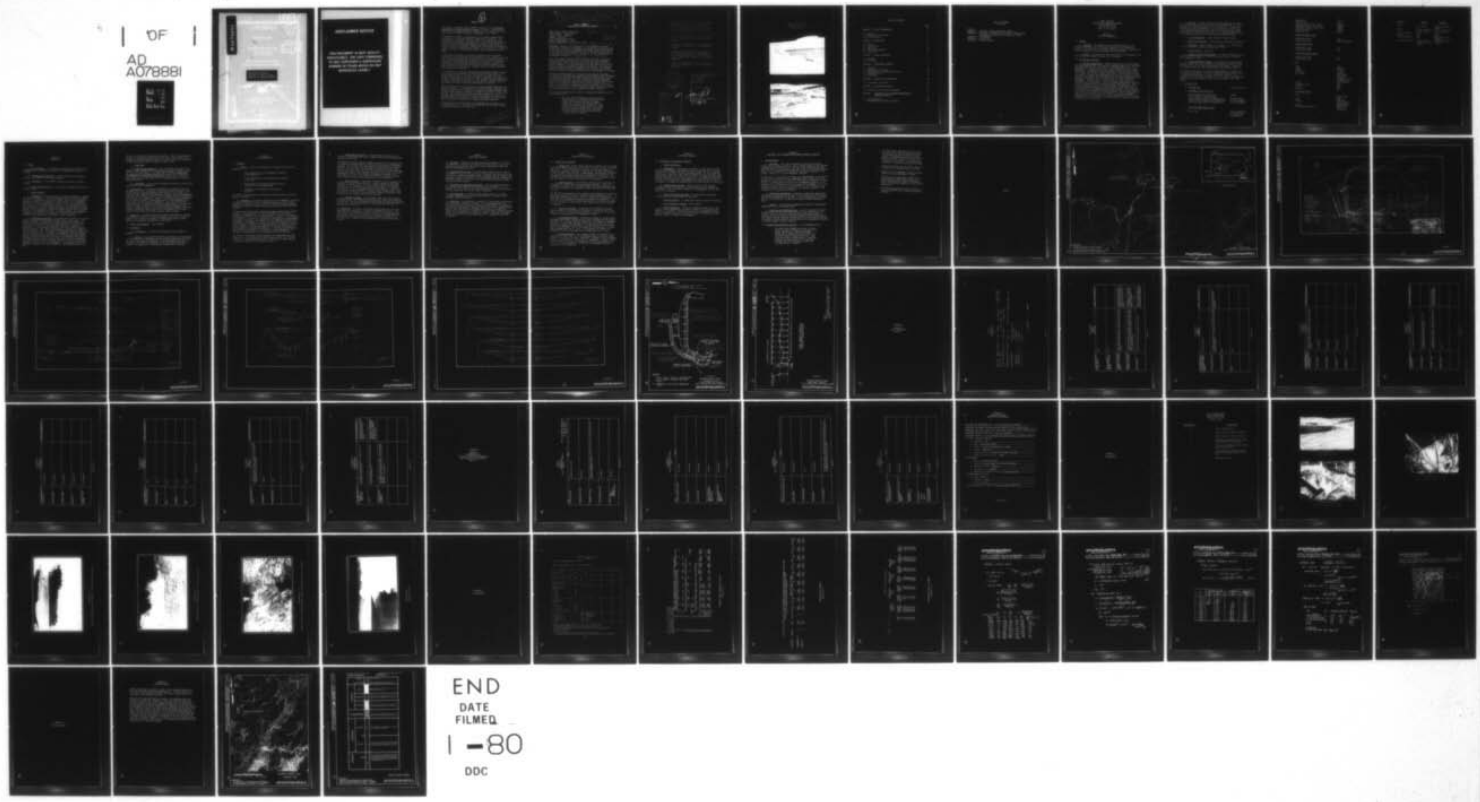
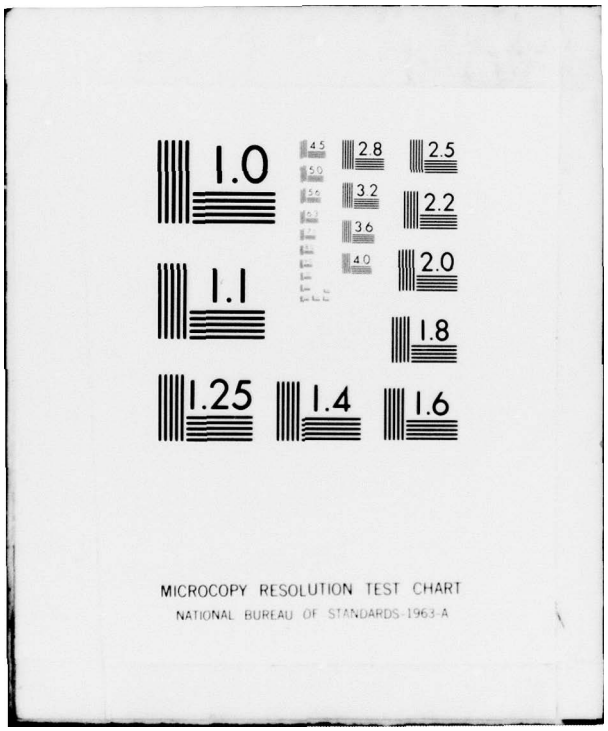
AD-A078 881 D'APPOLONIA CONSULTING ENGINEERS INC PITTSBURGH PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. MUSSER FORESTS DAM (NDI ID NUM--ETC(U)
JUN 79 L D ANDERSON DACW31-79-C-0014

UNCLASSIFIED NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Distribution Unlimited
Approved for Public Release
Contract No. DACW31-79-C-0014

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DDC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

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 Department of the Army, 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 visual observations and review of available data. Detailed investigation and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

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 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 the dam depends on numerous and constantly changing internal and external factors which are 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.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

(6) National Dam Inspection Program. Musser Forests Dam (NDI PA-287, DER IDV 32-65), Ohio River Basin, McKee Run, Indiana County, Pennsylvania. Phase I Inspection Report, National Dam Inspection Program

(Number) (Number)

NAME OF DAM: Musser Forests Dam (11) Jun 79
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Indiana
STREAM: McKee Run (12) 71
SIZE CLASSIFICATION: Small
HAZARD CLASSIFICATION: High
DATE OF INSPECTION: May 23 and 25, 1979 (10) Lawrence D. Anderson

ASSESSMENT: Based on the evaluation of the conditions of Musser Forests Dam, the dam is considered to be unsafe due to severe erosion in the primary spillway and emergency discharge channel along the toe of the dam near the left abutment and due to the lack of an operable outlet works for the reservoir. However, it is not considered to be an emergency condition. (15) DACW31-79-C-0014

Field observations indicate that the crest of the dam is irregular with elevations ranging from 1.7 to 5.9 feet above the emergency spillway crest level. The irregularities do not appear to be due to recent movements. The upstream slope of the dam has no erosion protection and has been partially eroded by wave action. The emergency spillway approach channel is overgrown with tall grass and cattails which may constitute a partial obstruction to flow through the spillway.

