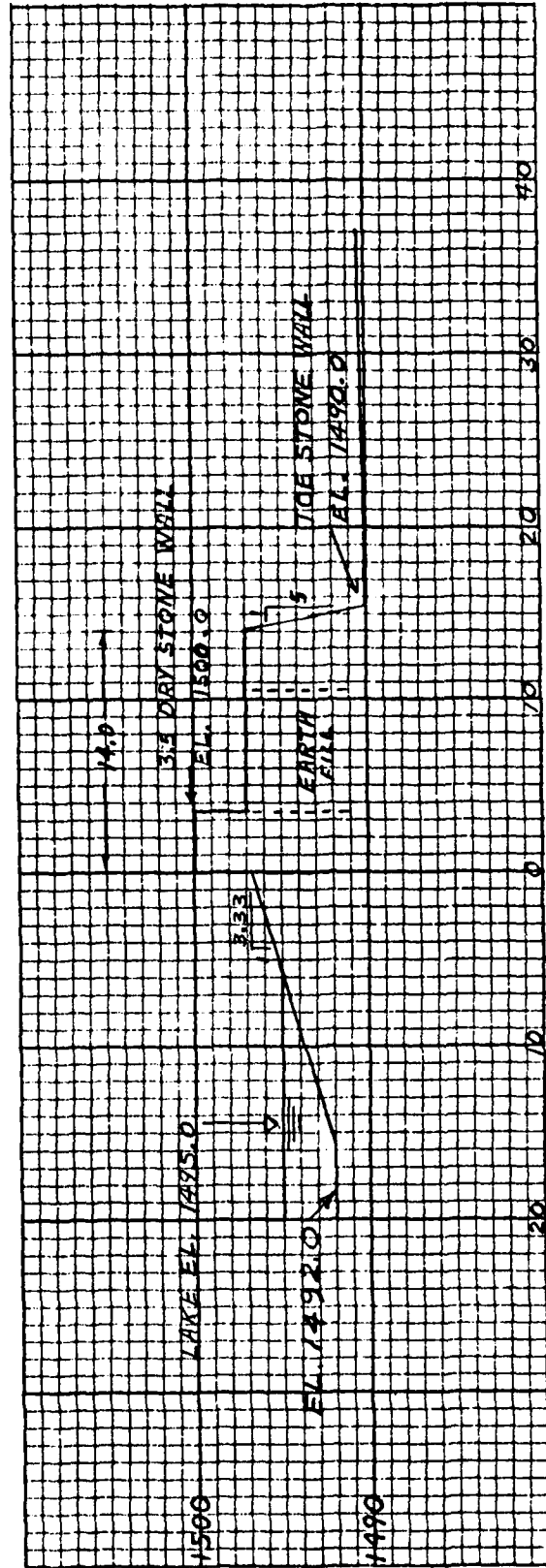
SECTION A

TYPICAL DAM SECTIONS

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM ___Lower Twin Lake___ STATE ___Pennsylvania___ COUNTY ___Wayne___

NDI # PA — ___00132___ PENNDER # ___64-018___

TYPE OF DAM ___Dry Rock Masonry w/Earth Fill___ SIZE ___Small___ HAZARD CATEGORY ___High___

DATE(S) INSPECTION ___December 2, 1980___ WEATHER ___Clear___ TEMPERATURE ___50°___ @ ___1:30___

POOL ELEVATION AT TIME OF INSPECTION ___1495___ M.S.L.

TAIL WATER AT TIME OF INSPECTION ___N/A___ M.S.L.

OWNER REPRESENTATIVES

___None___

_____

_____

_____

_____

OTHERS

_____

_____

_____

_____

_____

INSPECTION PERSONNEL

___Vaden Butler , Engineer___

___James Diaz , Geologist___

___Wayne Himes , Surveyor___

_____

_____

RECORDED BY ___Vaden Butler, P.E.___

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS	NDI# PA · 00132
SURFACE CRACKS	None Visible	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR ERO-SION OF EMBANK-MENT AND ABUTMENT SLOPES	None	
VERTICAL AND HORI-ZONTAL ALIGNMENT OF THE CREST	Horizontal - Good Vertical - Slight sag in middle	
RIPRAP FAILURES	About 15' of upstream loose stone wall is breached and stones dumped at downstream toe. Sounds of turbulent water below right side of breach.	
JUNCTION OF EMBANK-MENT AND ABUT-MENT, SPILLWAY AND DAM	Good; No visible seepage or erosion	

EMBANKMENT

NDI# PA - 00132

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	None
ANY NOTICEABLE SEEPAGE	Discharge at box drain appears to be leakage.
STAFF GAGE AND RECORDER	None
DRAINS	1.8' wide x 1.9' high drain visible only from downstream side. Entire flow in stream (250 GPM) emerging at this drain.
ROCK OUTCROPS	None visible at dam site. Many large slabs of boulder talus on right slope and in creek bed indicates shallow bedrock depth. 350 feet downstream of dam, near horizontal sandstone, bedrock ledges are exposed on the creek side slopes.
DAM FOUNDATION TREES, OTHER	Trees and brush on dam crest up to 8" in diameter.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS	NDI# PA - 00132
INTAKE STRUCTURE	None	
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	Outlet concealed in box (1.8' W. X 1.9' H.) in dry stone wall.	
OUTLET STRUCTURE	None visible	
OUTLET CHANNEL	Natural stream bed about 10' wide.	
GATE(S) AND OPERATIONAL EQUIPMENT	None	

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS
TYPE AND CONDITION	All that might be construed as emergency spillway is a breach in the upstream dry stone wall about 15 feet wide (see Exhibit A-2).
APPROACH CHANNEL	Filled stream channel 50' to 75' wide, about 300' long and about 2.5' deep.
SPILLWAY CHANNEL AND SIDEWALLS	None
STILLING BASIN PLUNGE POOL	None
DISCHARGE CHANNEL	Natural stream with 10'± bottom width.
BRIDGE AND PIERS EMERGENCY GATES	None

SERVICE SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS	NDI# PA · 00132				
TYPE AND CONDITION	No spillway. In case of very large flood, discharge would be through the dry stone wall and over entire length of dam. breached					
APPROACH CHANNEL	N/A					
OUTLET STRUCTURE	N/A					
DISCHARGE CHANNEL	N/A					

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS	NDI# PA · 00132
MONUMENTATION SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHERS		
OPERATION AND MAINTENANCE DATA	No maintenance in at least 25 years.	

RESERVOIR AREA AND DOWNSTREAM CHANNEL

NDIW PA - 00132

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS
SLOPES: RESERVOIR	Right abutment slopes 10 to 15 percent and is wooded. Left abutment slopes 5 to 10 percent and is wooded.
SEDIMENTATION	Sedimentation or man-placed soils has filled original stream channel to within 3.0' of water surface for a distance of about 300 feet upstream of the dam.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Normal channel for mountain stream.
SLOPES: CHANNEL VALLEY	Natural wooded stream valley
APPROXIMATE NUMBER OF HOMES AND POPULATION	7 occupied homes - 800-1200' downstream and south of road.
WATERSHED DESCRIPTION	Wooded mountainous area.

APPENDIX B

ENGINEERING DATA - CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM   Lower Twin Lake

NDI# PA·00132

ITEM	REMARKS								
PERSONS INTERVIEWED AND TITLE	Jessie Young, Caretaker								
REGIONAL VICINITY MAP	See Exhibit E-1, Appendix E								
CONSTRUCTION HISTORY	None Available								
AVAILABLE DRAWINGS	None								
TYPICAL DAM SECTIONS	See Exhibit A-3, Appendix A								
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	None available None available None Available								

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

NDI# PA - 00132

ITEM	REMARKS
SPILLWAY PLAN SECTION DETAILS	None
OPERATING EQUIP- MENT PLANS AND DETAILS	None
DESIGN REPORTS	None
GEOLOGY REPORTS	Information on sub-surface conditions at the damsite is not available. Geologic description of the site, extracted from "Groundwater in NE Pennsylvania, Bulletin W-4", Pennsylvania Topographic and Geologic Survey, 1937; and is presented in Appendix F.
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

NDI# PA - 00132

ITEM	REMARKS						
BORROW SOURCES	Unknown						
POST CONSTRUCTION DAM SURVEYS	None						
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None						
HIGH POOL RECORDS	None						
MONITORING SYSTEMS	None						
MODIFICATIONS	None						

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS					
PRIOR ACCIDENTS OR FAILURES	None reported					
MAINTENANCE RECORDS MANUAL	None					
OPERATION RECORDS MANUAL	None					
OPERATIONAL PROCEDURES	self-regulating.					
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None					
MISCELLANEOUS						

