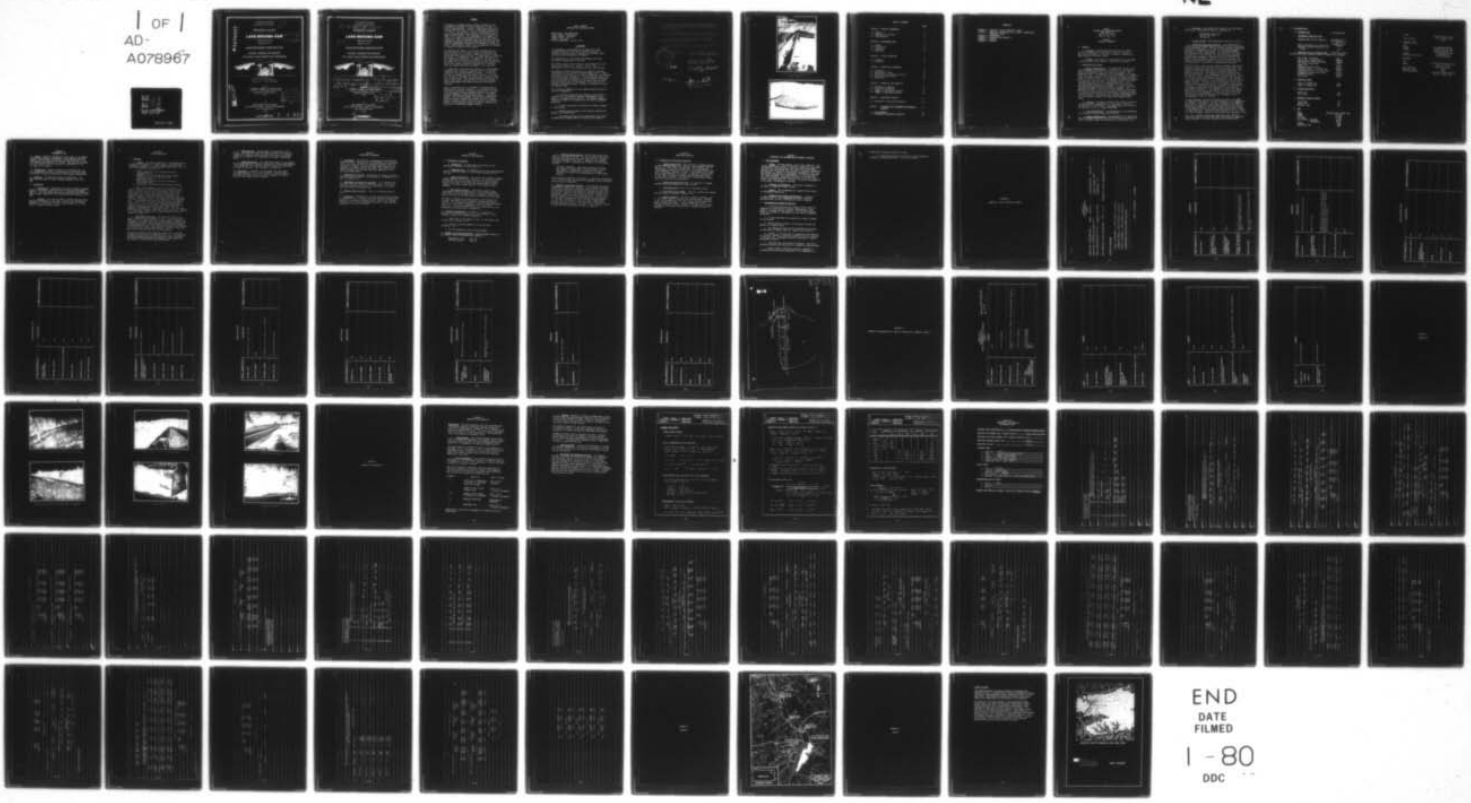
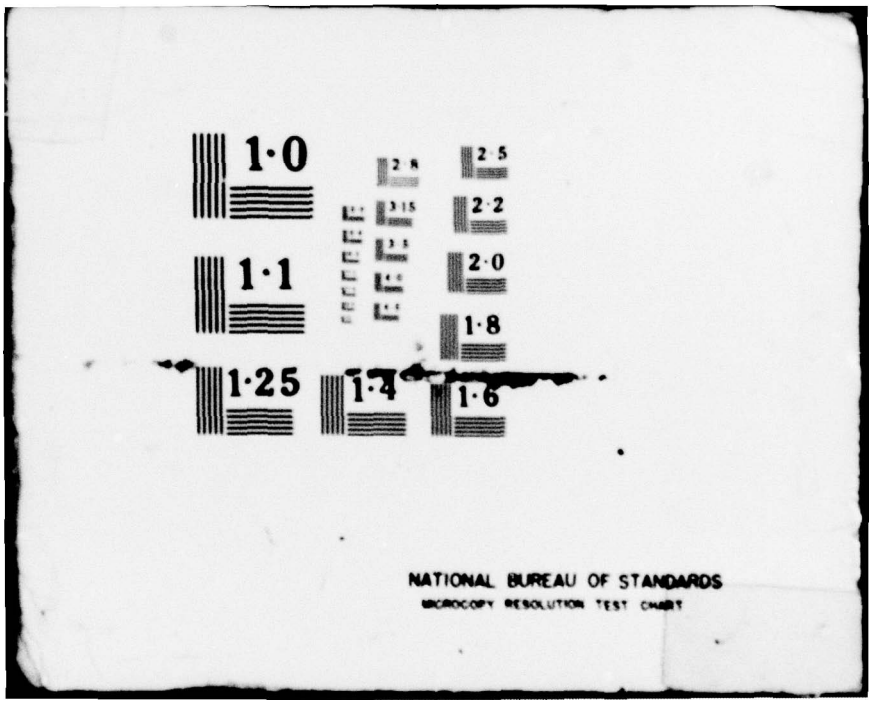
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SUSQUEHANNA RIVER BASIN

MILL CREEK, SULLIVAN COUNTY

PENNSYLVANIA

LAKE MOKOMA DAM

LEVEL II

NDS ID NO. PA-359

DER ID NO. 57-3

LAKE MOKOMA ASSOCIATION

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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Prepared By

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG, PENNSYLVANIA
15931

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FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

SEPTEMBER, 1979

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SUSQUEHANNA RIVER BASIN

MILL CREEK, SULLIVAN COUNTY

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PENNSYLVANIA

LAKE MOKOMA DAM

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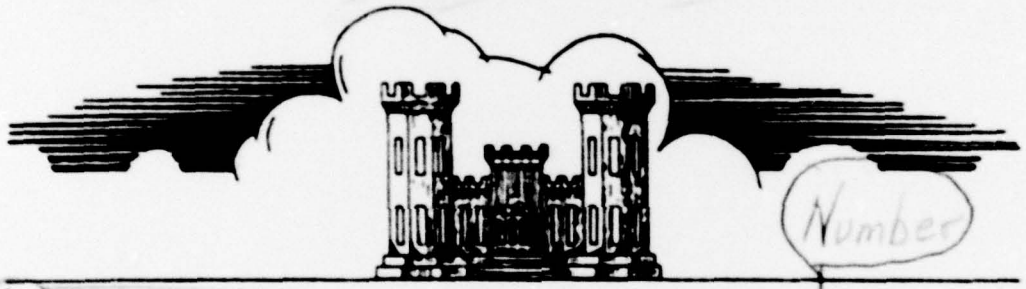
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LAKE MOKOMA ASSOCIATION

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



Number

(6) National Dam Inspection Program, Lake Mokoma Dam (NDS-ID PA-359, DER ID 57-3) Mill [redacted] Creek, Sullivan County, Pennsylvania, Phase I Inspection Report.

Number

L. ROBERT KIMBALL & ASSOCIATES

CONSULTING ENGINEERS & ARCHITECTS

EBENSBURG, PENNSYLVANIA

15931

FOR

DEPARTMENT OF THE ARMY

BALTIMORE DISTRICT CORPS OF ENGINEERS

BALTIMORE, MARYLAND

21203

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines 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 identify expeditiously 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 investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed 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 inspection 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 reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway 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.

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PHASE I REPORT
NATIONAL DAM INSPECTION REPORT

NAME OF DAM: Lake Mokoma Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Sullivan
STREAM: Mill Creek
DATE OF INSPECTION: June 29, 1979

[Cont'd from p. i]

ASSESSMENT

The assessment of Lake Mokoma Dam is based upon visual observations made at the time of inspection, review of available records and data, hydraulic and hydrologic computations and past operational performance.

Lake Mokoma Dam is a high hazard - intermediate size dam. The Spillway Design Flood is the PMF.

The inspection and review of data of Lake Mokoma Dam did not reveal any problems of any emergency nature. The dam appears to be in fair condition with many deficiencies.

The existing spillway and reservoir are capable of passing approximately 15% of the PMF (Probable Maximum Flood). Based upon criteria established by the Corps of Engineers, the spillway is termed seriously inadequate. If Lake Mokoma Dam should fail due to overtopping, the hazard to life and property downstream from the dam would be significantly increased from that which would exist just prior to overtopping. As a result of the seriously inadequate spillway, the dam is considered an unsafe non-emergency dam.