The flood discharge capacity of Musser Forests Dam was evaluated and according to the recommended procedure and was found to pass 30 percent of the probable maximum flood (PMF) without overtopping the low spot on the crest of the dam. Therefore, according to the recommended criteria, the flood discharge capacity of Musser Forests Dam is classified to be inadequate. However, the spillway capacity is not considered to be seriously inadequate because overtopping of the low spot of the embankment by 0.4 foot during the passage of 50 percent of the PMF is not considered to pose a significant breach potential.

The following recommendations should be implemented immediately or on a continuing basis:

1. The owner should immediately retain a professional engineer to evaluate the erosion in the primary and emergency spillway discharge channel and to prepare and execute plans for providing adequate erosion protection. This study should also consider means of providing emergency drawdown facilities or restoring and improving the existing facilities with upstream closure or control.

411001 JOC

2. The owner should immediately initiate additional studies to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate spillway capacity. Filling of the low spots on the crest of the dam should be considered in conjunction with these studies.

3. Adequate erosion protection, such as riprap, should be provided on the upstream slope of the dam.

4. Vegetation in the emergency spillway approach and discharge channels should be immediately cleared.

5. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

6. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.

Lawrence D. Andersen, P.E.
Vice President

9 AUG 1979
Date

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

11 Sep 79
Date

Accession For	
NTIS GRA&I	✓
DDC TAB	
Unannounced	
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or special
A	23

MUSSER FORESTS DAM
NDI I.D. NO. PA-287
MAY 23, 1979

Upstream Face

Downstream Face

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
MUSSER FORESTS DAM
NDI I.D. NO. PA-287
DER I.D. NO. 32-65

SECTION 1
PROJECT 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. Musser Forests Dam is an earth embankment approximately 1200 feet long with a maximum height of 22 feet from the downstream toe and a crest width of approximately 15 feet. The embankment is L-shaped in plan view. Near the left abutment (looking downstream), the embankment curves upstream, forming the short leg of the L shape. The flood discharge facilities of the dam, which consist of a primary spillway and an emergency spillway, are located on the left abutment. The primary spillway consists of a concrete drop inlet structure which discharges into a 24-inch terra-cotta pipe through the embankment. The drop inlet is 3 feet square in plan view and is equipped with trash screens. There is no energy dissipating structure at the downstream end of the primary spillway discharge pipe. The spillway discharge channel is an earth channel which follows the toe of the embankment for approximately 200 feet and then turns right to join McKee Run. The emergency spillway was designed as a 50-foot-wide, 3-foot-deep earth channel on the left abutment. The reservoir drainpipe is an 8-inch steel pipe at the center of the main embankment. Reportedly, the flow through this pipe is controlled by a valve at the downstream end. This outlet system constitutes the emergency drawdown facilities for the reservoir.

b. Location. The dam is located near the headwaters of McKee Run in Rayne Township, Indiana County, Pennsylvania (Plate 1). Below the dam, McKee Run flows parallel to U.S. Route 119. A commercial building is located approximately 1/2 mile downstream from the dam. In the remaining one-mile reach, there are at least 10 homes within the potential flood plain of McKee Run. It is estimated that failure of the dam would cause loss of life and large property damage.

c. Size Classification. Small (based on 22-foot height).

d. Hazard Classification. High (based on downstream conditions).

e. Ownership. Musser Forests, Inc. (address: Mr. Fred Musser, Jr., Route 119 North, Indiana, Pennsylvania 17501).

f. Purpose of Dam. Irrigation.

g. Design and Construction History. The dam was designed by the Soil Conservation Service in 1950 and was constructed by the owner with completion in 1952.

h. Normal Operating Procedure. The reservoir is normally maintained at Elevation 1373, the level of uncontrolled primary spillway. When the lake is at or above the primary spillway level, inflow is discharged through the uncontrolled primary and emergency spillways.

The elevations shown on the design drawings appear to be relative to an arbitrary site datum. On the U.S. Geological Survey (USGS) Clymer 7.5-minute quadrangle map, the pool elevation is shown to be at Elevation 1373. Elevations referred to in this report were determined assuming the primary spillway crest to be at Elevation 1373 (USGS datum).

1.3 Pertinent Data

a. Drainage Area — 0.35 square miles

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site	Unknown
Outlet conduit at maximum pool	4
Gated spillway capacity at maximum pool	Not applicable
Ungated spillway capacity at maximum pool	676 (as designed)
Total spillway capacity at maximum pool	676 (as designed)

c. Elevation (USGS Datum) (feet)

Top of dam	1375.7 (measured low spot); 1377 (as designed)

Maximum pool	1375.7
Normal pool	1373
Upstream invert outlet works	Unknown
Downstream invert outlet works	Unknown
Streambed at center line of dam	1354±
Maximum tailwater	Unknown
Downstream toe	1355±

d. Reservoir Length (feet)

Normal pool level	1600
Maximum pool level	1700 (estimated)

e. Storage (acre-feet)

Normal pool level	140
Maximum pool level	207

f. Reservoir Surface (acres)

Normal pool level	23
Maximum pool level	27±

g. Dam

Type	Earth
Length	1200 feet
Height	22 feet
Top width	15 feet
Side slopes	Downstream: 2.5H:1V (as measured); Upstream: 3H:1V (as designed)
Zoning	None
Impervious core	None
Cutoff	Yes
Grouting	None

h. Regulating Outlet

Type	8-inch steel pipe
Length	150± feet
Closure	Valve on the downstream end
Access	Inaccessible
Regulating facilities	Valve on 8-inch pipe

i. Spillway

	Primary	Emergency
Type	Drop inlet	Trapezoidal earth channel
Length	9 feet (perimeter of drop inlet)	37 feet (perpendicular to flow)
Crest elevation	1373	1374±
Gates	None	None
Upstream channel	Lake	Trapezoidal earth channel
Downstream channel	24-inch outlet conduit and earth channel	Trapezoidal earth channel

SECTION 2
DESIGN DATA

2.1 Design

a. Data Available. The available information was provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER).

(1) Hydrology and Hydraulics. Limited hydrology and hydraulic analyses are included in the design drawings.

(2) Embankment. The available information consists of design drawings.

(3) Appurtenant Structures. The available information consists of design drawings.

b. Design Features

(1) Embankment. The dam consists of an earth embankment, L-shaped in plan view (Plate 2). The design drawings (Plate 3) show the embankment to be a homogeneous fill with a central cutoff trench extending to impervious material. As designed, the side slopes of the embankment were 2H to 1V on the downstream face and 3H to 1V on the upstream face. As indicated in the design drawings (Plate 2), the embankment material was to be placed in six-inch layers and compacted by sheepsfoot rollers. However, state construction inspection reports indicate that an initial portion of the embankment was built by a dozer without such compaction. Apparently, upon the state's request, the remaining portion of the embankment was completed with sheepsfoot roller compaction.