SIZE OF DRAINAGE AREA. ____1.03 sq. mi.____

ELEVATION TOP NORMAL POOL __1496.5__   STORAGE CAPACITY ____316 ac. ft.____

ELEVATION TOP FLOOD CONTROL POOL __NA__   STORAGE CAPACITY __NA__

ELEVATION MAXIMUM DESIGN POOL __N/A__   STORAGE CAPACITY __NA__

ELEVATION TOP DAM: __1496.5__   STORAGE CAPACITY: ____316 ac. ft.____

SPILLWAY DATA   NOT APPLICABLE

   CREST ELEVATION: _____

   TYPE: __No existing spillway_____

   CREST LENGTH: _____

   CHANNEL LENGTH: _____

   SPILLOVER LOCATION: _____

   NUMBER AND TYPE OF GATES: _____

OUTLET WORKS   NOT APPLICABLE EXCEPT AS NOTED

   TYPE: __None visible._____

   LOCATION: _____

   ENTRANCE INVERTS: __Not visible. Appears to be buried.__

   EXIT INVERTS: __Elev. 1486.2_____

   EMERGENCY DRAWDOWN FACILITIES __None_____

HYDROMETEOROLOGICAL GAGES

   TYPE: __N/A_____

   LOCATION: _____

   RECORDS: _____

MAXIMUM NON-DAMAGING DISCHARGE: __Unknown_____

APPENDIX C

PHOTOGRAPHS

RUBBLE MASONRY WALLS

ORIGINAL STREAM CHANNEL

16" PIPE

DIKE

ACCESS ROAD

DIVERSION CHANNEL
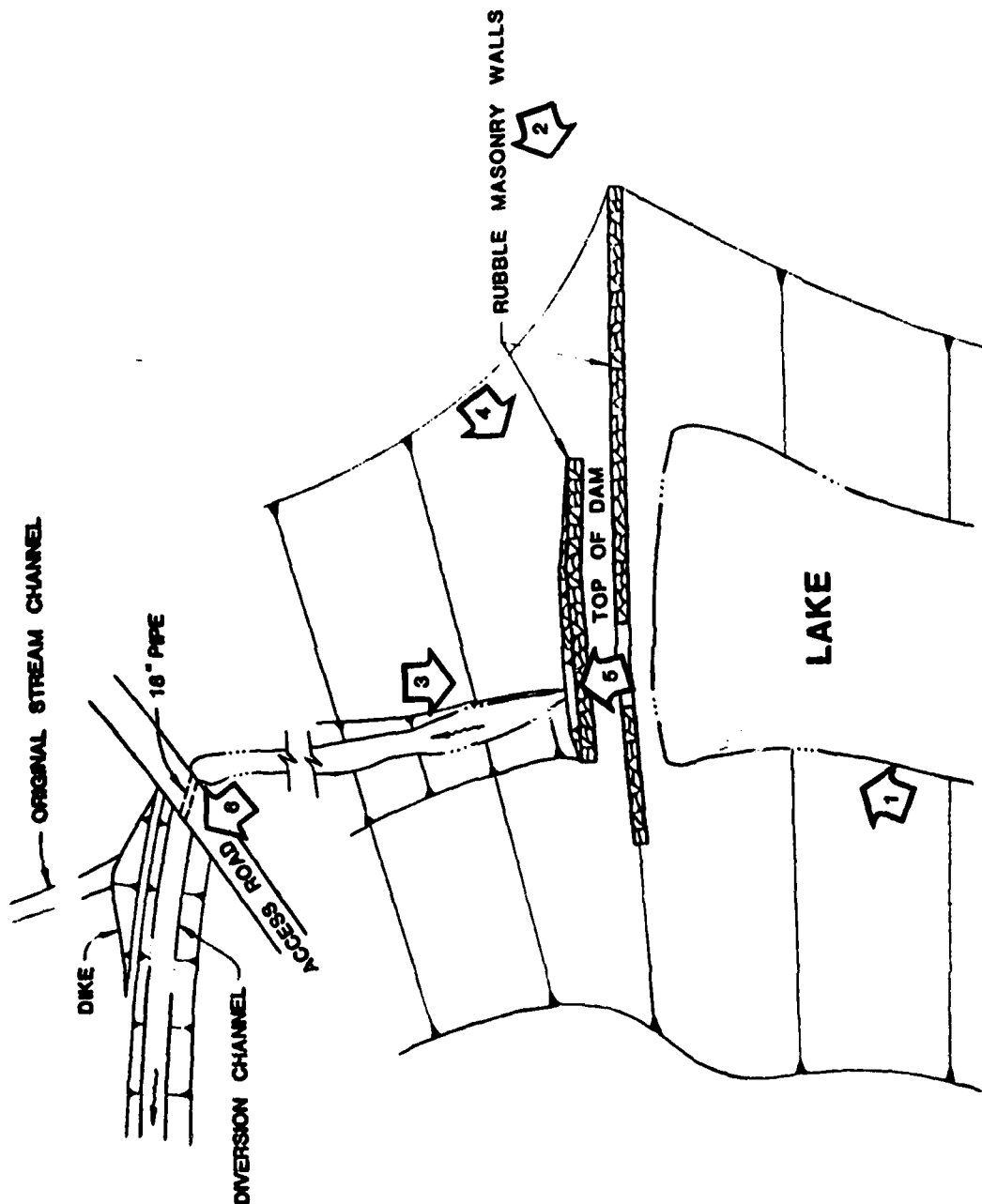
TOP OF DAM

LAKE

LOWER TWIN LAKE DAM
PHOTOGRAPHS LOCATION MAP

EXHIBIT C-1
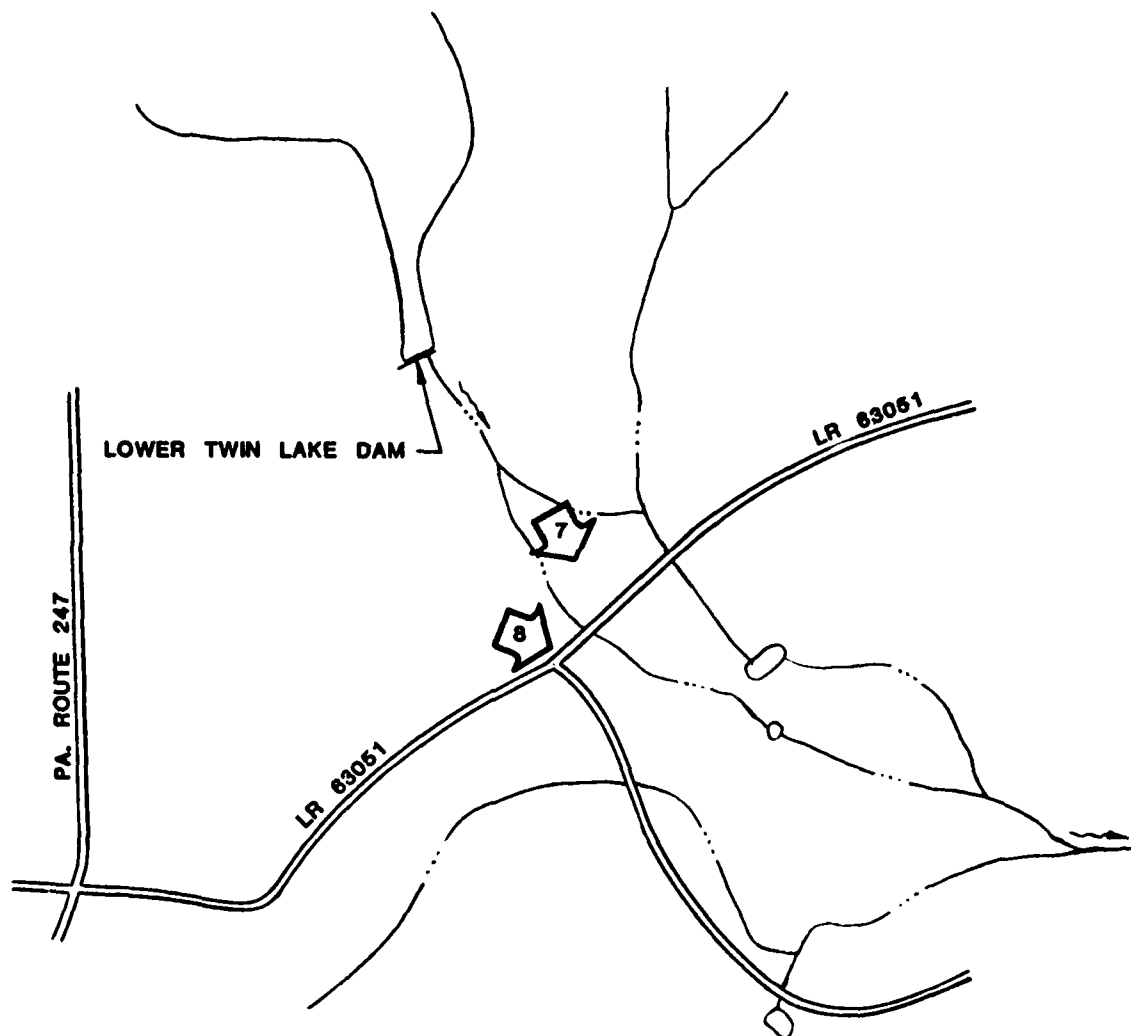
LOWER TWIN LAKE DAM
DOWNSTREAM PHOTOGRAPHS LOCATION MAP

EXHIBIT C-2

1. UPSTREAM FACE OF DAM

2. TOP OF DAM FROM RIGHT ABUTMENT SHOWING UPPER DRY MASONRY WALL

3. DOWNSTREAM FACE OF DRY STONE WALL SHOWING OUTLET OPENING

4. UPPER & LOWER DRY MASONRY WALL SHOWING BREACH AREA

6. DOWNSTREAM VIEW OF DIVERSION CHANNEL (ARROW TO LEFT)
   AND ORIGINAL CHANNEL (ARROW TO TOP)

5. DOWNSTREAM VIEW OF STREAM CHANNEL FROM DAM

7. DOWNSTREAM VIEW OF HOMES 1000' BELOW DAM

8. EASTWARD VIEW FROM ROAD OF HOMES 1000' BELOW DAM

APPENDIX D

HYDROLOGY AND HYDRAULICS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY INVESTIGATIONS

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the over-topping potential of the dam, and (2) estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam over-topping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.

- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would over-top the dam.

- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program, refer to the Users Manual for the Flood Hydrograph Package (HEC-1), Dam Safety Investigations prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB _LOWER TWIN LAKE_ _PA-00132_

SHEET NO _____ OF _____

CALCULATED BY _WEH_ _____ DATE _2/13/81_

CHECKED BY _____ DATE _____

SCALE _____

1.) DEVELOP INFLOW HYDROGRAPH TO UPPER TWIN LAKE

2.) ROUTE THRU UPPER TWIN RESERVOIR

3.) ROUTE TO INLET OF LOWER TWIN RESERVOIR

4.) DEVELOP INFLOW HYDROGRAPH TO LOWER TWIN LAKE
OF ADDITIONAL DRAINAGE AREA.

5.) COMBINE HYDROGRAPHS

6.) ROUTE THRU LOWER TWIN RESERVOIR

7.) ROUTE TO DOWNSTREAM SECTIONS

LAKE COMO, PA.—N.Y.
SE/4 SYRACUSE 15 QUADRANGLE
N4145—W7515/7 5
1968

HANCOCK QUADRANGLE

0.79 Sq. Mi.

0.26 Sq. Mi.

Upper Twin Lake

Lower Twin Lake

Lake Como

High Lake

Armstrong Pond

EXHIBIT E-1

REGIONAL VICINITY
AND
WATERSHED BOUNDARY MAP

— — — LONGEST WATERCOURSE

⊙ CENTROID OF DRAINAGE AREA

D-3

EXHIBIT E-1

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

GENERAL DATA

RIVER BASIN	DELAWARE (SUB-BASIN 1) *
STREAM NAME	BRANCH OF KINNEYVILLE CREEK
DAM NAME	LOWER TWIN LAKE DAM
NDI ID No.	PA-00132
DER ID No.	DER 64-018
OWNER	CAMP WAYNE
LOCATION	PRESTON TWP., WAYNE Co., PA
	LAT. N 41°51'16"
	LONG. W 75°20'04"
SIZE CATEGORY	SMALL
HAZARD CATEGORY	HIGH
UPSTREAM DAMS	UPPER TWIN LAKE DAM
DOWNSTREAM DAMS	NONE

* PENN-DER WATER RESOURCES BULLETIN No. 5

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

UPPER TWIN LAKE

DRAINAGE BASIN & UNIT HYDROGRAPH DATA

DRAINAGE AREA   0.79 Sq. Mi.

SNYDER UNIT HYDROGRAPH COEFFICIENTS
AS SUPPLIED BY BALT. DIST. COE (DELAWARE BASIN ZONE 1)

$$C_p = 0.45$$
$$C_t = 1.23$$

LAG TIME $= T_p = C_t (L \times L_{ca})^{0.3}$

$L = 1.33$ mi RESERVOIR OUTLET TO DRAINAGE DIVIDE

$L_{ca} = 0.53$ mi RESERVOIR OUTLET TO CENTROID

$$\therefore T_p = 1.23(1.33 \times 0.53)^{0.3} = 1.11 \text{ HRS}.$$

RAINFALL DATA

PER HYDROMETEOROLOGICAL REPORT No. 33

PMF RAINFALL = 21.5" (24 HR & 200 Sq. Mi.)

RAINFALL DISTRIBUTION

6 HR	111 %
12 HR	123 %
24 HR	133 %
48 HR	142 %

JOB *LOWER TWIN LAKE   PA-00132*

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

SHEET NO _____ OF _____
CALCULATED BY _WEH_____ DATE _2/13/81_
CHECKED BY _____ DATE _____
SCALE _____

UPPER TWIN LAKE (CONT.)