The following recommendations and remedial measures should be instituted immediately.

1. A detailed hydrologic and hydraulic study should be conducted by a professional engineer knowledgeable in dam design to increase spillway capacity. The spillway capacity should be increased in accordance with the Corps of Engineers guidelines.

2. A trash boom should be installed to prevent blockage of the spillway.

3. Repairs should be made to the spillway concrete and masonry on a regular basis.

4. The seepage exiting from the downstream slope should be monitored on a weekly basis for quantity and turbidity.

5. Because of the high level of seepage and the potential for piping to develop, a stability analysis should be conducted of the structure. Piezometers should be installed to monitor the phreatic surface.

6. The drain line valve should be repaired. The valve should be operated and lubricated on a regularly scheduled basis.

7. Regular safety inspections should be conducted in accordance with provisions stipulated by the Commonwealth of Penasylvania regarding inspection of dams.

8. A warning system should be installed to warn downstream residents of high water levels or failure of the dam.



SUBMITTED BY: L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS

Kuang-Hwei Chuang

Kuang-Hwei Chuang, P.E.

SEP 18 1979

Date

R Jeffrey Kimball

R. Jeffrey Kimball, P.E.

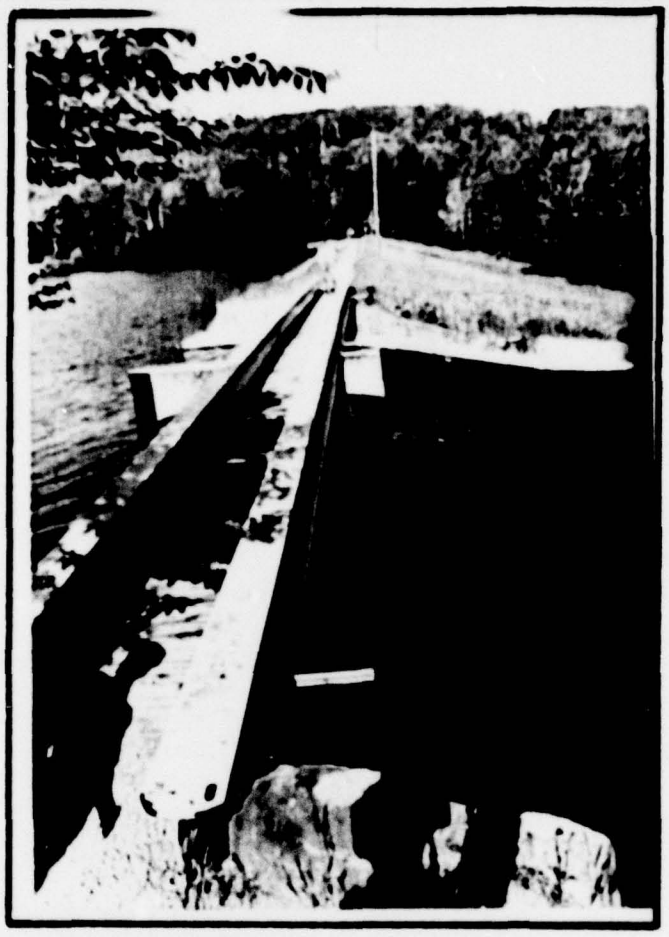
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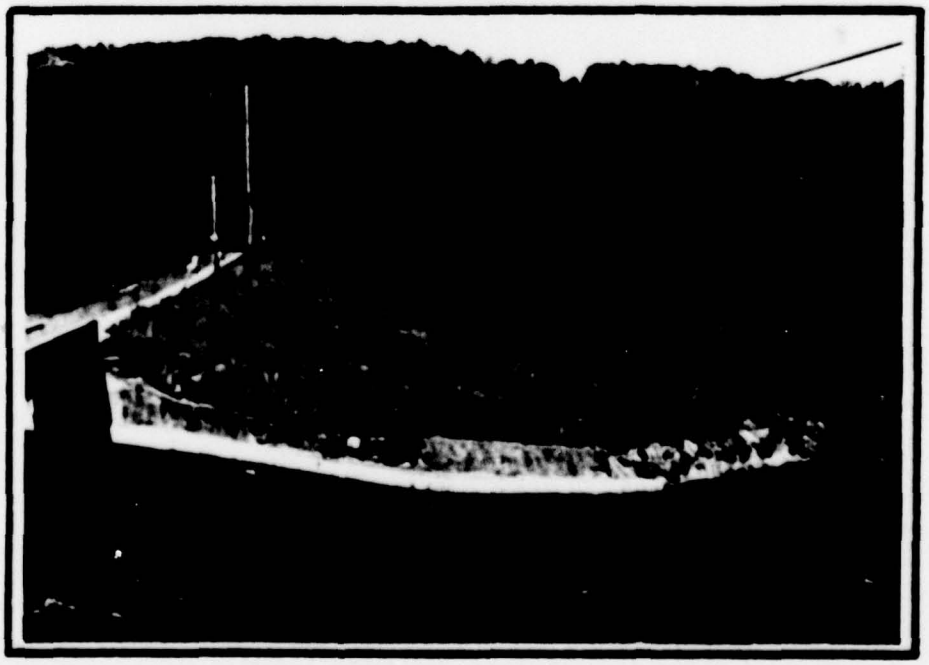
Date

James W Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer



Overview of dam and spillway from right abutment.



Overview of dam and toe.

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PHASE I
NATIONAL DAM INSPECTION PROGRAM
LAKE MOKOMA DAM
NDI I.D. NO. PA 359
DER I.D. NO. 57-3

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 inspection of dams throughout the United States.

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

1.2 Description of Project.

a. Dam and Appurtenances. Lake Mokoma Dam consists of an earth embankment constructed over a timber crib. The upstream slope is approximately 2H:1V and covered with riprap. The downstream slope is approximately 3H:1V and grassed. The crest width is 12 feet. The crest of the dam is traversed by a powerline along the downstream edge. The outlet works is located approximately 100 feet to the left of the emergency spillway and consists of a wet well, valve and pipe. The exposed portion of the pipe downstream consists of a 24" corrugated metal pipe. This corrugated metal pipe may be an extension of the outlet works when the downstream slope was flattened. The type of valve and pipe making up most of the outlet works is unknown. The emergency spillway is located on the right abutment and consists of a concrete lined chute. The spillway is 68.5 feet long with a concrete pier in the middle of the spillway supporting a bridge over the spillway. The spillway exit channel is approximately 100 feet long and consists of a trapezoidal shaped concrete chute.

Cont'd on p. 1-3

b. Location. The dam is located on Mill Creek, a tributary to Loyalsock Creek, approximately 1/2 mile east of LaPorte, Sullivan County, Pennsylvania. Lake Mokoma Dam can be located on the LaPorte, U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. Lake Mokoma Dam is an intermediate size structure (14 feet high, 1198 acre-feet).

d. Hazard Classification. Lake Mokoma Dam is a high hazard dam. Downstream conditions indicate that loss of more than a few lives is probable should the structure fail (See Section 3.1e).

e. Ownership. Lake Mokoma Dam is owned by the Lake Mokoma Association. Correspondence should be addressed to:

Lake Mokoma Association
LaPorte, PA 18626
717-238-9331

f. Purpose of Dam. Lake Mokoma Dam is used for recreation.

g. Design and Construction History. Lake Mokoma Dam was constructed by Lake Mokoma Company of Kennett Square, Pennsylvania, a land development agency. The facility was originally constructed and used for recreation before 1890. The original embankment consisted of a stone filled hemlock crib covered with double wood sheeting on the upstream side. The stone fill crib formed a stable unit for the cross section while the double sheeting provided water tightness. Pervious fill on both sides of the timber crib added required stability to the cross section. The original construction provided no cutoff device that penetrated the foundation for the purpose of decreasing underseepage.

A major portion of the structure failed in November 1926 and the dam was not repaired and put back into service until 1928. The concrete spillway was constructed in 1928, incorporating a steel sheet pile cutoff that penetrated the foundation materials beneath the spillway. The spillway cutoff was continued across the repaired section of the embankment by the installation of a concrete cutoff wall founded at a lower elevation than the bottom of the sheet piling placed beneath the spillway. The concrete cutoff continues to the left of the emergency spillway for approximately 120 feet. The end 15 feet of the concrete cutoff was placed against the upstream face of the originally placed timber cribbing. A clay material was used to backfill the upstream side of the newly constructed cutoff and gravel fill was used as downstream fill material. The remaining 380 feet of the embankment did not have the core wall placed. No repairs were done to this portion of the embankment. In addition, part of the 1928 construction included the raising of the undamaged portion of the embankment 2 feet in elevation.

The dam throughout its history has been the subject of a number of complaints originated by various departments of the Commonwealth with regard to the safety of the dam. According to the Commonwealth records, reports of some leakage through the structure and complaints of neglect by the owner to remove trees from the dam in the immediate area of the structure have been recorded a number of times since 1930. The spillway walls failed in 1947 as a result of a high discharge. Repairs to the spillway were completed in 1950.