(2) Appurtenant Structures. The appurtenant structures of the dam consist of primary and emergency spillways and an outlet works. The primary spillway is located near the left abutment and consists of a concrete drop inlet structure which discharges into a 24-inch terra-cotta pipe. The crest of the drop inlet structure is located at Elevation 1373. The emergency spillway is an earth channel located on the left abutment. The crest of the emergency spillway is at approximately Elevation 1374. As designed, the emergency spillway channel was to be 50 feet wide and 3 feet deep. The emergency spillway discharge channel is shown to be an earth channel 50 feet wide and approximately 500 feet long paralleling the short leg of the embankment and freely discharging into the valley near the left side of the main embankment. The outlet works facility for the dam consists of an 8-inch steel pipe through the center of the main embankment. Flow through this pipe is reportedly controlled by a valve located at the downstream end of the pipe.

The pipe is reported to be encased in concrete. Plate 3 illustrates the details of the primary spillway and outlet pipe. The profiles of the primary and emergency spillways and the cross sections of the emergency spillway discharge channel are shown on Plates 4 and 5.

c. Design Data

(1) Hydrology and Hydraulics. The calculations included in the design drawings indicate that the emergency spillway was sized to pass 342 cfs at a 2-foot depth. In a state report entitled, Report Upon the Application of the Musser Forests, Inc., dated July 6, 1951, the full capacity of the spillway is reported to be 676 cfs. The state report indicates that the capacity of the primary spillway is 40 cfs at maximum pool level.

(2) Embankment. The available information includes no quantitative design data for the embankment.

2.2 Construction. Very limited information is available on the construction of the dam. Although the construction notes included in the design drawings required embankment fill material to be placed in 6-inch layers and compacted with sheepsfoot rollers, various correspondence indicates that an initial portion of the embankment was constructed by a dozer without such compaction. However, it is reported that subsequent to the state's request, the remaining portion of the embankment was constructed with the specified compaction. The state construction permit required the emergency spillway discharge channel to be protected by either riprap or paving to avoid erosion during extreme floods. However, it appears that no such erosion protection measures were taken. Another construction change noted was the encasement of the 8-inch reservoir outlet pipe in concrete upon the state's request.

2.3 Operation. No formal operating records are available for the dam. According to the owner of the dam, the highest pool level in recent years occurred during the passage of Tropical Storm Agnes in 1972. However, the emergency spillway was not activated.

2.4 Other Investigations. None reported.

2.5 Evaluation

a. Availability. The available information was provided by PennDER.

b. Adequacy. The available information includes no technical data on the design of the embankment and very limited information is available on the hydrology and hydraulics of the appurtenant structures. Therefore, the available information is not considered sufficient to evaluate the adequacy of the design and construction of the dam.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Musser Forests Dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.

2. Visual examination of the appurtenant structures of the dam.

3. Observations of the factors affecting runoff potential of the drainage basin.

4. Evaluation of the downstream area hazard potential.

The specific observations are illustrated in Plate 6 and in the photographs in Appendix C.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

Discharge through the primary spillway discharge channel which follows the toe of the embankment near the left abutment was found to be eroding the embankment toe. At some sections, the toe of the embankment appears to be cut 4 to 5 feet deep by this erosion. This condition is considered to constitute a threat to the integrity of the embankment if allowed to continue. The condition of the remaining portion of the embankment is considered to be fair. The crest of the dam was found to be irregular. However, the irregularities do not appear to be from recent movements. The upstream slope of the dam has no erosion protection and has eroded due to wave action. A wet area was observed at the toe level of the dam at the center of the main embankment. No measurable seepage appears to be associated with this wet area.

The crest of the dam was surveyed relative to the emergency spillway crest level. The freeboard was found to range from 1.7 feet in the vicinity of the primary spillway to 5.9 feet near the right abutment. The dam crest profile is illustrated on Plate 7.

c. Appurtenant Structures. The appurtenant structures were examined for deterioration or other signs of distress and obstructions that would limit flow.

The emergency spillway approach channel was found to be overgrown with tall grass and cattails which may obstruct flow through the emergency spillway. The spillway discharge channel downstream from the primary spillway was also found to be overgrown with brush and trees which also may constitute obstruction to flow. Although the design drawings show the base width of the emergency spillway to be 50 feet, the field measurements show the base width of the emergency spillway to be approximately 37 feet. The visible portions of the primary spillway structures were inspected and found to be in fair condition.

d. Reservoir Area. A map review indicates that the watershed is predominantly covered with farmlands. Several commercial buildings belonging to Musser Forests, Inc., are located within the watershed. A portion of the reservoir area along the west side of the lake was being filled in for the construction of new greenhouses. A review of the regional geology (Appendix E) indicates that the shoreline of the reservoir is not likely to be susceptible to massive landslides, which would affect the storage volume of the reservoir.

e. Downstream Channel. Below the dam, McKee Run flows through a developed valley. One commercial building and at least ten houses are considered to be within the potential flood plain of McKee Run downstream from the dam. Further description of the downstream conditions is included in Section 1.2b.

3.2 Evaluation. In view of the severe erosion along the toe of the embankment, the condition of the dam is considered to be poor. The other significant conditions noted are the lack of adequate emergency drawdown facilities for the reservoir, the presence of vegetation in the emergency spillway channel which may constitute obstruction to flow, and lack of adequate erosion protection on the upstream slope of the dam.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. The reservoir is normally maintained at the crest level of the uncontrolled primary spillway with excess inflow discharging through the primary and emergency spillways.

4.2 Maintenance of the Dam. The maintenance condition of the dam is considered to be poor. Although it was found that the grass on the face of the dam is being periodically mowed, it appears that no attempts have been made to clear the vegetation in the emergency spillway approach and discharge channels or to correct the erosion problem along the primary spillway discharge channel.

4.3 Maintenance of Operating Facilities. The only operable facility for the dam is the valve on the 8-inch reservoir drainpipe. It is reported that this valve has not been operated since the construction of the dam. Operation of the valve was not observed.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are available via Musser Forests facilities near the dam site.

4.5 Evaluation. The maintenance condition of the dam and the operating facilities are considered to be poor. It is recommended that the erosion problem in the spillway discharge channel should be evaluated by a professional engineer and necessary erosion protection measures taken. Means of providing emergency drawdown facilities for the reservoir should also be considered. Vegetation in the emergency spillway approach channel and discharge channel should be cleared. The need for placing erosion protection on the upstream slope of the embankment should be considered.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Musser Forests Dam has a watershed of 0.35 square mile and impounds a reservoir with a surface area of 23 acres at normal pool level. The flood discharge facilities for the dam consist of primary and emergency spillways. Based on the available head relative to the low spot on the crest of the embankment, the combined capacity of the primary and emergency spillways is estimated to be 300 cfs. For discharge capacity calculations, the base width of the emergency spillway was taken as 37 feet, as measured in this inspection.

b. Experience Data. As previously stated, Musser Forests Dam is classified as a small dam in the high hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass flows between one-half and full PMF.