DAM DATA

TOP OF DAM ELEV. (LOW POINT)	1560.8
DAM LENGTH (INC. SPILLWAY)	320'
DAM HEIGHT	6.8'
DAM WIDTH	20'±
"C" VALUE - DAM	2.7
LEVEL DAM	

SPILLWAY DATA

THERE IS No CONVENTIONAL EMERGENCY SPILLWAY

THE SERVICE SPILLWAY CONSISTS OF A 4.8'H. × 2.3'W CONC.
BOX W/ 2' OF STOP LOGS TO RAISE THE WATER SURFACE
TO 1556.0 . THE CONC. BOX TRANSITIONS TO A 24"⌀
CMP @ THE OUTLET END. COMPUTE RATING CURVE
FOR THE OUTLET & INPUT DIRECTLY.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB _LOWER TWIN LAKE_ _PA-00132_
SHEET NO _____ OF _____
CALCULATED BY _WEH_ DATE _3/9/81_
CHECKED BY_____ DATE_____
SCALE _____

[UPPER TWIN LAKE SPILLWAY]

2.3'

EL. 1560.8

EL. 1558.5

EL. 1556.0

EL. 1554.0

4.5'

2.0'

STOPLOGS

ELEVATION   PROFILE
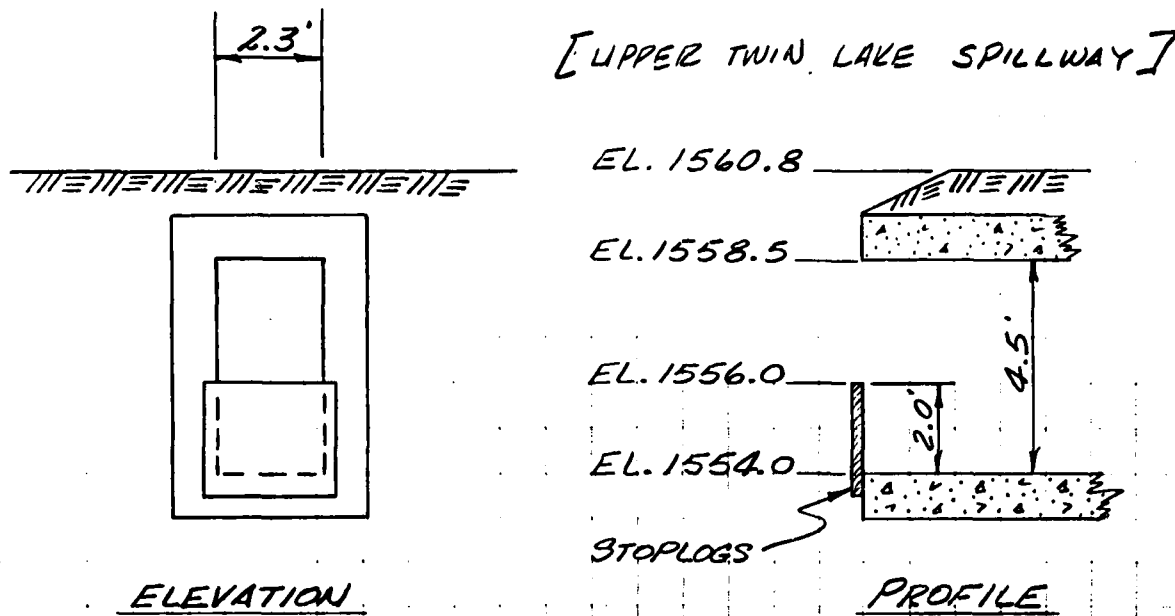
ASSUME SHARP CRESTED WEIR FLOW UNTIL ENTRANCE IS SUBMERGED

$$Q = CLH^{3/2}$$

$C = 3.1$

$L = 2.3'$

H = DEPTH OF WATER ABOVE STOPLOGS (W.S. - 1556.0)

AFTER THE ENTRANCE IS SUBMERGED USE ORIFICE FLOW

$$Q = Ca\sqrt{2gh}$$

$C = 0.7$

$a = 5.75$ S.F.

$g = 32.2$ FT/SEC²

h = DEPTH OF WATER ABOVE ¢ ORIFICE (W.S. - 1557.25)

JOB *LOWER TWIN LAKE PA-00132*

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

SHEET NO ___ OF ___
CALCULATED BY _WEH_ DATE _3/9/81_
CHECKED BY ___ DATE ___
SCALE ___

[*UPPER TWIN LAKE SPILLWAY*]

W.S. ELEV.	H₁	h	H₂	CFS
1556.0	0	—	—	0
1557.0	1.0	—	—	7
1558.5	2.5	—	—	28
1559.0	—	1.75	—	43
1560.0	—	2.75	—	54
1560.8	—	3.55	0	61
1561.0	—	3.75	0.2	63
1562.0	—	4.75	1.2	70
1563.0	—	5.75	2.2	77
1564.0	—	6.75	3.2	84
1565.0	—	7.75	4.2	90
1566.0	—	8.75	5.2	96

NOTE: SPILLWAY RATING CURVE TO BE INPUT DIRECTLY

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB _UPPER TWIN LAKE_
SHEET NO.
CALCULATED BY
CHECKED BY
SCALE

DATE _2-13-81_
DATE

RIGHT ABUTMENT

LEFT ABUTMENT

SPILLWAY

2.3 W X 4.8 H CONC. BOX
INVERT EL. 1554.0

LAKE EL. 1556.0
TOP OF STOP LOGS

1580.0

1560.8

1580.0

1560.8

1560.8

1578
1576
1574
1572
1570
1568
1566
1564
1562
1560
1558
1556
1554

0   1   2   +50   3   4   +50   5   6   7

D-9

LOWER TWIN LAKE   PA-00132
SHEET NO
CALCULATED BY WEH
CHECKED BY
SCALE

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

DATE 2/16/81
DATE

UPPER TWIN LAKE (CONT.)

STORAGE DATA

ELEV (FT.)	AREA (Ac)	STORAGE (MG.)	(AC.FT.)	DESCRIPTION
1483.7 (1)	0	0	0	RESERVOIR BOT.
1556	55	433 *	1325	NORMAL POOL
1560.8	74	534	1633	TOP OF DAM
1580	95	1062	3251	CONTOUR

(1) ESTABLISH ELEV. @ 0 AREA

USE STORAGE PER BULLETIN 5 = 433 MG. @ ELEV. 1556

$$\Delta E = \frac{3S}{A} = \frac{(3)(1325)}{55} = 72.3'$$

ELEV. @ 0 AREA = 1556 - 72.3 = 1483.7

* PENN-DER WATER RESOURCES BULLETIN No. 5

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB LOWER TWIN LAKE   PA-00132
SHEET NO   OF
CALCULATED BY WEH   DATE 2/16/81
CHECKED BY   DATE
SCALE

LOWER TWIN LAKE

DRAINAGE BASIN & UNIT HYDROGRAPH DATA

DRAINAGE AREA

DOWNSTR. OF UPPER TWIN LAKE DAM	0.24	SQ. MI.
UPPER TWIN LAKE	0.79	SQ. MI.
TOTAL =	1.03	SQ. MI.

LENGTH OF RESERVOIR – NORMAL   2100 FT.

                  – MAX   2200 FT.

SNYDER UNIT HYDROGRAPH COEFFICIENTS
AS SUPPLIED BY BALT. DIST. COE (DELAWARE BASIN ZONE 1)

$$C_p = 0.45$$
$$C_t = 1.23$$

$$\text{LAG TIME} = T_p = C_t \times (L')^{0.6}$$

$L' = 0.20$ MI. FROM RESERVOIR INLET TO DRAINAGE DIVIDE

$$\therefore T_p = 1.23 \times 0.20^{0.6} = 0.47 \text{ HRS}$$

RAINFALL DATA

PER HYDROMETEOROLOGICAL REPORT No. 33

PMF RAINFALL = 21.5" (24 HR & 200 SQ. MI.)

RAINFALL DISTRIBUTION

6 HR	111 %
12 HR	123 %
24 HR	133 %
48 HR	142 %

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

LOWER TWIN LAKE CONT.

DAM DATA

TOP OF DAM ELEV. (LOW POINT)	1496.5
DAM LENGTH	157'
DAM HEIGHT (TOP EARTH FILL)	10.3'
DAM WIDTH	14'
"C" VALUE - DAM	2.7

NON-LEVEL DAM

LENGTH OF DAM	BELOW ELEV.
0'	1496.5
11'	1496.9
14'	1498.0
57'	1500.0
164'	1500.8
179'	1502.0
230'	1506.0

SPILLWAY DATA

THERE IS NO SPILLWAY OF ANY KIND. THE TOTAL
OUTFLOW PASSES THRU THE DRY STONE MASONRY
DAM, OR POSSIBLY INTO A HIDDEN DRAIN SOME-
WHERE BELOW RESERVOIR LEVEL.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB *LOWER TWIN LAKE   PA-00132*
SHEET NO   OF
CALCULATED BY *WEH*   DATE *2/16/81*
CHECKED BY   DATE
SCALE

OUTLET WORKS DATA

THE ORIGINAL OUTLET WORKS IS NOT VISIBLE @ THE UPSTREAM SIDE & TOTALLY INOPERABLE.

STORAGE DATA

ELEV. (FT.)	AREA (Ac)	STORAGE (MG.)	STORAGE (AC.FT.)	DESCRIPTION
1463.3 (1)	0	0	0	RESERVOIR BOT.
1495.0	26	90*	275	
1496.5	28.4	103	316	TOP OF DAM (Breach)
1500	34	139	425	CONTOUR
1520	53	421	1288	CONTOUR