Since 1970, numerous repairs have been made to the structure including riprap of the upstream slope, flattening the downstream slope, raising of the crest and repair of the spillway walls.

1.3 Pertinent Data.

a. Drainage Area. 3.2 square miles

b. Discharge at Dam Site (cfs).

Maximum known flood at dam site	Approximately 376 June 1972 elevation 1758.0
Drain line capacity at normal pool	Unknown
Emergency spillway capacity at top of dam	1219

c. Elevation (U.S.G.S. Datum) (feet). - Elevations worked from spillway crest elevation shown on construction drawings.

Top of dam - low point	1759.7
Top of dam - design height	Unknown
Maximum pool - design surcharge	Unknown
Full flood control pool	N/A
Normal pool	1756.5
Emergency spillway crest	1756.5
Upstream portal - 24" drain line	Unknown
Downstream portal - 24" drain line	1742.6
Streambed at centerline of dam	1746.0
Maximum tailwater	Unknown
Toe of dam	1746.0

d. Reservoir (feet).

Length of maximum pool	6100
Length of normal pool	6000

e. Storage (acre-feet).

Normal pool	843
Top of dam	1198

f. Reservoir Surface (acres).

Top of dam	112
Normal pool	110
Spillway crest	110

g. Dam.

Type	Earthfill over timber crib
Length	500 feet
Height	14 feet
Top width	12 feet
Side Slopes - upstream	2H:1V
- downstream	3H:1V
Zoning	None
Impervious core	None

Cutoff	Concrete partial cutoff wall in 20% of dam
Grout curtain	None

h. Reservoir Drain.

Type	24" pipe through dam
Length	Approximately 110 feet
Closure	Valve in wet well on upstream slope of dam
Access	Discharge end
Regulating facilities	Valve in wet well

i. Spillway.

Type	Uncontrolled concrete chute
Length	Total 68.5 feet Effective 66 feet
Crest elevation	1756.5
Upstream channel	Lake
Downstream channel	Trapezoidal shaped concrete chute, 100 feet long

SECTION 2
ENGINEERING DATA

2.1 Design. Review of information in the files of the Commonwealth of Pennsylvania, Department of Environmental Resources revealed that construction drawings and specifications of the 1928 repairs were available for review. This data was reviewed for this study but was not suitable for reproduction to be included in this report.

2.2 Construction. Several construction photographs are the only information available on construction of the repairs made to the dam. No data is available on the original construction.

2.3 Operation. No operating records are maintained. The owner has just begun to record seepage readings at the toe of dam.

2.4 Evaluation.

a. Availibility. Engineering data were provided by PennDER Bureau of Dam Safety, Obstructions and Storm Water Management. Members of the Lake Mokoma Association accompanied the inspection team to answer questions on new construction and operation of the dam.

b. Adequacy. The type and amount of design data and other engineering information is minimal. However, the information available, in conjunction with the visual inspection, is sufficient to complete a Phase I Report.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of Lake Mokoma Dam was conducted by personnel of L. Robert Kimball and Associates accompanied by members of the Lake Mokoma Association on May 29, 1979. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portions of any outlet works and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. The dam appears to be in fair condition. The crest of the dam is 12 feet wide and has a recently placed gravel foot path over the top. The upstream slope is 2H:1V and covered with recently placed heavy stone riprap. The downstream slope is 3H:1V and partially covered with high grasses. Seepage is exiting on the downstream slope at a very consistent elevation (1750 to 1752) along the entire downstream slope. High grasses easily mark the location of this seepage zone. At the toe of the dam, five wooden flumes have been constructed to collect the seepage. Maximum seepage measured during the inspection was at weir number three which was measured at approximately 2 gallons per minute. The other four measuring points indicated less than 1 gallon per minute. However, it is questionable whether these flumes intercept all of the seepage (See page A-12).

c. Appurtenant Structures. The reservoir level at the time of inspection was at elevation 1756.5. The concrete weir appeared to be in fair condition. A walk bridge is located over the emergency spillway with a center pier partially blocking flow through the spillway. Effective length of the spillway opening is approximately 66 feet. The concrete side walls of the spillway exit channel have recently been repaired. Portions of the side walls are concrete and portions are stone masonry.

The drain line valve is kept partially opened all of the time because the valve cannot be completely shut. It is reported that the owners annually open the drain line in October. The drain line was not operated during the inspection. The operability and condition of the drain line is questionable.

d. Reservoir Area. The watershed is covered mostly with forest. The reservoir slopes are moderate and are not considered susceptible to massive landslides which would affect the storage volume of the reservoir or overtopping of the dam by displacing water.

e. Downstream Channel. The downstream channel of Lake Mokoma Dam is moderately wide. Several residences are located approximately 1 mile downstream of the dam and would be affected by flood flows or failure of the dam. (See information on page A-9).

3.2 Evaluation. In general, the embankment and appurtenant structures appeared to be in fair condition. The wet areas on the downstream slope of the dam should be examined at regular intervals and seepage quantity measured.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. The reservoir is maintained at approximately elevation 1756.5. Excess inflow is discharged over the spillway crest. The drain line valve is reportedly operated yearly in the month of October. The dam and appurtenant structures are inspected on a weekly basis by the owner. Monitoring of the seepage exiting from the downstream slope began May 5, 1979 and is performed weekly.

4.2 Maintenance of the Dam. Maintenance of the dam is usually performed twice each year by the association. Maintenance of the dam is considered fair.

4.3 Maintenance of Operating Facilities. It is reported that the drain line valve cannot be completely shut. The valve is reportedly operated once each year. Maintenance of the operating facilities is considered fair.

4.4 Warning System in Effect. There is no warning system in effect.

4.5 Evaluation. Maintenance of the dam and operating facilities is considered fair. The drain line valve should be repaired and operated on a regularly scheduled basis. There is no warning system in effect to warn downstream residents of large spillway discharges or failure of the dam.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. No design data is available on the hydrology or hydraulics of the structure.

b. Experience Data. The maximum flood to date was reportedly June 1972, when the reservoir level reached elevation 1758.0 (376 cfs).

c. Visual Observations. The spillway and spillway discharge channel appeared to be in good condition. The concrete on the spillway weir and spillway walls have recently been repaired. During flood flows, the spillway may become partially blocked because of the small opening and pier in the middle of the spillway.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D.

5.2 Evaluation Assumptions. To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. Water level in the reservoir prior to flood was at the spillway crest elevation 1756.5.

2. The top of dam was assumed to be the low point (elevation 1759.7).

3. No flow through the drain line was assumed.

5.3 Summary of Overtopping Analysis. Complete summary sheets for the computer output are presented in Appendix D.

Peak inflow (PMF)	9211 cfs
Spillway capacity	1219 cfs

a. Spillway Adequacy Rating. The Spillway Design Flood (SDF) for this dam is the PMF. The SDF is based on the hazard and size classification of the dam. Based on the following definition provided by the Corps of Engineers, the spillway is rated as seriously inadequate as a result of our hydrologic analysis.

> Seriously Inadequate - high hazard classification dams not capable of passing 50% of the PMF without failure when there is a significant increase in the hazard potential for loss of life downstream due to overtopping failure.

The spillway and reservoir are capable of controlling approximately 15% of the PMF without overtopping the embankment under conditions noted during the inspection.

5.4 Summary of Dam Breach Analysis. As the subject dam cannot satisfactorily pass 50% of the PMF, it was necessary to perform a dam breach analysis and downstream routing of the flood wave. This analysis determines the degree of increased flooding due to dam failure. Results of the dam breach analysis indicate that downstream flooding is significantly increased. Failure of the dam was assumed to occur with approximately one foot of water over the dam. Maximum flood level increase was approximately 3 feet with an increase of 3197 cfs (110%). These results indicate that failure due to overtopping will significantly increase downstream potential for loss of life. Detailed results of the flood wave routing are included in Appendix D.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. The high level of seepage exiting on the downstream slope is of concern. This seepage is approximately 4 to 6 feet above the downstream toe of the dam and approximately 4 feet below normal pool. The downstream material in the embankment consists of a sand. This material with a high head is very susceptible to piping. In addition, deterioration of the timber cribbing can create voids and subsidence areas in the crest of the dam. The stability of the structure during high head conditions is questionable.

b. Design and Construction Data. No stability or seepage analyses have been conducted for the structure.

c. Operating Records. There are no operating records.

d. Post Construction Changes. Many post construction changes have been made as outlined in Section 1.2g.

e. Seismic Stability. The dam is located in seismic zone 1. No seismic stability analyses has been performed. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading. Because of the low risk of seismic occurance and the visual observations, no dynamic analysis is required.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The dam appears to be in fair condition. The visual observations, review of available information, hydrologic and hydraulic calculations and past operational performance indicate that Lake Mokoma Dam's spillway is seriously inadequate. The spillway is capable of controlling approximately 15% of the PMF without overtopping the embankment. No stability analyses have been performed. The long term effect of the stability due to the extensive seepage and potential for piping, voids to develop, and subsidence is of concern. The dam is considered to be an unsafe, non-emergency structure.

b. Adequacy of Information. Sufficient information is available to complete a Phase I Report.

c. Urgency. The recommendations suggested below should be implemented immediately.

d. Necessity for Further Investigation. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 Recommendations/Remedial Measures.