The PMF inflow hydrograph for the reservoir was determined was using the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Engineering Center of the U.S. Army, Corps of Engineers. The data used for the computer analysis are presented in Appendix D. The full and one-half PMF inflow hydrographs were found to have peak flows of 1763 and 881 cfs, respectively. The computer outputs are included in Appendix D.

c. Visual Observations. Vegetation in the emergency spillway approach channel is considered to constitute a partial obstruction to flow in the event of the emergency spillway is activated. It is recommended that this vegetation be immediately cleared.

d. Overtopping Potential. Various percentages of the PMF inflow hydrograph were routed through the reservoir, starting from the normal pool elevation using the combined capacity of the primary and emergency spillways. It was found that the dam can pass 30 percent of the PMF without overtopping the embankment. At 40 percent of the PMF, the low spot on the embankment will be overtopped for a duration of 1.2 hours with a maximum depth of 0.1 foot. For 50 percent of the PMF, the embankment would be overtopped with a maximum depth of 0.4 foot.

e. Spillway Adequacy. The spillway capacity is estimated to be less than the lower limit of the recommended range of spillway design floods of one-half to full PMF. Therefore, according to the recommended criteria, the spillway is classified to be inadequate. However, it is not considered to be seriously inadequate, because overtopping of the low spot on the embankment by 0.4 foot is not considered to pose a significant breach potential.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, other than the potential stability problems introduced by erosion along the toe of the dam adjacent to the primary spillway discharge channel, the field observations did not reveal any other signs of distress at this time that would significantly affect the stability of the dam. Although no quantitative data are available to aid in the assessment of the stability of the dam, in view of the adequate past performance, the stability of the dam is considered to be adequate, assuming that the erosion problem is corrected.

(2) Appurtenant Structures. Severe erosion in the spillway discharge channel along the toe of the dam near the left abutment is considered to pose a stability problem to the embankment if this condition is not corrected.

b. Design and Construction Data. No quantitative design and construction data are available for this dam.

c. Operating Records. No operating records are kept for this dam.

d. Post-Construction Changes. None reported.

e. Seismic Stability. The dam is located in Seismic Zone 1 and based on visual observations, the static stability of the dam is considered to be adequate. Therefore, based on the recommended criteria for the evaluation of seismic stability of dams, the structure is presumed to present no hazard from earthquakes.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. The visual observations indicate that Musser Forests Dam is in poor condition. Due to severe erosion in the spillway discharge channel along the toe of the dam, which threatens the long-term stability of the embankment, and due to the lack of operable outlet works for the reservoir, the condition of the dam is considered to be unsafe. However, it is not an emergency condition.

The capacity of the spillway was found to be approximately 30 percent of the PMF, which is less than the recommended capacity based on the size and hazard classification for the dam. Therefore, the spillway is classified to be inadequate according to the recommended criteria. It is estimated that overtopping of the low spot of the embankment by 0.4 foot during the passage of 50 percent of the PMF will not introduce a significant breaching potential; therefore, the spillway capacity is not considered to be seriously inadequate.

b. Adequacy of Information. Although no design and construction information is available for the dam, in view of the fact that the dam has performed adequately in the past, it is considered that the assessment of the condition of the dam can be based on visual observation alone.

c. Urgency. The following recommendations should be implemented immediately or on a continuing basis.

d. Necessity for Additional Data. In view of the severe erosion in the primary spillway discharge channel and the inadequacy of the spillway capacity, the owner should initiate additional studies to prepare and execute plans for providing adequate erosion protection in the primary spillway discharge channel and to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate spillway capacity.

7.2 Recommendations/Remedial Measures. It is recommended that:

1. The owner should immediately retain a professional engineer to evaluate the erosion in the primary and emergency spillway discharge channel and to prepare and execute plans for providing adequate erosion protection. This study should also consider means of providing emergency drawdown facilities or restoring and improving the existing facilities with upstream closure or control.

2. The owner should immediately initiate additional studies to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate spillway capacity. Filling of the low spots on the crest of the dam should be considered in conjunction with these studies.

3. Erosion protection, such as riprap, should be provided on the upstream slope of the dam.

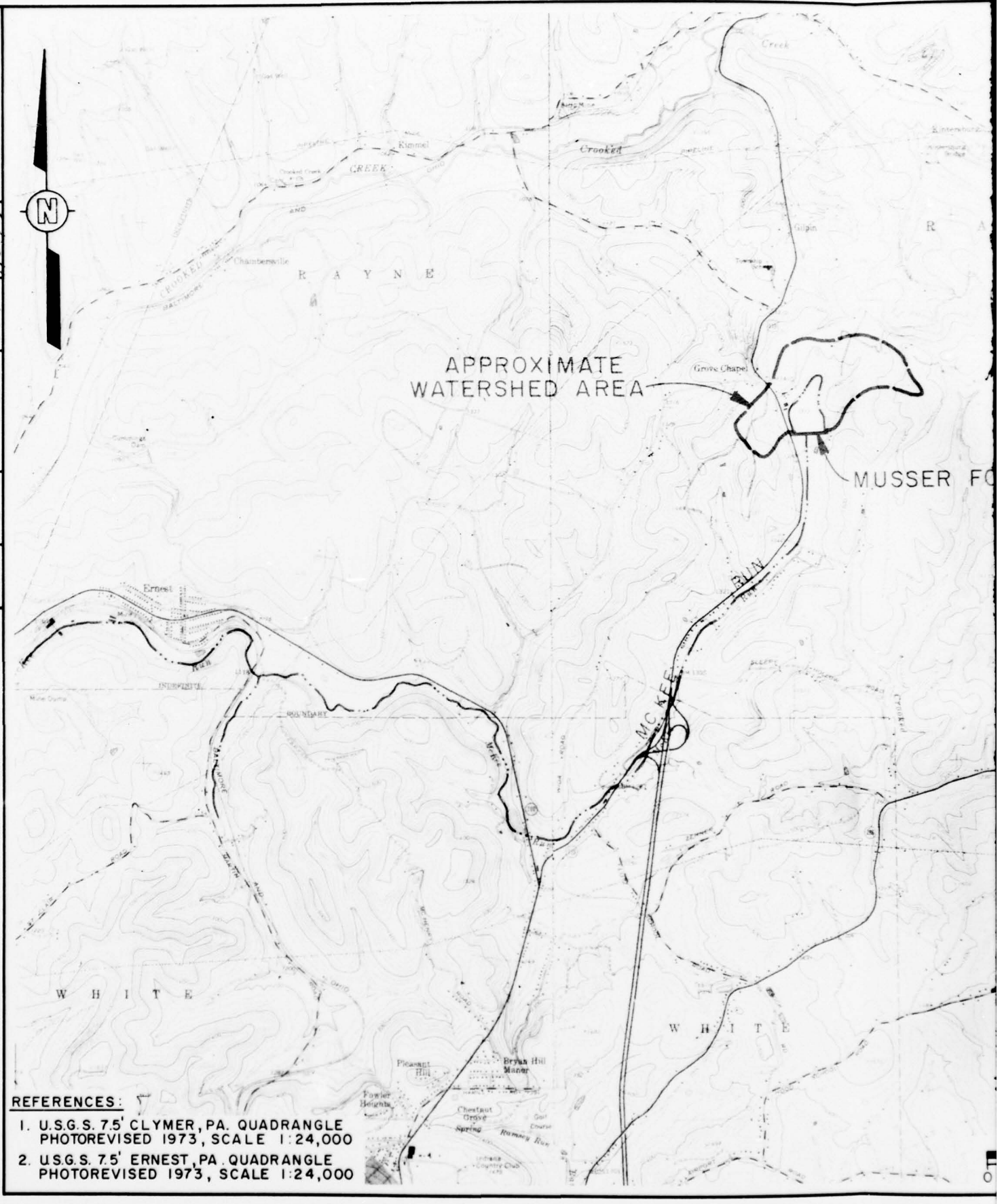
4. Vegetation in the emergency spillway approach channel should be immediately cleared.

5. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

6. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.

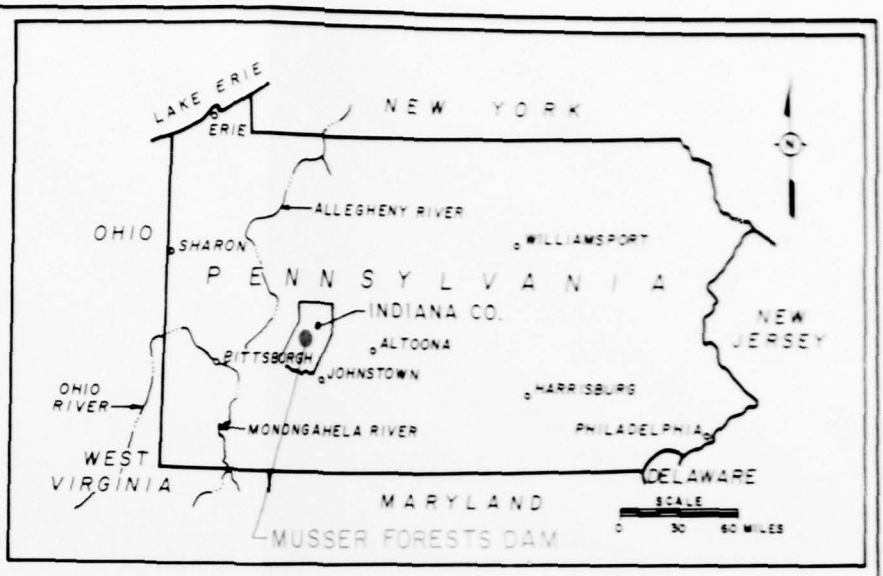
PLATES

DRAWN BY	ACS	CHECKED BY	BE	7-24-79	DRAWING NUMBER	78 J67-B174
	4-27-79	APPROVED BY	JHD	7/24/79		



REFERENCES:

1. U.S.G.S. 7.5' CLYMER, PA. QUADRANGLE PHOTOREVISED 1973, SCALE 1:24,000
2. U.S.G.S. 7.5' ERNEST, PA. QUADRANGLE PHOTOREVISED 1973, SCALE 1:24,000



KEY PLAN

MUSSER FORESTS DAM

RAYNE

CHERRYHILL

SCALE

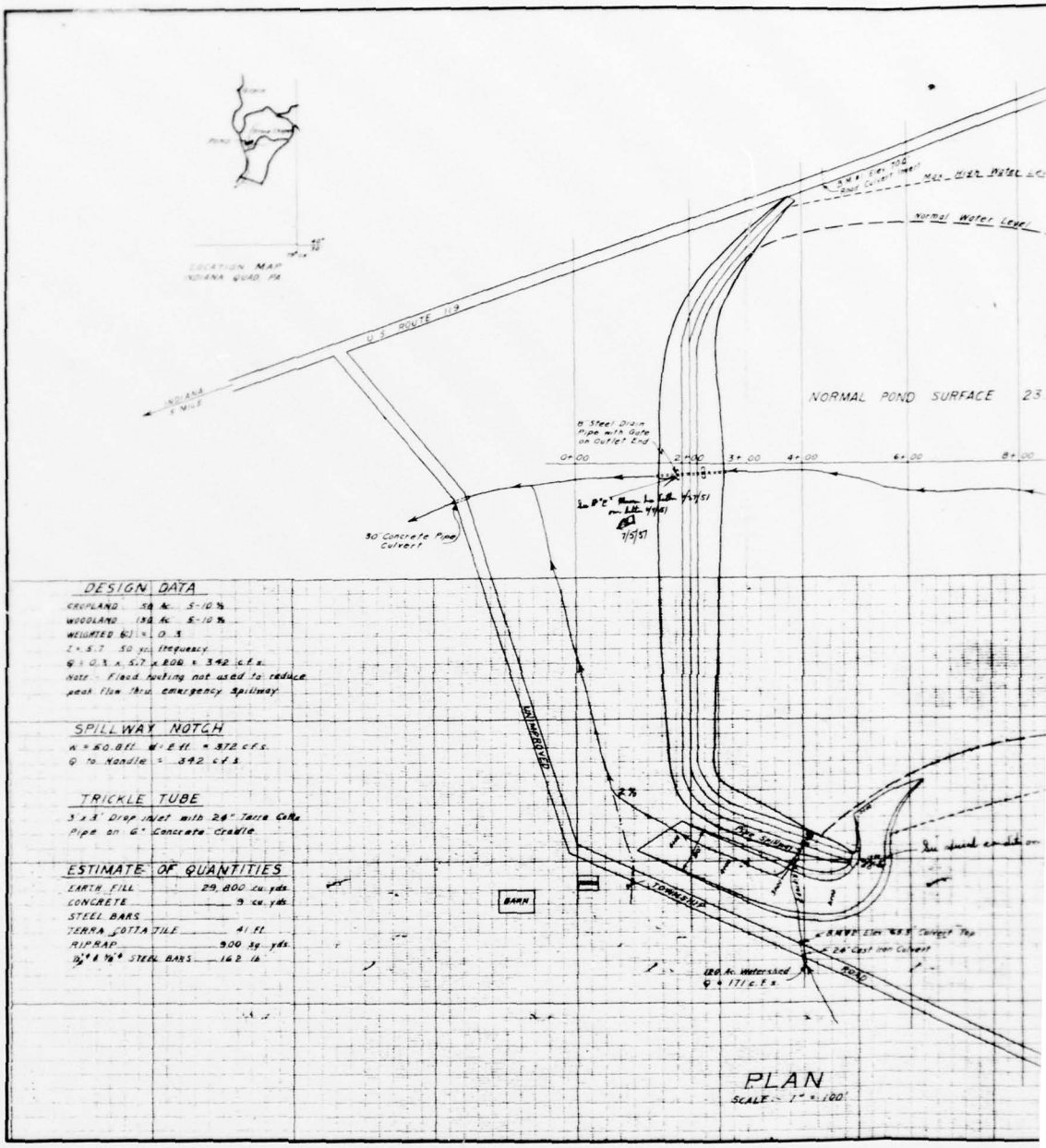
0 2000 4000 6000 8000 FEET

PLATE I

MUSSER FORESTS DAM
VICINITY, FLOOD PLAIN & WATERSHED MAP

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	RE	7-24-79	DRAWING NUMBER	76-67-B175
	6-13-79	APPROVED BY	JMD	7/24/79		