(1) ESTABLISH ELEV. @ 0 AREA

USE STORAGE PER BULLETIN 5 OF 90 MG. @ ELEV. 1495

$$\Delta E = \frac{3\overline{\forall}}{A} = \frac{(3)(275)}{26} = 31.7'$$

$$ELEV. @ 0 AREA = 1495 - 31.7 = \underline{\underline{1463.3}}$$

* PENN-DER WATER RESOURCES BULLETIN No. 5

JOB LOWER TWIN LAKE   DER 64·18

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

SHEET NO.
CALCULATED BY   RJM   DATE 1-23-81
CHECKED BY _____   DATE _____
SCALE HORZ. 1"=50'   VERT. 1"=4'
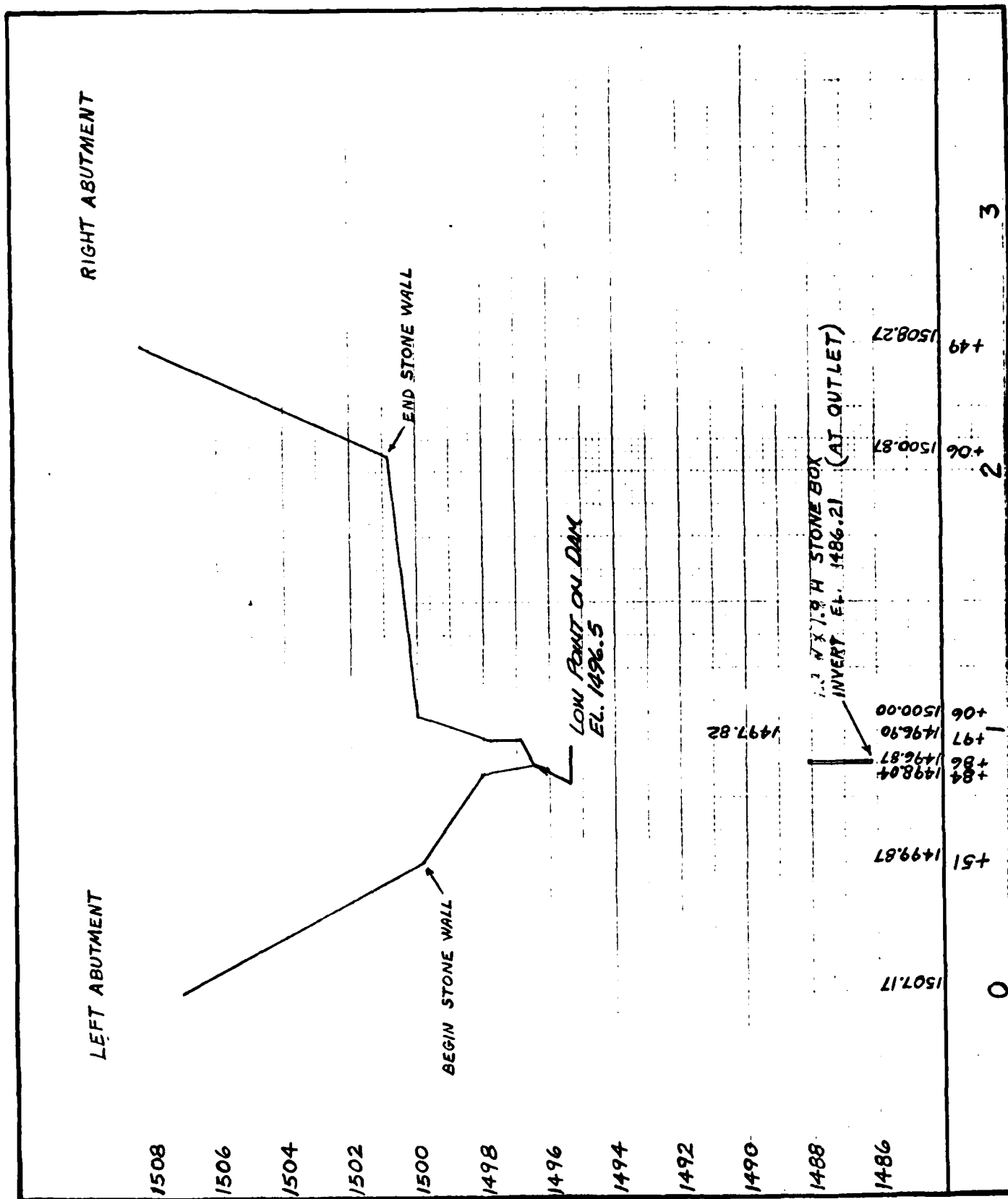
RIGHT ABUTMENT

END STONE WALL

LEFT ABUTMENT

BEGIN STONE WALL

LOW POINT ON DAM
EL. 1496.5

1497.82

2'±W X 1.8'H STONE BOX   (AT OUTLET)
INVERT EL. 1486.21

1508.27 +49
1500.87 +06   2
1500.00 +06
1496.90 +97
1496.87 +86
1498.04 +84
1499.87 +51
1507.17 0

1508
1506
1504
1502
1500
1498
1496
1494
1492
1490
1488
1486

3

D-14

JOB **LOWER TWIN LAKE** PA-00132

SHEET NO _____ OF _____

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

CALCULATED BY _WEH_ _____ DATE 3/23/81

CHECKED BY _____ DATE _____

SCALE _____

DUE TO THE DOWNSTREAM HAZARD CONDITIONS & THE RESULTS
OF THE OVERTOPPING ANALYSIS, A BREACH ANALYSIS WILL
BE MADE ON LOWER TWIN LAKE DAM. UPPER TWIN LAKE DAM
DOES NOT HAVE A POTENTIAL FOR OVERTOPPING FAILURE
SERIOUS ENOUGH TO WARRANT FURTHER INVESTIGATION.

THE DAM IS A DRY STONE MASONRY / EARTH FILL STRUCTURE.
HOWEVER, FIELD EXAMINATION SHOWS THAT THE DAM HAS
BEEN PARTIALLY BREACHED BY A PREVIOUS OVERTOPPING, AND
IS IN SUCH A WEAKENED STATE THAT ANOTHER OVERTOPPING
OF 1' TO 2' DEPTH WOULD RESULT IN MORE SERIOUS
DAMAGE. HOWEVER, THE DAM WAS PLACED AT THE OUTLET
OF A NATURAL LAKE, & EVEN IF THE FULL HEIGHT OF
DAM WERE TO FAIL, THE RESERVOIR WOULD NOT BE
DRAINED BELOW THE ELEV. OF THE NATURAL LAKE OUTLET,
SO ASSUME THE BOT. OF THE BREACH TO BE AT THIS
ELEV. = 1492.5
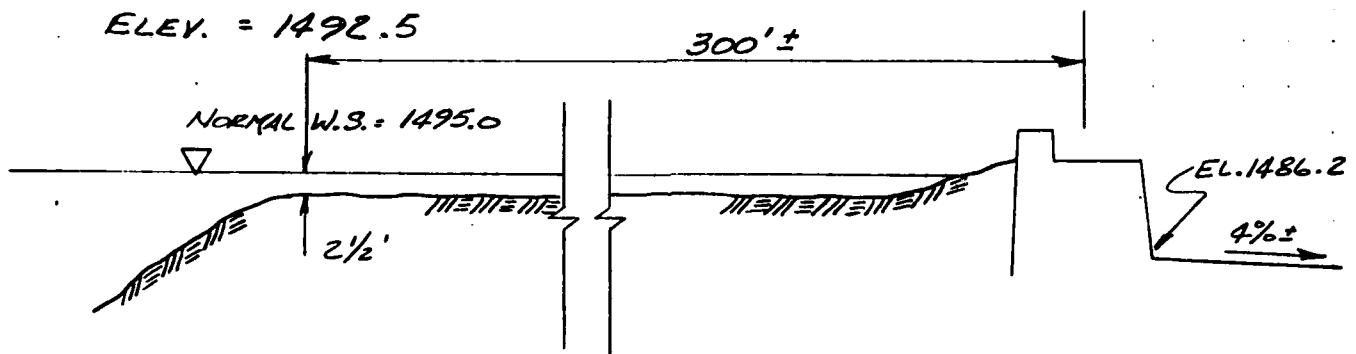
ANALYZE THE DAM FOR BREACH WIDTH OF 15', SIDE SLOPES OF
0.5 H ON 1V, BOT. ELEV. = 1492.5, FAILURE TIME OF
15 MIN. & BEGINNING WHEN OVERTOPPING REACHES 1' DEPTH.
INVESTIGATE FAILURES OCCURING DURING 0.2 PMF, THE MIN.
FLOOD MEETING THE OVERTOPPING CRITERIA, AND 0.5 PMF,
THE SELECTED SPILLWAY DESIGN FLOOD.

GEO-TECHNICAL SERVICES
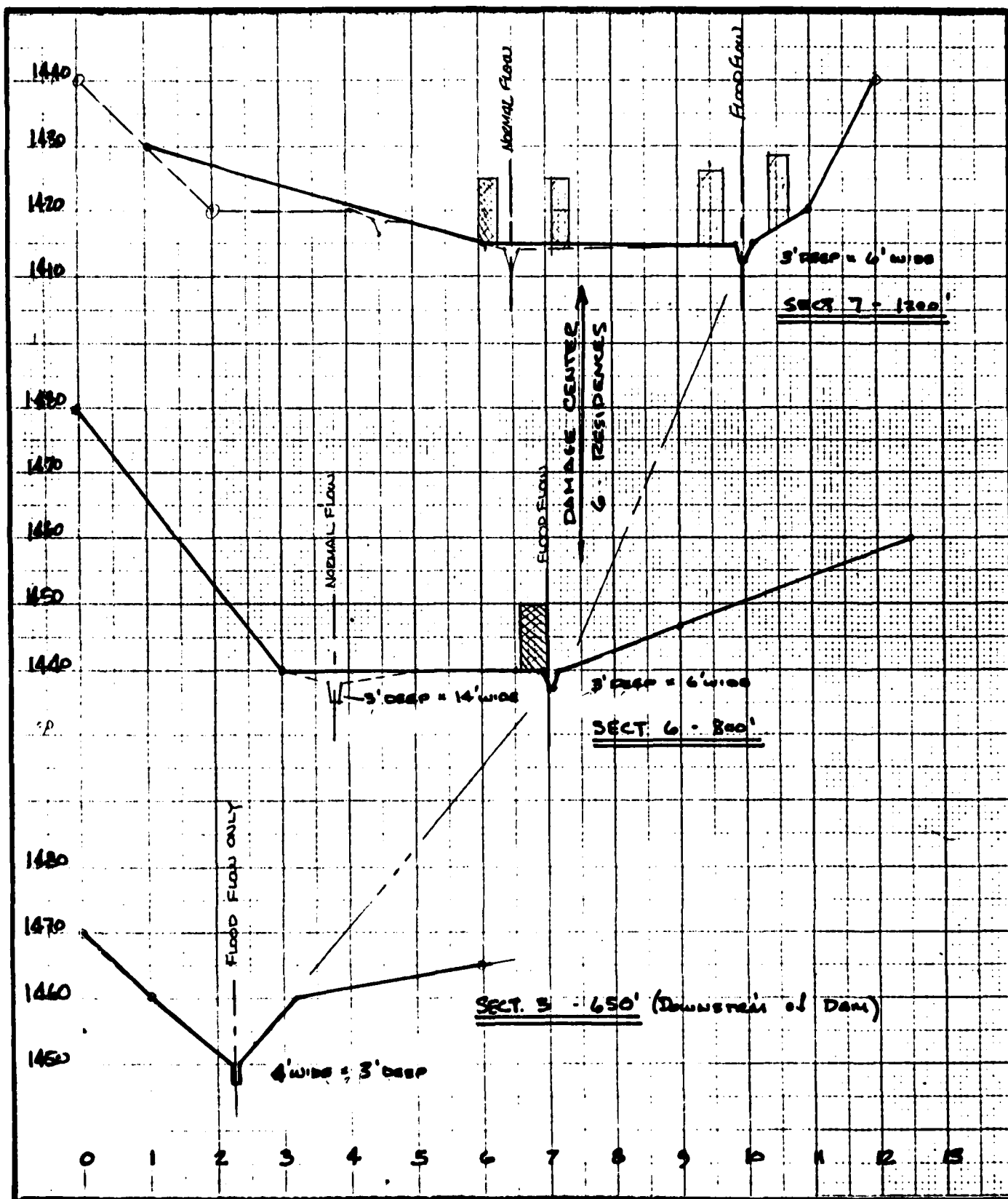Consulting Engineers & Geologists

JOB **LOWER TWIN LAKE**
SHEET NO ___1___ OF _1_
CALCULATED BY _____ sfm _____ DATE _4/81_
CHECKED BY _____ DATE _____
X-SECTIONS DOWNSTREAM OF DAM