1. A detailed hydrologic and hydraulic study should be conducted by a professional engineer knowledgeable in dam design to increase spillway capacity. The spillway capacity should be increased in accordance with the Corps of Engineers guidelines.

2. A trash boom should be installed to prevent blockage of the spillway.

3. Repairs should be made to the spillway concrete and masonry on a regular basis.

4. The seepage exiting from the downstream slope should be monitored on a weekly basis for quantity and turbidity.

5. Because of the high level of seepage and the potential for piping to develop, a stability analysis should be conducted of the structure. Piezometers should be installed to monitor the phreatic surface.

6. The drain line valve should be repaired. The valve should be operated and lubricated on a regularly scheduled basis.

7. Regular safety inspections should be conducted in accordance with provisions stipulated by the Commonwealth of

Pennsylvania regarding inspection of dams.

8. A warning system should be installed to warn downstream residents of high water levels or failure of the dam.

APPENDIX A

CHECKLIST, VISUAL INSPECTION, PHASE I

CHECK LIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Lake Mokoma Dam COUNTY Sullivan STATE Pennsylvania ID# PA 359

TYPE OF DAM Earthfill over timber crib HAZARD CATEGORY High

DATE(s) INSPECTION June 27, 1979 WEATHER Clear, Warm TEMPERATURE 70°

POOL ELEVATION AT TIME OF INSPECTION 1756.5 M.S.L. TAILWATER AT TIME OF INSPECTION 1743.3 M.S.L.

INSPECTION PERSONNEL:

James T. Hockensmith, L. Robert Kimball & Associates

Kuang-hwei Chuang, L. Robert Kimball & Associates

Oscar T. McConnell, L. Robert Kimball & Associates

Representatives from Lake Mokoma Associates

James T. Hockensmith RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal alignment appears to be good. Vertical alignment varied from 1759.7 to 1761.1.	
RIPRAP FAILURES	None. Riprap needs finer material to choke larger voids.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Grassed upstream and downstream slopes.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Appears to be good.	
ANY NOTICEABLE SEEPAGE	Seepage exiting along entire downstream slope at approximately elevation 1750 to 1752. Five measuring points on downstream toe. Maximum point, 2 gallons per minute.	
STAFF GAUGE AND RECORDER	None.	
DRAINS	None.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	N/A	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N/A	
DRAINS	N/A	
WATER PASSAGES	N/A	
FOUNDATION	N/A	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N/A	
STRUCTURAL CRACKING	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT	N/A	
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	N/A	
STAFF GAUGE OR RECORDER	N/A	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet conduit unobserved.	
INTAKE STRUCTURE	Unobserved.	
OUTLET STRUCTURE	24" corrugated metal pipe.	
OUTLET CHANNEL	Natural stream channel.	
EMERGENCY GATE	Unobserved during inspection.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete weir in good condition.	
APPROACH CHANNEL	Lake.	
DISCHARGE CHANNEL	Trapezoidal concrete lined. Good condition.	
BRIDGE AND PIERS	Pier and bridge in spillway.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Moderately wide. No obstructions noted.	
SLOPES	Stable.	
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 9 homes within 3 miles downstream of dam - 36 people.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderately steep, stable.	
SEDIMENTATION	Moderate.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

LAKE MOKOMA DAM
Scale: 1" = 100'
Z
Concrete Wall
Bridge Walkway
Tailwater 1743.3
Spillway
1756.5
Concrete Pier
1759.7
1760.9
Gate Tower
24" Corrugated Metal Pipe - Invert Elev. 1742.6
Flow = 2 gpm
1760.4
Water Level 1756.6
Lake
1760.4
1761.1
1760.6
1761.9
① , ② etc. Indicate Weir Points with Flow < 1 gpm
Unless Otherwise Noted

APPENDIX B

CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Lake Mokoma Dam

ID# PA 359

ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S Quadrangle.
CONSTRUCTION HISTORY	DER files and Gannett, Fleming, Corddry and Carpernter inspection report.
TYPICAL SECTIONS OF DAM	Construction drawings.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS RAINFALL/RESERVOIR RECORDS	Construction drawings. Construction drawings. None. None. None.

ITEM	REMARKS
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None.
POST-CONSTRUCTION SURVEYS OF DAM	None.
BORROW SOURCES	Unknown.

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	None.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Yes, DER files and Gannett, Fleming, Corddry and Carpenter inspection report.
MAINTENANCE OPERATION RECORDS	None.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	Construction drawings.
OPERATING EQUIPMENT PLANS & DETAILS	Construction drawings.

APPENDIX C

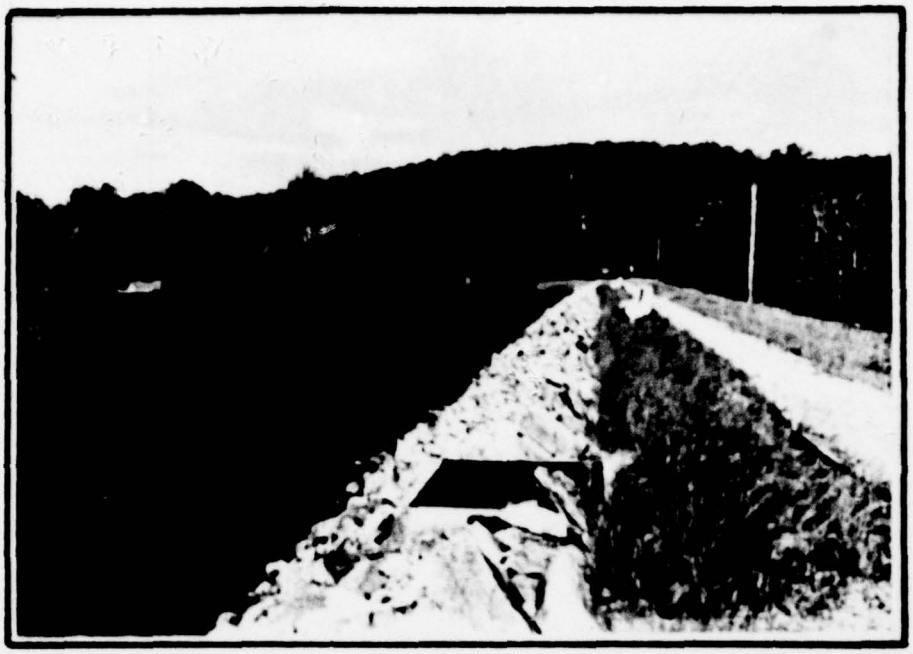
PHOTOGRAPHS



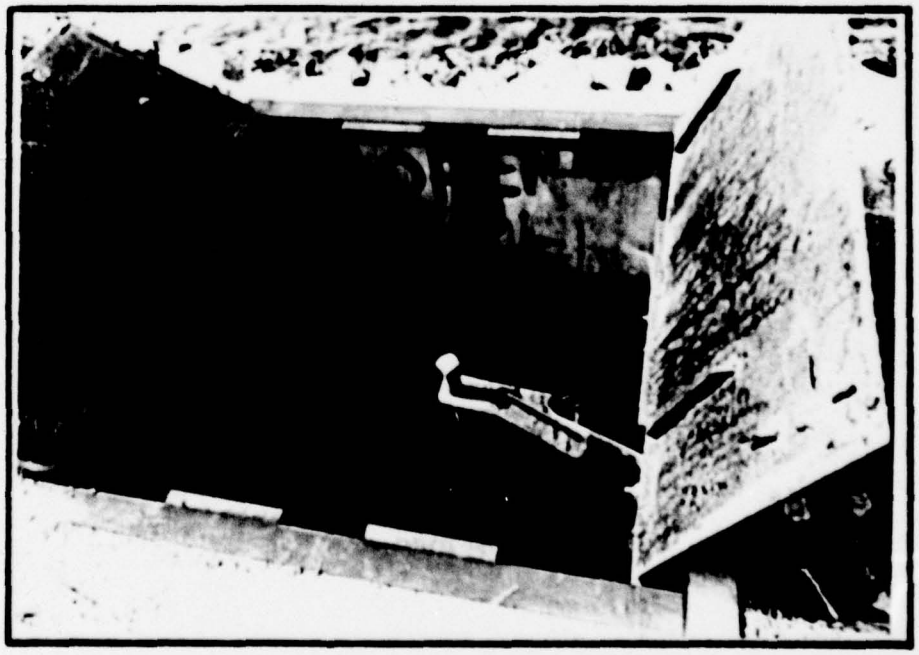
Downstream slope and wet area where high grass is present.