DESIGN DATA

CROPLAND 50 Ac. S-10%
WOODLAND 150 Ac. S-10%
WEIGHTED (c) = .0.3
I = 5.7 50 yr. frequency
Q = 0.3 x 5.7 x 80B = 342 c.f.s.
Note: Flood routing not used to reduce peak flow thru emergency spillway.

SPILLWAY NOTCH

n = 60 B.ft. W.E.ft. = 372 c.f.s.
Q to Handle = 342 c.f.s.

TRICKLE TUBE

3 x 3' Drop inlet with 24" Terra Cotta Pipe on 6" Concrete Cradle.

ESTIMATE OF QUANTITIES

EARTH FILL	29,800 cu. yds.
CONCRETE	9 cu. yds.
STEEL BARS	
TERRA COTTA TILE	41 Ft.
RIPRAP	900 sq. yds.
#4 & #6 STEEL BARS	162 lb.

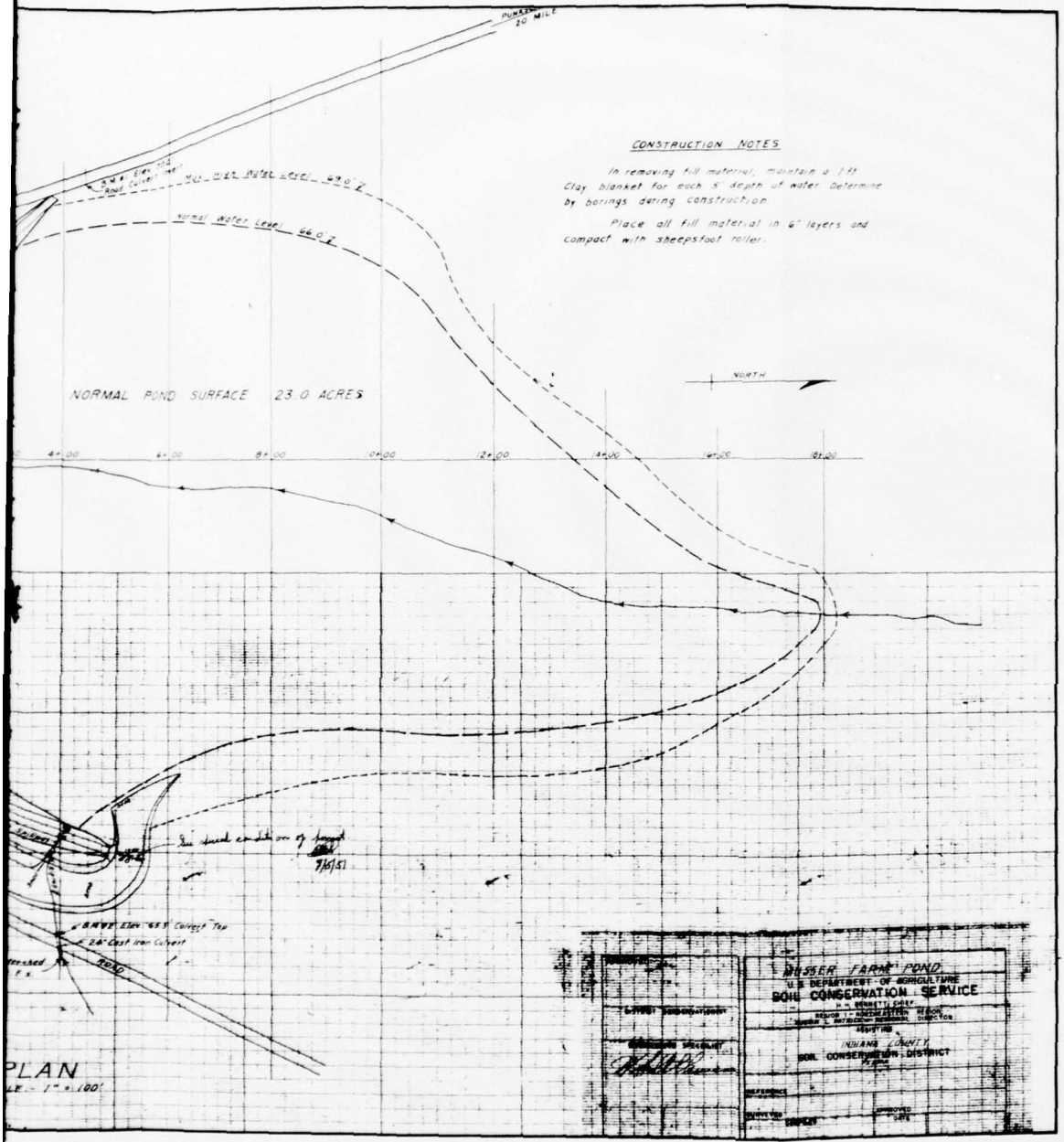
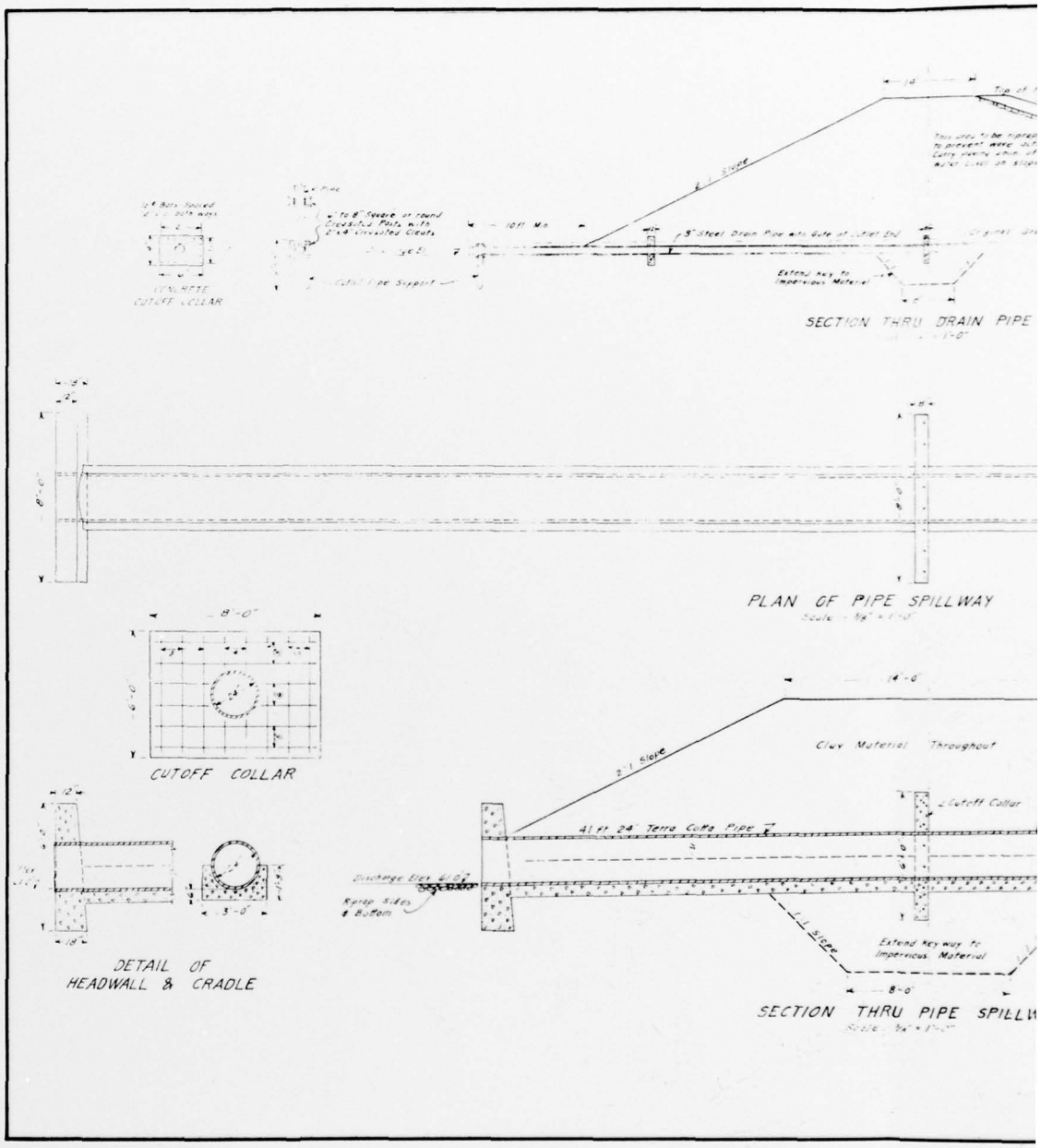