D-15 A

NOTE: LOWER TWIN DAM HAS NO OUTLET FACILITIES. SPILLWAY VALUES REFER TO LOW POINT ON EXISTING BREACH.

```
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION    JULY 1978
LAST MODIFICATION  01 APR 80

          A1     NATIONAL DAM INSPECTION PROGRAM
          A2     LOWER TWIN LAKE--PA00132 (OVERTOPPING ANALYSIS)
          A3     PRESTON TWP, WAYNE CO. PA
 1        B     150      0       0       0       0       0       0       0
 2        B1     5       0       1       7       1       0       0       0
 3        J1    .1      .1      .2      .3      .4      .5     .75
 4        K1     0       1
 5                    INFLOW TO UPPER TWIN LAKE (SUB-AREA 1)
 6        M      1     0.79     1      1.03
 7        P      0     21.5    111     123     133     142
 8        J      0       0       0       2       0       0       0
 9        X    1.11    0.45
10        K     -1.5   -.05
11        K1     0       1
12                   ROUTE THRU UPPER TWIN LAKE
13        Y1     0       0       0       0       1       1       1
14        Y      1       0                  -1556
15      Y41556.0 1557.0 1558.5 1559.0 1560.0 1560.8 1561.0 1562.0 1563.0 1564.0
16      Y41565.0 1566.0
17        V5    90      96      74      28      45      54      61      70      77      84
18        V5     0      55      95
19        SA     0
20      SE1483.7 1556  1560.8  1580
21      SS1556.0
22      SD1560.8 2.7    1.5     335
23        SL    335     600
24      SV1560.8 1561.5 1578
25        K      1       3
26        K1     0       1
27                   LOWER TWIN LAKE STA 3
28        K1     0       0       0       0       0       0       0
29        Y1     0       0
30        Y1     1       0
31        K1     0       1
32                   LOWER TWIN LAKE (SUB-AREA 2)
33        M      1     0.24     1      1.03
34        P      0     21.5    111     123     133     142
35        T      0       0
36        J    0.47    0.45
37        X    -1.5    -.05
38        K      2       3
39        K1     0       1
40                   INFLOW TO LOWER TWIN LAKE
41        K1     0       0       4       0       0       0       0       1
42        Y1     0       0
43        Y1     1       1
44        K1     0       1
45                   ROUTE THRU LOWER TWIN LAKE
46        SA     0      26     28.4    34      53
47      SE1463.3 1495  1496.5  1500    1520
48      SS1496.5 0       0      1.5
49      SD1496.5 2.7    1.5     0       0       0
50        SL    11      14      57     164     179     230
```

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```
                 SV1496.5  1496.9   1498   1500  1500.8   1502   1506
51   SV1496.5   1496.9   1498   1500  1500.8   1502   1506
52   K      1      5      0      0      1      0      1
53   K1        ROUTE TO STREAM SECTION AT STA 5
54   Y      0      0      0      1      1      0
55   Y1     1      0      0      0      0
56   Y6   .08    .04    .08   1470    650 0.0646
57   Y7     0   1470    100   1447   1450    221    225   1447
58   Y7   226   1450    320    600   1465
59   K      1      6      0      0      1      0      1
60   K1        ROUTE TO STREAM SECTION AT STA 6
61   Y      0      0      0      1      1      0
62   Y1     1      0      0      0      0
63   Y6   .08    .04    .08   1480    150 0.0667
64   Y7     0   1480    300   1437   1440    696    702   1437
65   Y7   703   1440    900   1250   1460
66   K      1      7      0      0      1      0      1
67   K1        ROUTE TO STREAM SECTION AT STA 7
68   Y      0      0      0      1      1      0
69   Y1     1      0      0      0      0
70   Y6   .08    .04    .08   1412    400 0.0650
71   Y7     0   1430    605   1412   1415    992    998   1412
72   Y7  1010   1415   1100   1200   1440
73   K     99
```

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NATIONAL DAM INSPECTION PROGRAM
LOWER TWIN LAKE--PA00152 (OVERTOPPING ANALYSIS)
PRESTON TWP, WAYNE CO, PA

JOB SPECIFICATION

NO	NMR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	-4	0

JOPER	NUT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 7 LRTIO= 1
RTIOS= .10 .20 .30 .40 .50 .75 1.00

****

SUB-AREA RUNOFF COMPUTATION

INFLOW TO UPPER TWIN LAKE (SUB-AREA 1)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.79	0.00	1.03	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	135.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 1.11 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 41 END-OF-PERIOD ORDINATES, LAG= 1.11 HOURS, CP= .45 VOL=1.00

19.	69.	134.	187.	203.	187.	162.	141.	123.	107.
93.	80.	70.	61.	55.	46.	40.	35.	30.	26.
23.	20.	17.	15.	13.	11.	10.	9.	7.	6.

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```
                                                                    END-OF-PERIOD FLOW
  MO.DA HR.MN PERIOD RAIN EXCS LOSS    MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q
  6.    5.    4.     3.   2.   2.      6.    5.    4.     3.   2.   2.   2.
  1.

                                          SUM   24.42  22.04  2.39  43874.
                                             ( 620.)( 560.)( 61.)( 1242.37)

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

                        HYDROGRAPH ROUTING

            ROUTE THRU UPPER TWIN LAKE

         ISTAQ  ICOMP  IECON  ITAPE  JPLT  JPRT  INAME  ISTAGE  IAUTO
           2      1      0           1     1      0       0

                              ROUTING DATA
         QLOSS  CLOSS   AVG    IRES  ISAME  IOPT  IPMP   LSTR
          0.0   0.000   0.00    1     1      0     0      0

         NSTPS  NSTDL   LAG   AMSKK    X     TSK   STORA  ISPRAT
           1      0    0.000  0.000  0.000  0.000  1556.    1
```

STAGE	1556.00	1557.00	1558.50	1559.00	1560.00	1560.80	1561.00	1562.00	1563.00	1564.00
	1565.00	1566.00
FLOW	0.00	7.00	28.00	43.00	54.00	61.00	63.00	70.00	77.00	84.00
	90.00	96.00

```
SURFACE AREA=   0.    55.     74.     95.
CAPACITY=       0.   1326.   1634.   3252.
ELEVATION=   1484.   1556.   1561.   1580.

         CREL   SPWID  COQW  EXPW  ELEVL  COQL  CAREA  EXPL
        1556.0   0.0   0.0   0.0    0.0   0.0    0.0   0.0

                         DAM DATA
                  TOPEL   COQO  EXPO  DAMWID
                 1560.8   2.7   1.5    335.
```

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CREST LENGTH
AT OR BELOW   0.   535.   600.
ELEVATION   1560.8   1561.5   1578.0

PEAK OUTFLOW IS   13. AT TIME   48.00 HOURS

PEAK OUTFLOW IS   34. AT TIME   47.25 HOURS

PEAK OUTFLOW IS   52. AT TIME   47.25 HOURS

PEAK OUTFLOW IS   69. AT TIME   47.25 HOURS

PEAK OUTFLOW IS   302. AT TIME   44.25 HOURS

PEAK OUTFLOW IS   1058. AT TIME   42.75 HOURS

PEAK OUTFLOW IS   1696. AT TIME   42.00 HOURS

HYDROGRAPH ROUTING

LOWER TWIN LAKE STA 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

IRES	ISAME	IOPT	IPMP	LSTR
0	0	0	0	0

QLOSS	CLOSS	AVG
0.0	0.000	0.00

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORM	ISPRAT
1	0	0	0.000	0.000	0.	0.000	0

SUB-AREA RUNOFF COMPUTATION

LOWER TWIN LAKE (SUB-AREA 2)

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	3	0	0	0	0	0	4	0	0

HYDROGRAPH DATA

IMYDB	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	FSAME	LOCAL
1	1	.24	0.00	1.03	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	133.00	142.00	0.00	0.03

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
J	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= .47   CP= .45   NTA= 0

RECESSION DATA

STRTQ= -1.50   QRCSN= -.05   RTIOR= 2.00

UNIT HYDROGRAPH 16 END-OF-PERIOD ORDINATES, LAG= .47 HOURS, CP= .45   VOL= 1.00

52. 132. 136. 93. 64. 44. 30. 21. 14. 10.

7. 5. 3. 2. 2. 1.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
		SUM	24.42	22.04	2.39	13655.
			(620.)(	560.)(	61.)(	386.67)

****

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COMBINE HYDROGRAPHS

INFLOW TO LOWER TWIN LAKE

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	3	2	0	0	0	0	1	0	0

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

HYDROGRAPH ROUTING

ROUTE THRU LOWER TWIN LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	1	0

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	IOFT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1497.	0

SURFACE AREA=	0.	26.	28.	34.	53.
CAPACITY=	0.	275.	316.	425.	1288.
ELEVATION=	1463.	1495.	1497.	1500.	1520.

DAM DATA

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1496.5	0.0	2.7	1.5	0.0	0.0	0.0	0.0

TOPEL	COQD	EXPD	DAMWID
1496.5	2.7	1.5	157.

CREST LENGTH AT GR BELOW	0.	11.	14.	57.	164.	179.	230.
ELEVATION	1496.5	1496.9	1498.0	1500.0	1500.8	1502.0	1506.0

PEAK OUTFLOW IS 19. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 57. AT TIME 42.75 HOURS

PEAK OUTFLOW IS   110. AT TIME 42.75 HOURS

PEAK OUTFLOW IS   173. AT TIME 42.50 HOURS

PEAK OUTFLOW IS   277. AT TIME 45.25 HOURS

PEAK OUTFLOW IS   1138. AT TIME 43.00 HOURS

PEAK OUTFLOW IS   2011. AT TIME 42.25 HOURS

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

HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 5

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ROUTING DATA

IRES	ISAME	IOPT	IPMP	LSTR
1	1	0	0	0

QLOSS	CLOSS	AVG
0.0	0.000	0.00

LAG	AMSKK	X	TSK	STORA	ISPRAT
0	0.000	0.000	0.000	0.	0

NSTPS	NSTDL
1	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1447.0	1470.0	650.	.06460

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CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1470.00 100.00 1460.00 220.00 1450.00 221.00 1447.00 225.00 1447.00
226.00 1450.00 320.00 1460.00 600.00 1460.00 1465.00

| STORAGE | 0.00 | .08 | .17 | .34 | .93 | 1.98 | 3.51 | 5.50 | 7.96 | 10.88 |
| | 14.28 | 18.17 | 23.24 | 29.76 | 37.72 | 47.11 | 57.18 | 67.47 | 77.98 | 88.71 |

| OUTFLOW | 0.00 | 43.98 | 129.78 | 274.51 | 619.41 | 1312.65 | 2477.07 | 4219.55 | 6637.27 | 9820.55 |
| | 13854.54 | 18268.78 | 23231.99 | 30442.87 | 39878.71 | 52052.30 | 68851.00 | 87962.89 | 109316.08 | 132859.35 |

| STAGE | 1447.00 | 1448.21 | 1449.42 | 1450.63 | 1451.84 | 1453.05 | 1454.26 | 1455.47 | 1456.68 | 1457.89 |
| | 1459.11 | 1460.32 | 1461.53 | 1462.74 | 1463.95 | 1465.16 | 1466.37 | 1467.58 | 1468.79 | 1470.00 |

| FLOW | 0.00 | 43.98 | 129.78 | 274.51 | 619.41 | 1312.65 | 2477.07 | 4219.55 | 6637.27 | 9820.55 |
| | 13854.54 | 18268.78 | 23231.99 | 30442.87 | 39878.71 | 52052.30 | 68851.00 | 87962.89 | 109316.08 | 132859.35 |

MAXIMUM STAGE IS   1447.5

MAXIMUM STAGE IS   1448.4

MAXIMUM STAGE IS   1449.1

MAXIMUM STAGE IS   1449.8

MAXIMUM STAGE IS   1450.6

MAXIMUM STAGE IS   1452.7

MAXIMUM STAGE IS   1453.8

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

HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 6

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

IRES	ISAME	IOPT	LSTR
0	1	1	0

CLOSS	AVG	IPMP
0.000	0.00	

QLOSS
0.0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	

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NORMAL DEPTH CHANNEL ROUTING

```
          QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH    SEL
          .0800   .0800   .0800   1437.0  1480.0   150.   .06670
```