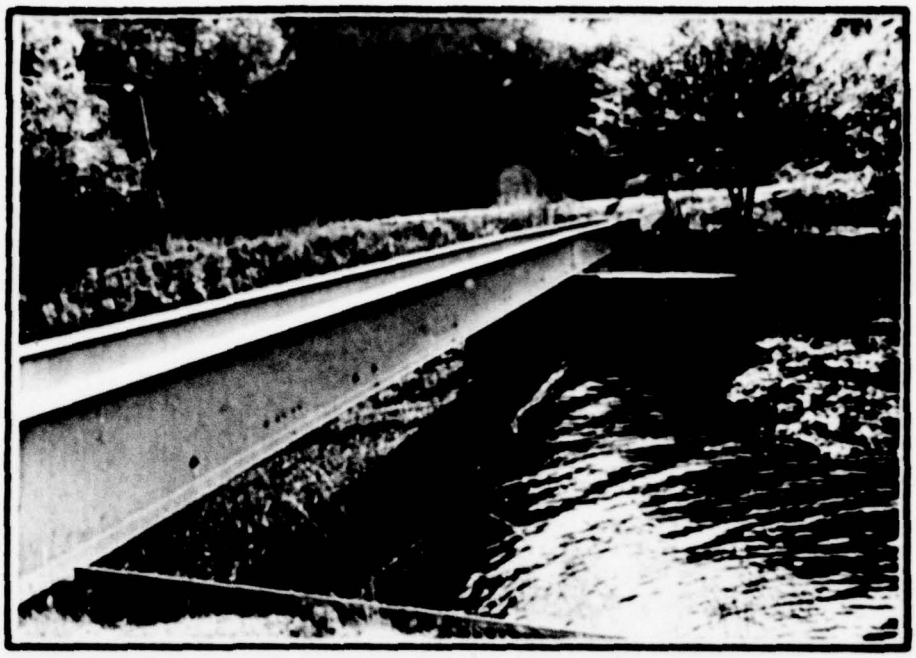
Downstream slope and wet area where man is standing.



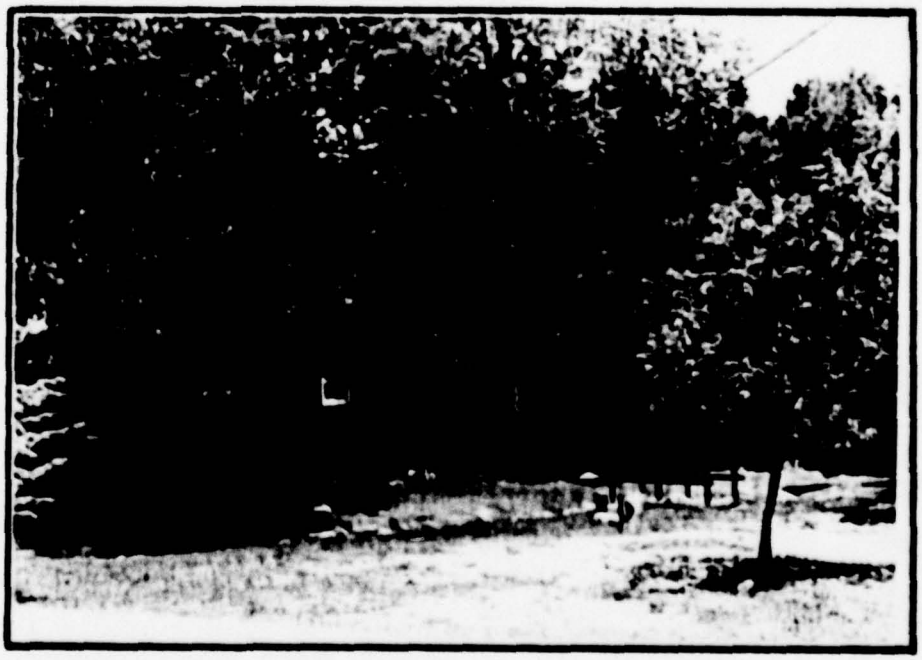
Upstream slope - valve box in foreground.



Opened valve box.



Spillway weir and bridge.



Downstream residence.

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation. The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Reports No. 40 prepared by the National Weather Service.

The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

Parameter	Definition	Where Obtained
C_t	Coefficient representing variations of watershed slope and storage	From Corps of Engineers*
L	Length of main stream channel miles	From U.S.G.S. 7.5 minute topographic
L_{ca}	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic
C_p	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

3. Routing. Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping. Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach and Downstream Routing. The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE MOKOMA
I.D. NUMBER PA. 57-3
SHEET NO. 1 OF 3
BY DTM DATE 8-10-79

LAKE MOKOMA

DRAINAGE AREA

AREA = 3.2 mi^2 (PA. DEP. AND U.S.G.S. 7.5-MIN. QUAD)

UNIT HYDROGRAPH PARAMETERS

DAMSITE LOCATED IN ZONE #17, SUSQUEHANNA RIVER BASIN. FROM CORPS OF ENGINEERS, BALTIMORE DISTRICT REGIONAL STUDY.

$C_p = 0.45$, $C_t = 1.13$

$L = 2$ mi , $L_{ca} = 0.42$ mi (FROM USGS 7.5-MIN. QUAD.)

$t_p = C_t (L \times L_{ca})^{0.3} = 1.13 (2 \times 0.42)^{0.3}$

$t_p = 1.1$ HRS. (SNYDERS LAG (t_p) IN. HRS.)

LOSS RATE AND BASE FLOW PARAMETERS

AS RECOMMENDED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT.

STRTL = 1 INCH
CNSTL = 0.05 IN/HR
STRTQ = 1.50 cfs/mi^2
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.0

PROBABLE MAXIMUM STORM

FROM H.R. NO. 40
PMP, INDEX RAINFALL = 22.2 (0.99) = 22.0 IN

$R_6 = 117\%$, $R_{12} = 127\%$, $R_{24} = 136$, $R_{48} = 143\%$, $R_{72} = 145\%$

ELEVATION-AREA-CAPACITY RELATIONSHIP

FROM USGS. 7.5-MIN. QUAD, PA. DER. FILES AND FIELD INSPECTION DATA.

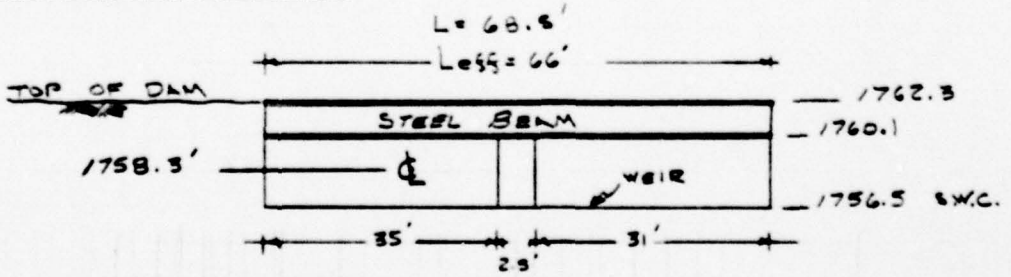
AT SPILLWAY CREST ELEV. 1756.5', AREA = 110 ACRES
INITIAL STORAGE = 847 AC.FT
AT 1760', AREA = 112 AC.
AT 1780', AREA = 152 AC.

FROM CONIC METHOD FOR RESERVOIR VOLUME. FLOOD HYDROGRAPH PACKAGE (HEC-1). DAM SAFETY VERSION (USERS MANUAL).

$H = 3V/A = 3(847)/110 = 23.1'$ (USE 23.0')
ELEV. AT CAPACITY EQUALS ZERO;
1756.5' - 23' = 1733.5'

AREA (AC.)	0	110	112	140	152
ELEV. (FT.)	1733.5	1756.5	1760	1770	1780

DISCHARGE RATING



$Q_1 = CLH^{3/2}$ WHERE $C = 3.1$, $L = L_{eff} = 66'$

$Q_2 = CA\sqrt{2gh}$ WHERE $C = 0.6$, $A = 251\ FT^2$

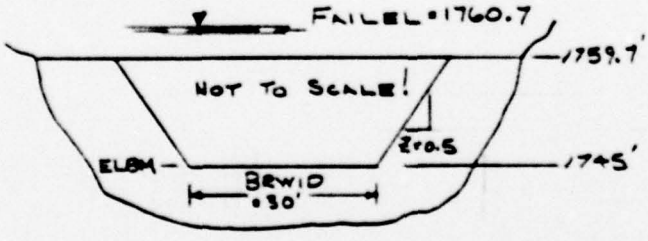
$Q_3 = CLH^{3/2}$ WHERE $C = 3.0$, $L = 68.5'$

ELEV. (FT.)	WEIR		ORIFICE		WEIR		DISCHARGE
	h_1 (FT.)	Q_1 (cfs)	h_2 (FT.)	Q_2 (cfs)	h_3 (FT.)	Q_3 (cfs)	Q (cfs)
1756.5	0	0					0
1757	.5	72					72
1758	1.5	576					576
1760.3	3.8	1,516					1,516
1761	4.5	1,953					1,953
1762.5			4.2	2,477	.2	18	2,495
1764			5.7	2,885	1.7	456	3,341
1766			7.7	3,354	3.7	1,463	4,817
1770			11.7	4,134	7.7	4,391	8,525
1780			21.7	5,630	17.7	15,303	20,933

OVERTOP PARAMETERS

TOP OF DAM (LOW SPOT) = 1759.7'
LENGTH OF DAM = 500'
COEFFICIENT OF DISCHARGE = 3.0 (BROAD CREST WIER)
$\$L_{MAX}$ = 540', $\$Y_{MAX}$ = 1762'

DAM BREACH



RATIO OF PMF = 0.40
TFAIL = 2 HRS.
WSEL = 1756.5

CHANNEL ROUTING

CHANNEL ROUTING CROSS SECTIONS OBTAINED FROM U.S.G.S. 7.5-MIN. QUAD. CHANNEL MANNINGS (n), QN(1) = 0.06, QN(2) = 0.05.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 3.2 square miles, woodland, moderate slopes

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1756.5 (843 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1759.7

SPILLWAY CREST:

a. Elevation 1756.5
b. Type Uncontrolled concrete chute
c. Width Ogee - broad crested
d. Length Effective - 66 feet
e. Location Spillover Right abutment
f. Number and Type of Gates None.