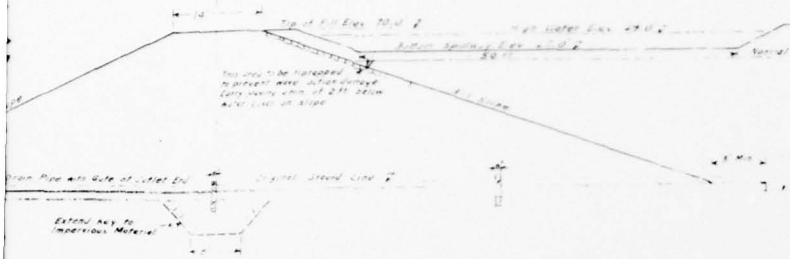
PLATE 2

2

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY		12-24-77	DRAWING NUMBER
	6-13-79	APPROVED BY		1/24/78	7C J67-B176





SECTION THRU DRAIN PIPE

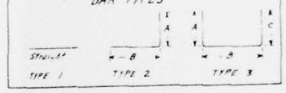
PLAN OF PIPE SPILLWAY

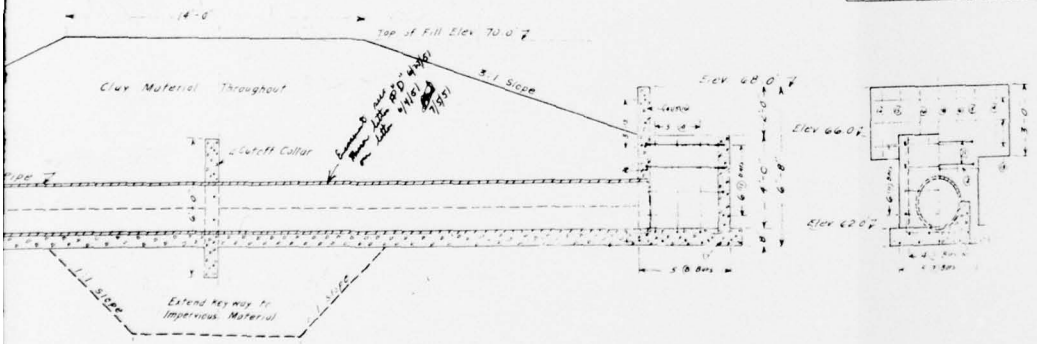
STEEL SCHEDULE

Mark	No.	Size	Length	Type	A	B	C	Total Ft.
1	2	#4	5'-0"	1				20'-0"
2	8	#4	5'-6"	1				44'-0"
3	6	#4	5'-6"	1				33'-0"
4	4		1'-4"	1				5'-8"
5	4		7'-6"	1				30'-0"
6	2		2'-3"	1				9'-6"
7	5		5'-2"	1				25'-10"
8	5		4'-8"	1				23'-4"
9	4		8'-0"	2	3'-0"	4'-0"		32'-0"
10	3		11'-5"	3	4'-0"	3'-5"	4'-0"	34'-5"
11	6		10'-3"	3	3'-5"	3'-5"	3'-5"	61'-6"
12	1		3'-8"	1				3'-8"
13	1		6'-8"	1				20'-0"
14	2		2'-8"	1				5'-4"
15	2		6'-4"	1				12'-8"
16	3		3'-9"	1				11'-3"

Total Weight of Steel — 162 lb.