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
```
     0.00 1480.00  300.00 1440.00  695.00 1440.00  696.00 1437.00  702.00 1437.00
   705.00 1440.00  900.00 1447.00 1250.00 1460.00
```

STORAGE	0.00	.05	2.33	6.21	10.72	15.85	21.59	27.94	34.90	42.46
	50.63	59.24	67.99	76.87	85.89	95.03	104.31	113.72	123.27	132.94
OUTFLOW	0.00	185.72	4613.09	20480.66	46265.25	81943.61	127741.67	184002.13	251162.09	329689.58
	420068.27	530413.66	654306.26	789880.67	936855.60	1095010.02	1264167.77	1444187.35	1634954.61	1836377.47
STAGE	1437.00	1439.26	1441.53	1443.79	1446.05	1448.32	1450.58	1452.84	1455.11	1457.37
	1459.63	1461.89	1464.16	1466.42	1468.68	1470.95	1473.21	1475.47	1477.74	1480.00
FLOW	0.00	185.72	4613.09	20480.66	46265.25	81943.61	127741.67	184002.13	251162.09	329689.58
	420068.27	530413.66	654306.26	789880.67	936855.60	1095010.02	1264167.77	1444187.35	1634954.61	1836377.47

MAXIMUM STAGE IS   1437.2

MAXIMUM STAGE IS   1437.7

MAXIMUM STAGE IS   1438.3

MAXIMUM STAGE IS   1439.1

MAXIMUM STAGE IS   1439.3

MAXIMUM STAGE IS   1439.8

MAXIMUM STAGE IS   1440.2

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```
••••••••••    ••••••••••    ••••••••••    ••••••••••    ••••••••••    ••••••••••    ••••••••••    ••••••••••
```

HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 7

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

$GN(1)$	$GN(2)$	$GN(3)$	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1412.0	1440.0	400.	.06500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
```
   0.00 1430.00  605.00 1415.00  990.00 1415.00  992.00 1412.00  996.00 1412.00
1010.00 1415.00 1100.00 1420.00 1200.00 1440.00
```

STORAGE	0.00	.13	.35	6.18	13.37	21.72	31.18	41.58	52.88	65.08
	78.19	92.21	107.12	122.69	138.39	154.18	170.07	186.05	202.14	218.33
OUTFLOW	0.00	132.45	523.33	4794.54	14330.47	28624.92	47903.78	72197.54	101478.53	135888.18
	175593.16	220773.72	271617.60	335679.43	407636.52	485306.38	568534.00	657186.68	751149.44	850321.62
STAGE	1412.00	1413.47	1414.95	1416.42	1417.89	1419.37	1420.84	1422.32	1423.79	1425.26
	1426.74	1428.21	1429.68	1431.16	1432.63	1434.11	1435.58	1437.05	1438.53	1440.00
FLOW	0.00	132.49	523.33	4794.54	14330.47	28624.92	47903.78	72197.54	101478.53	135888.18
	175593.16	220773.72	271617.60	335679.43	407636.52	485306.38	568534.00	657186.68	751149.44	850321.62

NORMAL DEPTH CHANNEL ROUTING

MAXIMUM STAGE IS   1412.2

MAXIMUM STAGE IS   1412.6

MAXIMUM STAGE IS   1413.2

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MAXIMUM STAGE IS   1413.6

MAXIMUM STAGE IS   1414.0

MAXIMUM STAGE IS   1415.2

MAXIMUM STAGE IS   1415.5

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

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS						
				RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 .75	RATIO 7 1.00
HYDROGRAPH AT	1	.79 (2.05)	1	210. (5.94)	420. (11.88)	629. (17.82)	839. (23.76)	1049. (29.70)	1573. (44.55)	2098. (59.40)
ROUTED TO	2	.79 (2.05)	1	13. (.37)	34. (.96)	52. (1.48)	69. (1.96)	302. (8.56)	1058. (29.97)	1696. (48.01)
ROUTED TO	3	.79 (2.05)	1	13. (.37)	34. (.96)	52. (1.48)	69. (1.96)	302. (8.56)	1058. (29.97)	1696. (48.01)
HYDROGRAPH AT	3	.24 (.62)	1	99. (2.80)	198. (5.60)	297. (8.40)	396. (11.20)	495. (14.01)	742. (21.01)	989. (28.01)
2-COMBINED	3	1.03 (2.67)	1	103. (2.91)	206. (5.83)	312. (8.84)	418. (11.83)	524. (14.85)	1256. (35.56)	2096. (59.37)
ROUTED TO	4	1.03 (2.67)	1	19. (.54)	57. (1.62)	110. (3.10)	173. (4.91)	277. (7.83)	1138. (32.23)	2011. (56.96)
ROUTED TO	5	1.03 (2.67)	1	19. (.54)	57. (1.62)	110. (3.10)	173. (4.91)	277. (7.83)	1138. (32.24)	2010. (56.92)
ROUTED TO	6	1.03 (2.67)	1	19. (.54)	57. (1.62)	110. (3.10)	173. (4.91)	277. (7.83)	1139. (32.24)	2010. (56.92)
ROUTED TO	7	1.03 (2.67)	1	19. (.54)	57. (1.62)	110. (3.10)	175. (4.91)	277. (7.84)	1138. (32.23)	2010. (56.91)

SUMMARY OF DAM SAFETY ANALYSIS   (UPPER TWIN LAKE)

PLAN 1 ....

	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	STORAGE	1556.00	1556.00	1560.80
	OUTFLOW	1326.	1326.	1634.
		0.	0.	61.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1557.43	0.00	1408.	15.	0.00	48.00	0.00
.20	1558.69	0.00	1487.	34.	0.00	47.25	0.00
.30	1559.85	0.00	1565.	52.	0.00	47.25	0.00
.40	1560.97	.17	1647.	69.	3.50	47.25	0.00
.50	1561.51	.71	1687.	302.	5.75	44.25	0.00
.75	1562.12	1.32	1732.	1058.	7.25	42.75	0.00
1.00	1562.49	1.69	1760.	1696.	7.75	42.00	0.00

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SUMMARY OF DAM SAFETY ANALYSIS (LOWER TWIN LAKE)

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1496.50	1496.50	1496.50
STORAGE	316.	316.	316.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX-OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1497.37	.87	341.	19.	48.00	43.50	0.00
.20	1498.04	1.54	361.	57.	48.00	42.75	0.00
.30	1498.62	2.12	379.	110.	48.00	42.75	0.00
.40	1499.08	2.58	394.	175.	48.00	42.50	0.00
.50	1499.60	3.10	411.	277.	48.00	43.25	0.00
.75	1501.28	4.78	469.	1138.	48.00	43.00	0.00
1.00	1502.11	5.61	498.	2011.	48.00	42.25	0.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW CFS	MAXIMUM STAGE FT	TIME HOURS
.10	19.	1447.5	43.50
.20	57.	1448.4	43.00
.30	110.	1449.1	42.75
.40	175.	1449.8	42.50
.50	277.	1450.6	45.50
.75	1138.	1452.7	43.00
1.00	2010.	1453.8	42.25

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PLAN 1   STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	19.	1437.2	43.50
.20	57.	1437.7	43.00
.30	110.	1438.3	42.75
.40	173.	1439.1	42.50
.50	277.	1439.3	45.50
.75	1139.	1439.8	43.00
1.00	2010.	1440.2	42.25

PLAN 1   STATION 7

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	19.	1412.2	43.10
.20	57.	1412.6	43.01
.30	110.	1413.2	42.75
.40	173.	1413.6	42.50
.50	277.	1414.0	45.50
.75	1138.	1415.2	43.00
1.00	2010.	1415.5	42.25

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81/05/08. 09.53.58.
PROGRAM TWBK
A1      NATIONAL DAM INSPECTION PROGRAM
A2      LOWER TWIN LAKE--PA00132 (BREACH ANALYSIS)
A3      PRESTON TWP, WAYNE CO, PA
B       150
B1        5
J1        1        2        1
K         .2       .5
KM            INFLOW TO UPPER TWIN LAKE (SUB-AREA 1)
PB      100      .79     1.03
PI       21.5    111      123      133      142
KM
KO       1.11
KX      -1.5    0.45
        -1.5   -.05
KM            ROUTE THRU UPPER TWIN LAKE
Y1        0
Y41556.0  1557.0   1558.5   1559.0   1560.0   1560.8   1561.0   1562.0   1563.0   1564.0
T41565.0  1566.0     28       43       54       61       63       70       77       84
Y5       90       96       74       95
SA1483.7  1556    1560.8   1580
SS1556.0  2.7      1.5      335
SD1560.8  335      600
SL         .335    1578
SV1560.8 1561.5
KM            LOWER TWIN LAKE STA 3
K         1
Y1        1        0        0        0
KM            LOWER TWIN LAKE (SUB-AREA 2)
PB      100      .24     1.03
PI       21.5    111      123      133      142
KM
KO       0.47
KX      -1.5    0.45
        -1.5   -.05
KM            INFLOW TO LOWER TWIN LAKE
K         1        4        0        0
Y1        0        0        0        1
KM            ROUTE THRU LOWER TWIN LAKE
Y1        1        0        0        1        0      -1496.5
SA1463.3  26      28.4      34       53
SE1495   1496.5   1496.5   1500     1520
SS1496.5  2.7      2.7      1.5
SD1496.5  1.5      157      164      179      230
SL         11       14       57      1502     1506
SV1496.9 1498    1500     1500.8   1502.5
SB         15    1492.5   1496.5   1497.5
```

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ROUTE 5 TO STREAM SECTION AT STA 5

K1						
K1	1	0	0	0	0	1
Y1						
Y6	.08	.04	.08	0.0646	650	1447
Y7	226	1470	100	221	1450	1460
Y7	1	1450	320	1	1465	1460

ROUTE 6 TO STREAM SECTION AT STA 6

K1						
K1	0	0	0	0	0	0
Y1	1	.04	.08	0.0667	150	1437
Y6	.08	1480	300	696	1440	1440
Y7	703	1440	900	1	1460	1447

ROUTE 7 TO STREAM SECTION AT STA 7

K1						
Y1	0	0	0	0	0	0
Y6	1	.04	.08	0.0650	400	1412
Y7	.08	1430	.605	992	1415	1415
Y7	1010	1475	1100	0	1440	1420
K	99		0			

NATIONAL DAM INSPECTION PROGRAM
LOWER TWIN LAKE--PA00132 (BREACH ANALYSIS)
PRESTON TWP, WAYNE CO, PA

JOB SPECIFICATION

NG	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	1	0

	JGPER	NWT	LROPT	TRACE
	4	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= .20 .50

****

SUB-AREA RUNOFF COMPUTATION

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INFLOW TO UPPER TWIN LAKE (SUB-AREA 1)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

	IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
	1	1	.79	0.00	1.03	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .200

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 1.11   CP= .45   NTA= 0

RECESSION DATA
STRTQ= -1.50   QRCSN= -.05   RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 4.68 AND R= 7.13 INTERVALS

UNIT HYDROGRAPH 41 END-OF-PERIOD ORDINATES, LAG= 1.11 HOURS, CP= .45   VOL= 1.00

| 19. | 69. | 134. | 187. | 187. | 202. | 162. | 141. | 123. | 107. |
| 53. | 80. | 70. | 61. | 52. | 46. | 40. | 35. | 30. | 26. |

```
                                    25.     20.     17.     15.     13.     11.     10.      9.      7.      6.
                                     6.      5.      4.      4.      3.      3.      2.      2.      2.      2.
                                     1.
```

MO.DA HR.MN PERIOD RAIN EXCS LOSS

END-OF-PERIOD FLOW
COMP Q   MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q

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                                                    SUM   24.42  22.04   2.39   43874.
                                                        ( 620.)( 560.)(  61.)( 1242.37)
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HYDROGRAPH ROUTING

ROUTE THRU UPPER TWIN LAKE

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	2	1	0	0	0	0	1	0	0

ROUTING DATA

	CLOSS	AVG	IRES	ISAME	IOPT	LSTR
QLOSS	0.000	0.00	1	1	0	0
0.0						

	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
NSTPS	1	0	0.000	0.000	0.000	0.000	-1556.	-1
1								

STAGE	1556.00	1557.00	1558.50	1559.00	1560.00	1560.80	1561.00	1562.00	1563.00	1564.00
	1565.00	1566.00								

FLOW	0.00	7.00	26.00	43.00	54.00	61.00	63.00	70.00	77.00	84.00
	90.00	96.00								

SURFACE AREA=	0.	55.	74.	95.
CAPACITY=	0.	1324.	1634.	3252.
ELEVATION=	1484.	1556.	1561.	1580.