OUTLET WORKS:

a. Type 24" pipe
b. Location Through dam
c. Entrance inverts Unknown
d. Exit inverts 1742.6
e. Emergency draindown facilities Valve on upstream slope

HYDROMETEOROLOGICAL GAUGES:

a. Type None.
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: June 1972, elevation 1758.0 estimated
376 cfs

```
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
```

```
    1  AI    ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2  A2    HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE MOKOMA DAM
    3  A3    RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (PA. 57-31)
    4  B   288     0      15      0       0       0       0       0       0       0
    5  B1    5
    6  J     1      4       1
    7  J1   .1     .4      .5      1
    8  K     0      1                                      1
    9  K1    INFLOW TO RESERVOIR
   10  M     1      1     3.2              3.2                                     1
   11  P           22.0    117     127     136     143     145
   12  I                                                  1.0    0.05
   13  W   1.1   0645
   14  X  -165   -.05     2.0
   15  K     1      2                                      1
   16  K1    ROUTE THROUGH RESERVOIR
   17  Y                                      1       1
   18  Y1    1                                                -1756.5     -1
   19  Y4 1756.5   1757    1758   1760.3    1761    1762.5    1764    1766    1770    1780
   20  Y5    0     72      376    1916      1953    2495      3341    4817    8529    20933
   21  SA    0    110      112     140       122
   22  SE 1733.5 1756.5    1760    1770      1780
   23  SS 1756.5
   24  SD 1759.7   3.0     1.5     500
   25  SL   90     350     500     540
   26  SV 1759.7 1760.9    1761    1762
   27  K    99       1
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE  79/09/12.
     TIME  15.51.48.
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE MOROMA DAM
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (PA. 57-31)

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	15	0	0	0	0	0	0	0

JOPER	NRT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1

RTIOS= .10 .40 .50 1.00

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

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

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

HYDROGRAPH DATA

IMYDG	IWHG	TAREA	SNAP	IRSDA	IRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.20	0.00	3.20	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.00	117.00	127.00	136.00	143.00	145.00	0.00

IRSPC 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= 1.10 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= 4.66 AND R= 7.04 INTERVALS

UNIT HYDROGRAPH 40 END-OF-PERIOD ORDINATES, LAG= 1.10 HOURS, CP= .45 VOL= 1.00

77.	284.	552.	767.	830.	761.	661.	573.	497.	431.
374.	324.	281.	244.	212.	184.	159.	138.	120.	104.
90.	78.	68.	59.	51.	44.	38.	33.	29.	25.
22.	19.	16.	14.	12.	11.	9.	8.	7.	6.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9211.	5868.	1953.	667.	192215.
CMS	261.	166.	55.	19.	5443.
INCHES		17.06	22.71	23.28	23.28
MM		433.28	576.76	591.36	591.36
AC-FT		2910.	3873.	3971.	3971.
THOUS CU M		3589.	4778.	4899.	4899.

D16

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	0.000	0.000	0.000	-1757.	-1

STAGE	1756.50	1757.00	1758.00	1760.30	1761.00	1762.50	1764.00	1766.00	1770.00
1780.00									
FLOW	0.00	72.00	376.00	1516.00	1953.00	2495.00	3341.00	4817.00	8529.00
20933.00									
SURFACE AREA=	0.	110.	112.	140.	152.				
CAPACITY=	0.	843.	1232.	2489.	3949.				
ELEVATION=	1734.	1787.	1760.	1770.	1780.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1756.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1759.7	3.0	1.5	500.

CREST LENGTH AT OR BELOW ELEVATION	50.	350.	500.	540.
	1759.7	1760.9	1761.0	1762.0

STATION 2, PLAN 1, RATIO 1

PEAK OUTFLOW IS 486. AT TIME 43.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	486.	399.	180.	65.	18758.
CMS	14.	11.	5.	2.	531.
INCHES		1.16	2.10	2.27	2.27
MM		29.46	53.31	57.71	57.71
AC-FT		128.	358.	388.	388.
THOUS CU M		244.	442.	478.	478.

STATION 2. PLAN 1. RATIO 2

PEAK OUTFLOW IS 2910. AT TIME 42.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2910.	2000.	756.	264.	76006.
CMS	82.	57.	21.	7.	2152.
INCHES		5.81	8.79	9.21	9.21
MM		147.66	223.27	233.84	233.84
AC-FT		992.	1499.	1570.	1570.
THOUS CU M		1223.	1850.	1937.	1937.

STATION 2. PLAN 1. RATIO 3

PEAK OUTFLOW IS 3928. AT TIME 41.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3928.	2591.	950.	330.	95131.
CMS	111.	73.	27.	9.	2694.
INCHES		7.53	11.04	11.52	11.52
MM		191.35	280.54	292.67	292.67
AC-FT		1285.	1886.	1966.	1966.
THOUS CU M		1585.	2324.	2424.	2424.

D-1

STATION 2. PLAN 1. RATIO 4

PEAK OUTFLOW IS 8701. AT TIME 41.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8701.	5632.	1920.	663.	190818.
CMS	246.	159.	54.	19.	5403.
INCHES		16.37	22.33	23.11	23.11
MM		415.87	567.15	587.06	587.06
AC-FT		2793.	3809.	3943.	3943.
THOUS CU M		3445.	4698.	4863.	4863.

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 .50	RATIO 3 .20	RATIO 4 1.00
HYDROGRAPH AT	1	3.20	1	921.	3684.	4606.	9211.
		(8.29)		(26.08)	(104.33)	(130.41)	(260.83)
ROUTED TO	2	3.20	1	486.	2910.	3928.	8701.
		(8.29)		(13.75)	(82.40)	(111.23)	(246.37)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1756.20	1756.20	1759.70
STORAGE	843.	843.	1198.
OUTFLOW	0.	0.	1219.

RATIO OF PMP	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	1758.22	0.00	1039.	986.	0.00	93.25	0.00
.40	1761.09	1.39	1355.	2910.	5.25	42.00	0.00
.50	1761.50	1.80	1403.	3928.	6.25	41.75	0.00
1.00	1762.84	3.14	1561.	8701.	9.25	41.25	0.00

.....
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
.....

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
     1          A1       RATIO OF PMF ROUTED THE RESERVOIR AND DOWNSTREAM
     2          A2       DOWNSTREAM CONDITION DUE TO OVERTOP LAKE MOKOMA  PA.
     3          A3       PLAN 1 ASSUMES BREACH. PLAN 2 ASSUMES NO BREACH
     4          B   288       0      15       0       0       0       0       0       0       0
     5          B1    5
     6          J     2       1       1
     7          J1   .5
     8          K     0       1                                       1
     9          K1     INFLOW TO RESERVOIR
    10          M     1       1     3.2               3.2                                     1
    11          P           22.0     117     127     136     143     145
    12          T                                                   1.0    0.05
    13          W   1.1     0.55
    14          X  -1.5     -.05     2.0
    15          K     1       2                                       1
    16          K1       ROUTE THROUGH RESERVOIR
    17          Y                                       1       1
    18          Y1    1                                                 -1756.5      -1
    19          Y91756.5    1757     1758  1760.3     1761  1762.5     1764    1766    1770    1780
    20          Y5    0       72      376    1516     1953    2495     3341    4817    8525   20933
    21          SA    0      110      112     140      152
    22          SE1733.2  1756.5     1760    1770     1780
    23          SS1756.5
    24          SD1759.7     3.0      1.5     500
    25          SL    50     350      500     540
    26          SV1759.7  1760.9     1761    1762
    27          SB    30       .5     1745       2  1756.5  1760.7
    28          SD    30       .5     1745       2  1756.5  1762.0
    29          K     1       3                                       1
    30          K1     CHANNEL ROUTING - MOD PULS REACH 2-3
    31          Y                                       1       1
    32          Y1    1
```

```
33          Y6   .06     .05     .06     1698    1740    2000   0.0227
34          Y7     0    1740     200    1720     320    1700      355   1698     365   1698
35          Y7   370    1700     625    1720     725    1740
36          K      1       4                                       1
37          K1        CHANNEL ROUTING - MOD PULS REACH 3-4
38          Y                                    1       1
39          Y1     1
40          Y6   .06     .05     .06     1658    1700    3000   0.0133
41          Y7     0    1700     200    1680     300    1660      305   1658     315   1658
42          Y7   320    1660     425    1680     525    1700
43          K      1       4                                       1
44          K1        CHANNEL ROUTING - MOD PULS REACH 4-5
45          Y                                    1       1
46          Y1     1
47          Y6   .06     .05     .06     1538    1580    4000   0.0300
48          Y7     0    1580      90    1560     190    1540      195   1538     205   1538
49          Y7   210    1540     300    1560     400    1580
50          K     99
```

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79

RUN DATE 79/09/14.
TIME 14.07.43.