	CREL	SPWID	CCGW	EXPW	ELFVL	COGL	CAREA	EXPL
	1556.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

	TOPEL	COCD	EXPD	DAMWID
	1560.8	2.7	1.5	335.

CREST LENGTH	0.	335.	600.
AT OR BELOW			
ELEVATION	1560.8	1561.5	1578.0

PEAK OUTFLOW IS   302. AT TIME   44.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	302.	198.	56.	28.	5412.
CMS	9.	6.	2.	1.	153.
INCHES		2.34	2.65	2.66	2.66
MM		59.36	67.19	67.45	67.45
AC-FT		98.	111.	112.	112.
THOUS CU M		121.	137.	138.	138.

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HYDROGRAPH ROUTING

LOWER TWIN LAKE STA 3

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

CLOSS	AVG	IKES	ISAME	IQPT	IPMP	LSTR
0.000	0.00	0	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	SICRA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

GLOSS						
0.0						

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

                              SUB-AREA RUNOFF COMPUTATION

          LOWER TWIN LAKE (SUB-AREA 2)

          ISTAQ   ICOMP   IRCON   ITAPE   JPLT   JPRT   INAME   ISTAGE   IAUTO
             3       0       0       0      0      0      1       0        0

                    HYDROGRAPH DATA
          IHYDG   IUHG   TAREA   SNAP   TPSDA   TRSPC   RATIO
             1      1     .24    0.00   1.03    0.00    0.000

                    PRECIP DATA
             SPFE    PMS    R6     R12    R24    R48    R72    R96
             0.00   21.50  111.00 127.00 137.00 142.00 0.00   0.00

TRSPC COMPUTED BY THE PROGRAM IS  .603

                    LOSS DATA
          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   ISNOW   ISAME   LOCAL
             0     0.00    0.00    1.00    0.05    0.00    1.00      0       1        0

                    UNIT HYDROGRAPH DATA
                         TP=  .47   CP=  .45   NTA=  0

                    RECESSION DATA
                    STRTQ=  -1.00   QRCSN=  -.05   RTIOR=  2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE  TC= 1.90 AND R= 2.71 INTERVALS

      UNIT HYDROGRAPH 16 END-OF-PERIOD ORDINATES, LAG=  .47 HOURS, CP=  .45   VOL= 1.00
       52.    132.    136.     64.     44.     30.     21.     14.     10.
        7.      5.      3.      2.      1.
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HYDROGRAPH ROUTING

ROUTE THRU LOWER TWIN LAKE

	ISTAQ	ICOMP	ITCON	ITAPE	JPLT	JPPT	INAME	ISTAGE	IAUTO
	4	1	0	0	0	0	1	0	0

ROUTING DATA

	GLOSS	AVG	IRFS	ISAME	IOPT	IPMP		LSTR	
	0.000	0.00	1	1	0	0		0	

GLOSS		NSTPS	NSTDL	L/G	ANSRK	X	TSK	STORA	ISPRAT
0.0		1	2	0	0.000	0.000	0.000	-1497.	0

SURFACE AREA   0.   2.   28.   74.   57.

CAPACITY-   0.   275.   316.   425.   1288.

ELEVATION   1483.   1492.   1497.   1500.   1520.

	CREL	SPWID	COQW	EXPW	ELEVL	COQL	CCQL	CAREA	EXPL
	1496.5	0.0	2.7	1.5	0.0	0.0	0.0	0.0	0.0

DAM DATA

	ICFEL	COQD	EXPD	DAMWID					
	1496.5	2.7	1.5	157.	52.	164.	179.	230.	

CREST LENGTH   0.   11.   14.

AT OR BELOW					
ELEVATION	1496.5	1496.9	1496.0	1500.0	1500.8	1502.0	1506.0

DAM BREACH DATA

	BRWID	Z	ELEM	TFAIL	WSEL	FAILEL
	15.	.50	1492.50	.25	1496.50	1497.50

STATION   4. PLAN 1. RATIO 1

BEGIN DAM FAILURE AT 40.25 HOURS

PEAK OUTFLOW IS   593. AT TIME   40.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	593.	265.	74.	37.	7110.
CMS	17.	7.	2.	1.	201.
INCHES		2.39	2.68	2.68	2.68
MM		60.71	67.95	67.96	67.96
AC-FT		131.	147.	147.	147.
THOUS CU M		162.	181.	181.	181.

BEGIN DAM FAILURE AT ?.00 HOURS

PEAK OUTFLOW IS 584. AT TIME 28.25 HOURS

STATION 4, PLAN 1, RATIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	584.	390.	146.	73.	13993.
CMS	17.	11.	4.	2.	396.
INCHES		3.52	5.27	5.27	5.27
MM		89.46	133.73	133.75	133.75
AC-FT		143.	269.	289.	289.
THOUS.CU M		232.	357.	357.	357.

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HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 5

ISTAQ	ICOMP	ITAPE	JPLT	JFLT	INAME	ISTAGE	IAUTO
5	1	0	0	0	1	0	0

ROUTING DATA
IRES	ISAME	IOPT	IPMP	LSTR
1	1	0	0	0

	CLOSS	AVG	LAG	AMSKK	X	TSK	STORA	ISPRAT
GLOSS	0.000	0.00	0	0.000	0.000	0.000	0.	0
1.0								

NSTPS	NSTDL
1	0

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NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELAVT	ELMAX	RLNTH	SEL
.0600	.0400	.0600	1447.0	1470.0	650.	.06450

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1470.00 100.00 1460.00 220.00 1450.00 221.00 1447.00 225.00 1447.00
226.00 1450.00 320.00 1460.00 600.00 1465.00

STORAGE	0.00	.0A	.17	.34	.93	1.9A	3.51	5.50	7.96	10.88
	14.28	18.17	23.24	29.76	37.72	47.11	57.18	67.47	77.98	86.71

OUTFLOW	0.00	43.54	129.78	274.51	61?.41	1312.65	2477.07	4219.55	6637.27	9820.55
	13824.54	1426?.78	23231.??	30442.?7	5987?.71	52052.30	6R?51.??	A7962.89	109316.08	132859.35

STAGE	1447.00	1448.21	144?.42	1450.63	1451.?4	1453.05	1454.26	1455.47	1456.68	1457.89
	1459.11	1460.32	1461.53	1462.74	1463.?5	1465.16	1466.37	1467.58	1468.79	1470.00

FLOW	0.00	43.9?	124.7?	?74.51	61?.41	1312.6?	2477.07	4219.55	6637.27	9820.55
	13824.54	1426?.78	23231.??	30442.?7	3987?.71	5202?.39	6?851.00	A7?62.89	109316.08	132859.35

STATION 5, PLAN 1, RTIO 1

STATION 5, PLAN 1, RTIO 2

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MAXIMUM STAGE IS 1451.6

MAXIMUM STAGE IS 1451.7

****

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HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 6

ISTAQ	ICOMP	IECON	ITAFE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

FOUTING DATA

IRES	ICAME	ICPT	IPMP	LSTR
1	1	0	0	0

CLOSS	AVG
0.000	0.000

NSTPS	NSTDL	LAG	AMSKK	TSK	STORA	ISPRAT
1	?	0	0.000	0.000	0.	0

GLOSS
0.0

NORMAL DEPTH CHANNEL ROUTING

CN(1)   SN(2)   CN(2)   ELMT   ELMX   ELPTH   SEL
.0500   .0400   .0500   1437.0   1430.0   1530.   .06670

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 14-0.00   360.00 1440.60   6+5.00 1440.00   736.00 1437.00   702.00 1437.00
763.00 1440.00   900.00 1447.00 1250.00 1460.00

STORAGE	0.00	.05	2.13	4.21	10.72	15.85	21.59	27.94	34.90	42.46
	50.63	59.64	67.99	76.87	85.89	95.03	104.31	113.72	123.27	132.94
OUTFLOW	0.00	165.72	4613.09	20480.66	46265.25	81943.61	127741.67	184002.13	251162.09	329689.58
	420068.27	530413.66	654306.24	789580.67	936855.60	1095010.02	1264167.77	1444187.35	1634954.61	1836377.47
STAGE	1437.00	1439.26	1441.53	1443.79	1446.05	1446.32	1450.58	1452.84	1455.11	1457.37
	1455.63	1461.89	1464.16	1466.42	1468.68	1470.95	1473.21	1475.47	1477.74	1480.00
FLOW	0.00	165.72	4613.09	20480.66	46265.25	81943.61	127741.67	184002.13	251162.09	329689.58
	420068.27	530413.66	654306.24	789880.67	936855.60	1095010.02	1264167.77	1444187.35	1634954.61	1836377.47

STATION   6. PLAN 1, RTIO 1

MAXIMUM STAGE IS   1439.5

STATION   6. PLAN 1, RTIO 2

MAXIMUM STAGE IS   1439.5

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

ROUTE TO STREAM SECTION AT STA 7

HYDROGRAPH ROUTING

ISTAQ	ICOMP	IFCON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	1	0	0	0	0	1	0	0

ROUTING DATA

CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.000	0.00	1	1	0	0	0

GLOSS	NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
0.0	1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

	CN(1)	CN(2)	CN(3)	ELEVT	ELMAX	RLNTH	SEL
	.0800	.0400	.0600	1412.0	1440.0	410.	.06500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1430.00 605.00 1415.00 990.00 1415.00 992.00 1412.00 998.00 1412.00
1010.00 1415.00 1100.00 1420.00 1200.00 1440.00

STORAGE	0.00	.13	.55	6.18	13.37	21.72	31.18	41.58	52.88	65.08
	78.19	92.21	107.12	122.69	136.39	154.18	170.07	186.05	202.14	218.33
OUTFLOW	6.00	130.49	525.33	4794.54	14330.47	28624.92	47903.78	72197.54	101478.53	135888.18
	175593.16	220773.72	271617.60	435579.43	407635.52	445306.38	568534.00	657186.68	751149.44	850321.62
STAGE	1412.00	1413.47	1414.55	1416.62	1417.89	1419.37	1420.84	1422.32	1423.79	1425.26
	1426.74	1426.21	1429.68	1431.16	1432.63	1434.11	1435.58	1437.05	1438.53	1440.00
FLOW	0.00	130.49	525.33	4794.54	14330.47	28624.92	47903.78	72197.54	101478.53	135888.18
	175593.16	220773.72	271617.60	435579.43	407635.52	445306.38	568534.00	657186.68	751149.44	850321.62

STATION   7, PLAN 1, RTIO 1

STATION   7, PLAN 1, RTIO 2

MAXIMUM STAGE IS   1415.0

MAXIMUM STAGE IS   1415.0

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

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO .20	RATIO 1 .20	RATIO 2 .50
HYDROGRAPH AT	1	.79 (2.05)	1	423. (11.22)(	1045. (29.70)(
ROUTED TO	2	.79 (2.05)	1	34. (.96)(	302. (8.56)(
ROUTED TO	3	.79 (2.05)	1	34. (.96)(	302. (8.56)(
HYDROGRAPH AT	3	.24 (.62)	1	196. (5.60)(	495. (14.01)(
2 COMBINED	3	1.03 (2.67)	1	206. (5.83)(	524. (14.85)(
ROUTED TO	4	1.03 (2.67)	1	593. (16.78)(	584. (16.53)(
ROUTED TO	5	1.03 (2.67)	1	597. (16.91)(	591. (16.73)(
ROUTED TO	6	1.03 (2.67)	1	612. (17.33)(	605. (17.14)(
ROUTED TO	7	1.03 (2.67)	1	624. (17.68)(	616. (17.50)(

[UPPER TWIN]

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1556.00	1556.00	1560.80
STORAGE	1326.	1326.	1634.
OUTFLOW	0.	0.	61.

PLAN 1								
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1554.69			0.00	1447.	0.00	47.25	0.00
.50	1561.51			.71	1687.	5.75	44.25	0.00

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SUMMARY OF DAM SAFETY ANALYSIS

LOWER TWIN

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1496.50	1496.50	1496.50
STORAGE	316.	316.	316.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1497.60	1.10	348.	593.	41.50	40.50	40.25
.50	1497.55	1.05	346.	584.	40.75	38.25	38.00

PLAN 1   STATION   5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	597.	1451.8	40.75
.50	591.	1451.7	38.50

PLAN 1   STATION   6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	612.	1439.5	40.75
.50	605.	1439.5	38.50

PLAN 1   STATION   7

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	624.	1415.0	40.75
.50	618.	1415.0	38.50

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APPENDIX E

EXHIBITS

LAKE COMO, PA.—N.Y.
SE/4 STARRUCCA 15 QUADRANGLE
N4145—W7515/7.5
1968

EXHIBIT E-1
REGIONAL VICINITY
AND
WATERSHED BOUNDARY MAP

HANCOCK QUADRANGLE
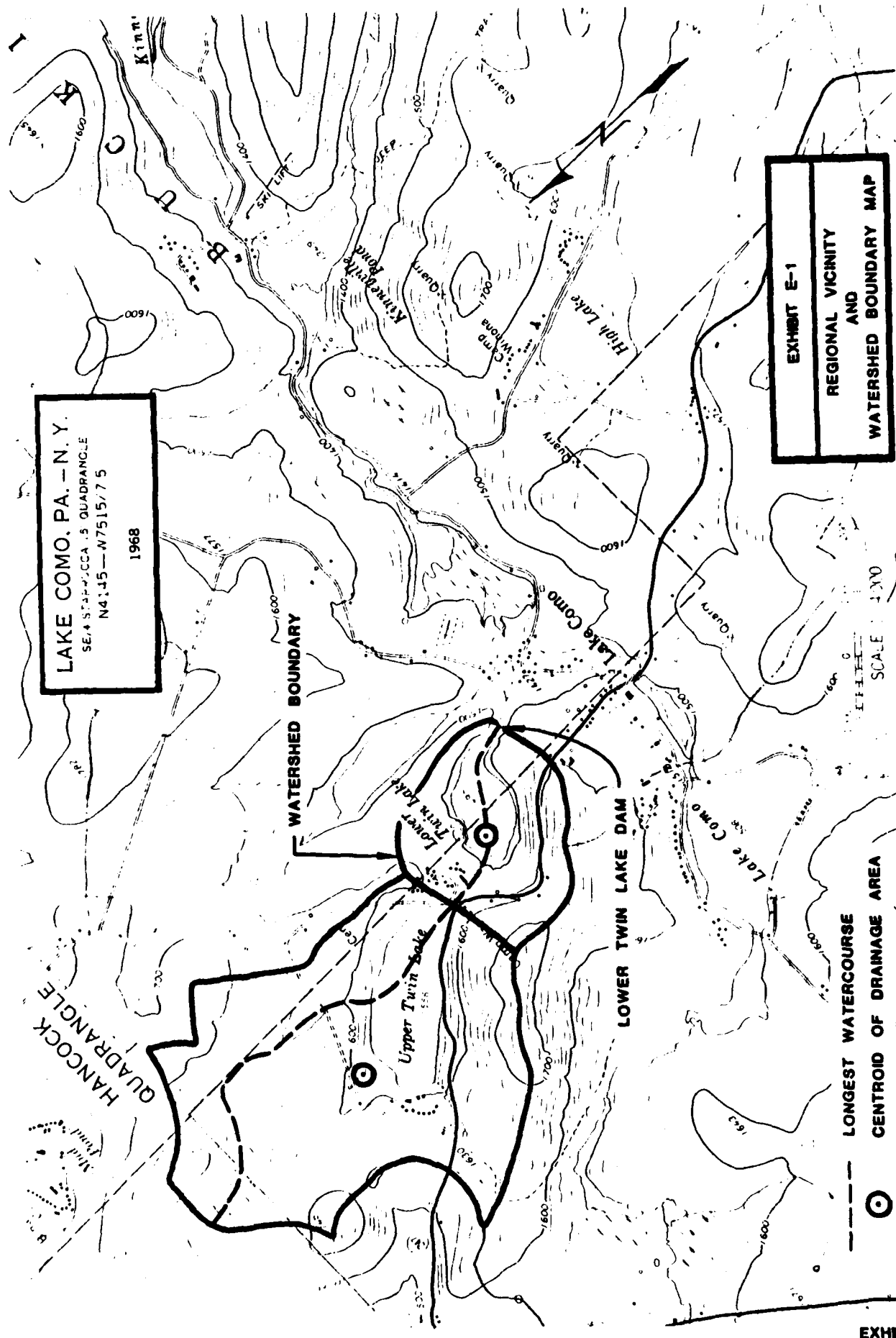
WATERSHED BOUNDARY

LOWER TWIN LAKE DAM

Lower Twin Lake

Upper Twin Lake

Lake Como

Kinnetrite Pond

Camp Winona

High Lake

—— LONGEST WATERCOURSE

⊙ CENTROID OF DRAINAGE AREA

SCALE 1:200

EXHIBIT E-1

APPENDIX F

GEOLOGY

LOWER TWIN LAKE DAM

APPENDIX F

GEOLOGY

Lower Twin Lake Dam and reservoir area are located within the Glaciated Allegheny Plateau Section of the Appalachian Plateaus Physiographic Province. Deposits of glacial drift of variable thickness cover the entire area. The drift was deposited by the Wisconsin Ice Sheet during the Pleistocene period of geologic time.

The glacial drift is composed primarily of till which is a reddish brown, unsorted compact mixture of clay, silt, sand, gravel, and cobbles with occasional boulder sized pieces. The stone pieces are sub-angular to rounded and consist mainly of sandstone and siltstone derived from the Catskill formation, the dominant rock formation in the area. The clay content and compact nature of the till makes it a relatively impervious soil type.

Some deposits of glacial outwash are also found in the area. The outwash is composed of loose, poorly sorted to stratified deposits of silt, sand, and gravel. The outwash deposits are generally very pervious.

Other loose pervious soils in the area are the recent deposits of alluvial silt, sand, and gravel with some clay. These soils are localized and limited to streambeds and flood plain areas.

The bedrock underlying the entire dam and reservoir area is the Catskill Formation of the Susquehanna Group. This group of formations is of Upper Devonian age. The Catskill Strata generally consists of well-indurated red shale, siltstone, and fine sandstone with some gray, green, and brown shale, siltstone, and sandstone layers. Occasional conglomeratic layers are encountered. The red shales are the dominant lithology and the residual soils derived from this rock are usually high in clay and silt and contain numerous flaky and angular fragments and flat, slabby boulders. The right abutment at the dam is covered with many such flat, slabby boulders and the dry masonry walls of the dam itself are constructed from similar one and two-man sized boulders. About 350 feet downstream of the dam, near-horizontal sandstone ledges outcrop on the right side of the stream channel.

The regional structure of the bedrock in the area indicates that the bedrock underlying the dam and reservoir area is near-horizontal. The regional strike of the strata is northeast-southwest.

Although depth to the bedrock at the dam site is unknown, the steep earth slope on the left abutment indicates at least 14 feet of overburden soil.

Ref.: *Ground Water of Northeastern Pennsylvania, Stanley W. Lohman 1937, Bulletin W-4, Pennsylvania Geologic Survey.*

LOWER TWIN LAKE DAM
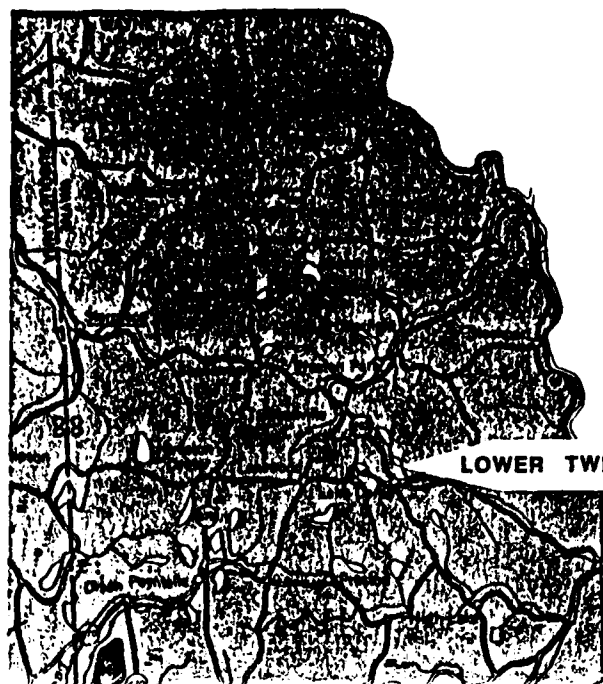
0 1 2 3 4 5   10 MILES

SCALE: 1   4 MILES

LEGEND

DEVONIAN
UPPER

CENTRAL AND EASTERN PENNSYLVANIA

Oswayo Formation
Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses; includes red shales which become more numerous eastward. Relation to type Oswayo not proved.

Catskill Formation (Dck)
Chiefly red to brownish shales and sandstones, includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east.

Marine beds (Dm)
Gray to olive brown shales, graywackes, and sandstones; contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock; Tully Limestone at base.

Susquehanna Group (Ds)
Barbed line is "Chemung-Catskill" contact of Second Pennsylvania Survey County reports; barbs on "Chemung" side of line.

NOTE:

GEOLOGIC MAP AND LEGEND OBTAINED FROM GEOLOGIC MAP OF PENNSYLVANIA BY PA. TOPOGRAPHIC AND GEOLOGIC SURVEY, DATED 1960

PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LOWER TWIN LAKE DAM
GEOLOGIC MAP

GEO - Technical Services, Inc.
HARRISBURG, PA

FEBRUARY 1981

EXHIBIT F