RATIO OF PMF ROUTED THE RESERVOIR AND DOWNSTREAM
DOWNSTREAM CONDITION DUE TO OVERTOP LAKE MOROMA PA.
PLAN 1 ASSUMES BREACH, PLAN 2 ASSUMES NO BREACH

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	15	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

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

RTIOS= .40

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	IRSDA	IRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.20	0.00	3.20	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.00	117.00	127.00	136.00	141.00	145.00	0.00

IRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	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= 1.10 CP= .45 NIA= 0

RECESSION DATA

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

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 4.66 AND R= 7.04 INTERVALS

UNIT HYDROGRAPH 40 END-OF-PERIOD ORDINATES. LAG= 1.10 HOURS. CP= .45 VOL= 1.00

77.	284.	552.	767.	830.	761.	661.	573.	497.	431.
374.	324.	281.	244.	212.	184.	159.	138.	120.	104.
90.	78.	68.	59.	51.	44.	38.	33.	29.	25.
22.	19.	16.	14.	12.	11.	9.	8.	7.	6.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9211.	5868.	1953.	667.	192215.
CMS	261.	166.	55.	19.	5443.
INCHES		17.06	22.71	23.28	23.28
MM		433.28	576.76	591.36	591.36
AC-FT		2718.	3823.	3711.	3711.
THOUS CU M		3589.	4778.	4899.	4899.

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HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3684.	2347.	781.	267.	76886.
CMS	104.	66.	22.	8.	2177.
INCHES		0.82	9.08	9.31	9.31
MM		173.31	230.70	236.54	236.54
AC-FT		1164.	1549.	1589.	1589.
THOUS CU M		1436.	1911.	1959.	1959.

PLAN 2 SAME AS PLAN 1

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

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

ALL PLANS HAVE SAME ROUTING DATA

GLOSS	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	0.000	0.000	0.000	-1757.	-1

STAGE	1756.50	1757.00	1758.00	1760.30	1761.00	1762.50	1764.00	1766.00	1770.00
1780.00									
FLOW	0.00	72.00	376.00	1516.00	1953.00	2495.00	3341.00	4817.00	8525.00
20933.00									

SURFACE AREA=	0.	110.	112.	160.	152.
CAPACITY=	0.	843.	1232.	2489.	3949.
ELEVATION=	1734.	1757.	1760.	1770.	1780.

CREL	SPILD	COOM	EXPM	ELEVL	COOL	CARLA	EXPL
1756.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1759.7	3.0	1.5	500.

CREST LENGTH AT OR BELOW ELEVATION	50. 1759.7	350. 1760.9	500. 1761.0	540. 1762.0

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
30.	.50	1745.00	2.00	1756.50	1760.70

STATION 2, PLAN 1, RATIO 1

BEGIN DAM FAILURE AT 41.25 HOURS
PEAK OUTFLOW IS 6003. AT TIME 43.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6003.	3482.	1149.	390.	112334.
CMS	170.	99.	33.	11.	3181.
INCHES		10.12	13.36	13.61	13.61
MM		257.09	339.42	345.60	345.60
AC-FT		1727.	2279.	2321.	2321.
THOUS CU M		2130.	2812.	2863.	2863.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
30.	.50	1745.00	2.00	1756.50	1762.00

STATION 2, PLAN 2, RATIO 1

PEAK OUTFLOW IS 2910. AT TIME 42.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2910.	2000.	756.	264.	76006.
CMS	82.	57.	21.	7.	2152.

INCHES		5.81	8.79	9.21	9.21
SQ MI		147.66	223.27	233.84	233.84
AC-FT		992.	1499.	1570.	1570.
THOUS CU M		1223.	1850.	1937.	1937.

HYDROGRAPH ROUTING

CHANNEL ROUTING - MOD PULS REACH 2-3

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

ALL PLANS HAVE SAME 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	TSR	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMVI	ELMAX	RLNTH	SEL
.0600	.0500	.0600	1698.0	1740.0	2000.	.02270

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1740.00 200.00 1720.00 350.00 1700.00 355.00 1698.00 365.00 1698.00
370.00 1700.00 625.00 1720.00 725.00 1740.00

STORAGE	0.00	1.59	6.33	15.60	29.62	47.79	70.69	98.14	130.14
166.67	207.75	252.73	301.07	352.78	407.85	466.29	528.10	593.27	661.80
733.70									
OUTFLOW	0.00	214.60	1105.07	3216.14	7017.13	12910.98	21262.87	32411.74	46676.69
64361.01	85818.34	112500.11	143267.43	178239.10	217545.09	261321.93	309709.94	362851.50	420890.01
483969.14									
STAGE	1698.00	1700.21	1702.42	1704.63	1706.84	1709.05	1711.26	1713.47	1715.68
1717.89	1720.11	1722.32	1724.53	1726.74	1728.95	1731.16	1733.37	1735.58	1737.79
1740.00									
FLOW	0.00	214.60	1105.07	3216.14	7017.13	12910.98	21262.87	32411.74	46676.69
64361.01	85818.34	112500.11	143267.43	178239.10	217545.09	261321.93	309709.94	362851.50	420890.01
483969.14									

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STATION 3. PLAN 1. RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5944.	3482.	1149.	390.	112331.
CMS	168.	99.	33.	11.	3181.
INCHES		10.12	13.36	13.61	13.61
MM		257.11	339.62	345.59	345.59
AC-FT		1727.	2279.	2321.	2321.
THOUS CU M		2130.	2812.	2863.	2863.

MAXIMUM STORAGE = 26.

MAXIMUM STAGE IS 1706.2

STATION 2. PLAN 2. RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2903.	2000.	156.	269.	15997.
CMS	82.	57.	21.	7.	2152.
INCHES		5.81	8.79	9.21	9.21
MM		147.68	223.27	233.81	233.81
AC-FT		992.	1499.	1570.	1570.
THOUS CU M		1223.	1850.	1937.	1937.

MAXIMUM STORAGE = 19.

MAXIMUM STAGE IS 1709.3

HYDROGRAPH ROUTING

CHANNEL ROUTING - MOD PULS REACH 3-4

ISTAQ	ICONP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO

10/17

4	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME 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	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

ON(1)	ON(2)	ON(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	1658.0	1700.0	3000.	.01330

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1700.00 200.00 1680.00 300.00 1660.00 305.00 1658.00 315.00 1658.00
320.00 1660.00 425.00 1680.00 525.00 1700.00

STORAGE	0.00	2.37	7.47	16.02	28.01	43.46	62.36	84.70	110.50
139.74									
	172.44	209.45	251.52	298.63	350.80	408.01	470.27	537.57	609.93
687.33									
OUTFLOW	0.00	164.12	749.99	1921.03	3840.53	6653.30	10492.70	15483.77	21744.97
29389.44									
	38483.75	48509.53	60571.16	74793.34	91314.29	110276.17	131821.17	156089.84	183220.37
213348.40									
STAGE	1658.00	1660.21	1662.42	1664.63	1666.84	1669.05	1671.26	1673.47	1675.68

1677.89	1680.11	1682.32	1684.53	1686.74	1688.95	1691.16	1693.37	1695.58	1697.79
1700.00									
FLOW	0.00	166.12	749.99	1921.03	3840.53	6653.30	10492.70	15483.77	21744.97
29389.44	38483.75	48509.53	60571.16	74793.34	91314.29	110276.17	131821.17	156089.84	183220.37
213368.40									

STATION 4, PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5849.	3480.	1149.	390.	112324.
CMS	166.	99.	33.	11.	3181.
INCHES		10.12	13.36	13.61	13.61
MM		256.95	339.41	345.57	345.57
AC-FT		1726.	2279.	2321.	2321.
THOUS CU M		2128.	2812.	2863.	2863.

MAXIMUM STORAGE = 39.

MAXIMUM STAGE IS 1668.4

STATION 4, PLAN 2, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2907.	1999.	756.	264.	75980.

CMS	82.	57.	21.	7.	2152.
INCHES		5.81	8.79	9.20	9.20
MM		147.61	223.27	233.76	233.76
AC-FT		991.	1499.	1570.	1570.
THOUS CU M		1223.	1849.	1936.	1936.

MAXIMUM STORAGE = 22.

MAXIMUM STAGE IS 1665.8

****

HYDROGRAPH ROUTING

CHANNEL ROUTING - MOD PULS REACH 4-5

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

ALL PLANS HAVE SAME 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	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0900	.0600	1538.0	1580.0	4000.	.03000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1580.00 90.00 1560.00 190.00 1540.00 195.00 1538.00 205.00 1538.00
210.00 1540.00 300.00 1560.00 400.00 1580.00

STORAGE	0.00	3.16	9.76	20.62	35.74	55.13	78.77	106.68	138.86
175.29									
	215.99	260.35	310.18	363.67	421.42	483.53	549.70	620.24	692.04
774.10									
OUTFLOW	0.00	246.47	1115.52	2823.80	5594.35	9626.06	15102.68	22196.71	31071.82
41884.42									
	54784.88	69921.66	87435.13	107460.52	130129.87	155572.22	183913.81	215278.27	249786.81
287558.39									
STAGE	1538.00	1540.21	1542.42	1544.63	1546.84	1549.05	1551.26	1553.47	1555.68
1557.89									
	1560.11	1562.32	1564.53	1566.74	1568.95	1571.16	1573.37	1575.58	1577.79
1580.00									
FLOW	0.00	246.47	1115.52	2823.80	5594.35	9626.06	15102.68	22196.71	31071.82
41884.42									
	54784.88	69921.66	87435.13	107460.52	130129.87	155572.22	183913.81	215278.27	249786.81
287558.39									

STATION 9, PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5752.	3478.	1162.	390.	112318.
CMS	163.	98.	33.	11.	3180.
INCHES		10.11	13.36	13.60	13.60
MM		256.80	339.41	345.55	345.55
AC-FT		1725.	2279.	2321.	2321.
THOUS CU M		2127.	2812.	2862.	2862.

MAXIMUM STORAGE = 36.

MAXIMUM STAGE IS 1546.9

D-26

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2907.	1998.	756.	264.	75965.
CMS	82.	57.	21.	7.	2151.
INCHES		5.81	8.79	9.20	9.20
MM		147.51	223.26	233.71	233.71
AC-FT		991.	1499.	1570.	1570.
THOUS CU M		1222.	1849.	1936.	1936.

MAXIMUM STORAGE = 21.

MAXIMUM STAGE IS 1544.7

D-27

15/7

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 .40
HYDROGRAPH AT	1	3.20	1	3684.
		(8.291	(	104.331(
			2	3684.
			(	104.331(
ROUTED TO	2	3.20	1	6003.
		(8.291	(	169.981(
			2	2910.
			(	82.401(
ROUTED TO	3	3.20	1	5944.
		(8.291	(	168.321(
			2	2903.
			(	82.211(
ROUTED TO	4	3.20	1	5849.
		(8.291	(	165.631(
			2	2907.
			(	82.311(
ROUTED TO	4	3.20	1	5752.
		(8.291	(	162.891(
			2	2907.
			(	82.311(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1756.50	1756.50	1759.70
STORAGE	843.	843.	1198.
OUTFLOW	0.	0.	1219.

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
.40	1760.97	1.27	1341.	6003.	2.50	43.25	41.25

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1756.50	1756.50	1759.70
STORAGE	843.	843.	1198.
OUTFLOW	0.	0.	1219.

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
.40	1761.03	1.32	1355.	2910.	5.25	42.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	5944.	1706.2	43.25

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	2903.	1704.3	42.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	5849.	1668.4	43.25

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	2907.	1665.8	42.25

PLAN 1 STATION 4

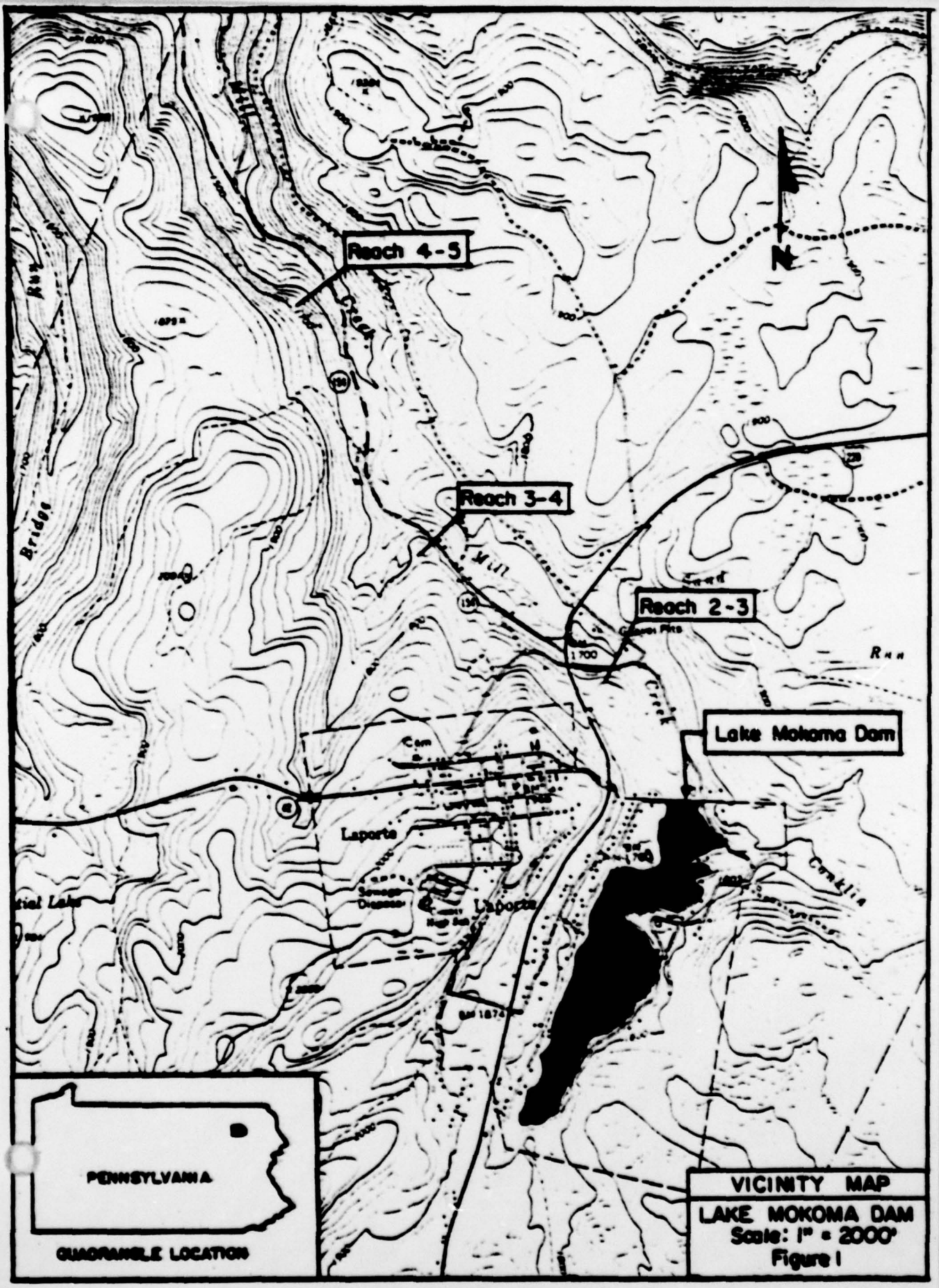
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	5752.	1546.9	43.50

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	2907.	1544.7	42.25

APPENDIX E

DRAWINGS


Reach 4-5
Reach 3-4
Reach 2-3
Lake Mokoma Dam
Laporte
PENNSYLVANIA
QUADRANGLE LOCATION
VICINITY MAP
LAKE MOKOMA DAM
Scale: 1" = 2000'
Figure 1

APPENDIX F

GEOLOGY

General Geology.

Lake Mokoma Reservoir and Dam lie within the Allegheny High Plateaus Section of the Appalchian Plateaus Physiographic Province. This area is characterized by nearly horizontal strata with local open folds. ANticlines and synclines are usually quite broad. There are no known faults in the vicinity of the reservoir.

The bedrock in this area consists of the Mississippian aged Pocono Group. The rocks in this group include fine to coarse-grained sandstone, gray to greenish-gray conglomeratic beds, thin beds of shale and siltstone, and a few coal beds. The moderate to thick beds are well developed. The abundant joints are also well developed and moderately to closely spaced in a regular pattern. This formation is highly resistant to weathering and usually has only a thin mantle of weathered material. It is an excellent foundation material for heavy structures. The surface drainage is good while the interstitial and secondary porosity give the unit a high effective porosity.



GEOLOGIC MAP OF MOKOMA LAKE DAM AREA

Pocono Group

Predominantly gray, fluvial, massive cross-bedded conglomeratic and sandstone with some shale; includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Logan, Corry, and Knapp Formations; includes part of Chemung of W. L. Fuller in Fuller and Truax reports

Scale: 1:250,000