BAR TYPES





SECTION THRU PIPE SPILLWAY

MUSSER FARM POND

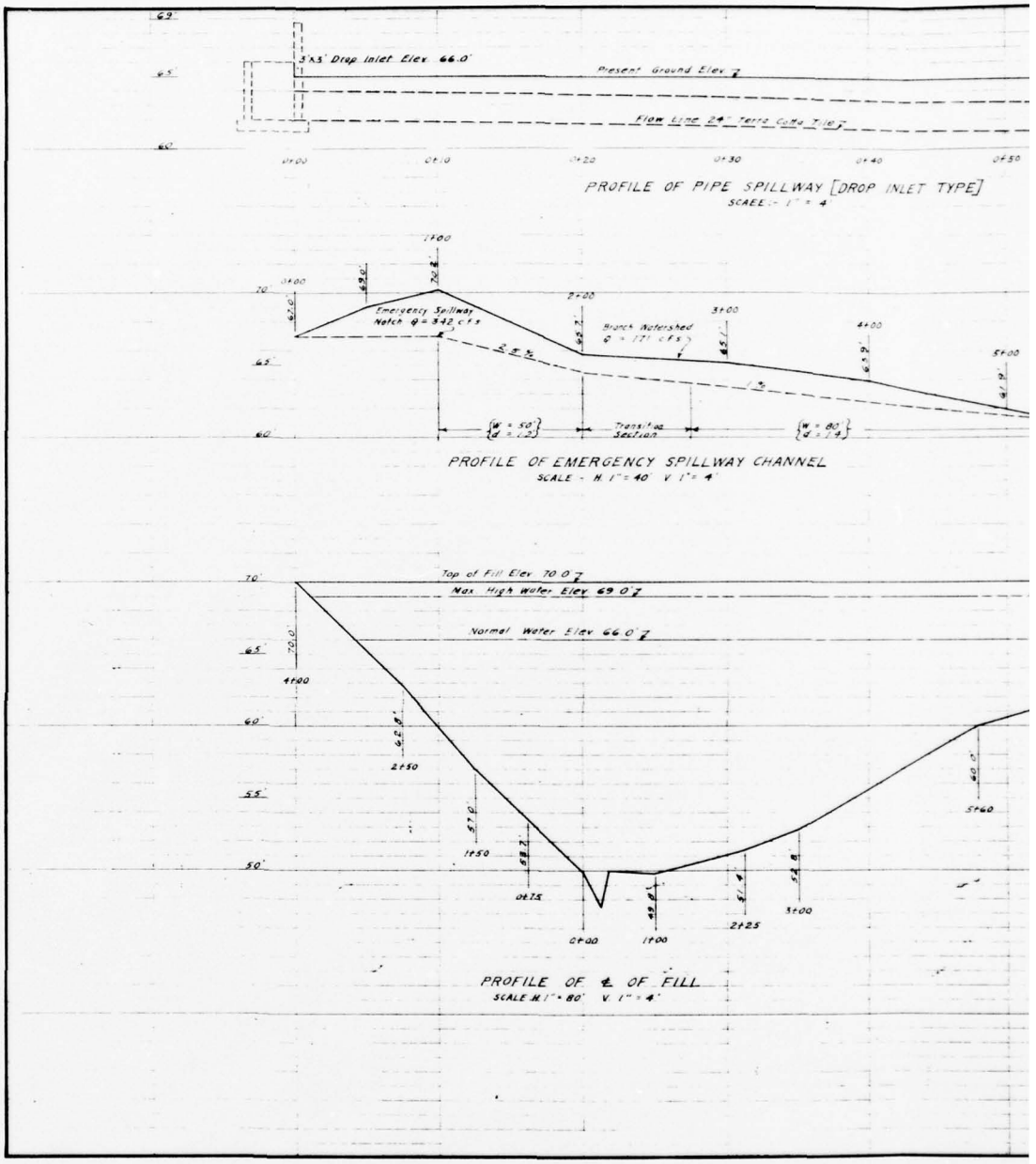
SHEET 5 OF 5

PLATE 3

2

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	1-24-79	DRAWING NUMBER	67-B177
	6-13-79	APPROVED BY	JMP	7/24/79		



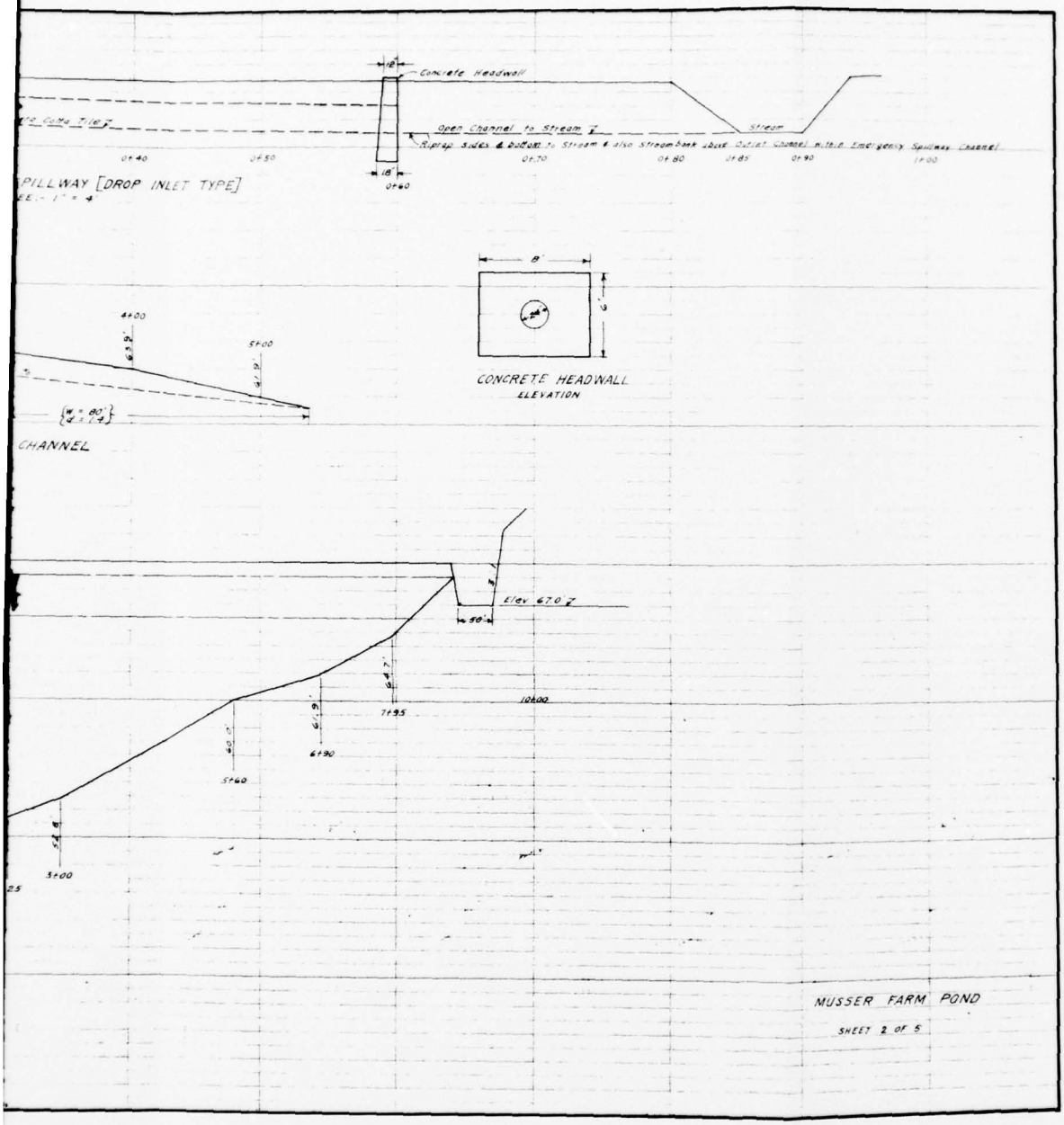
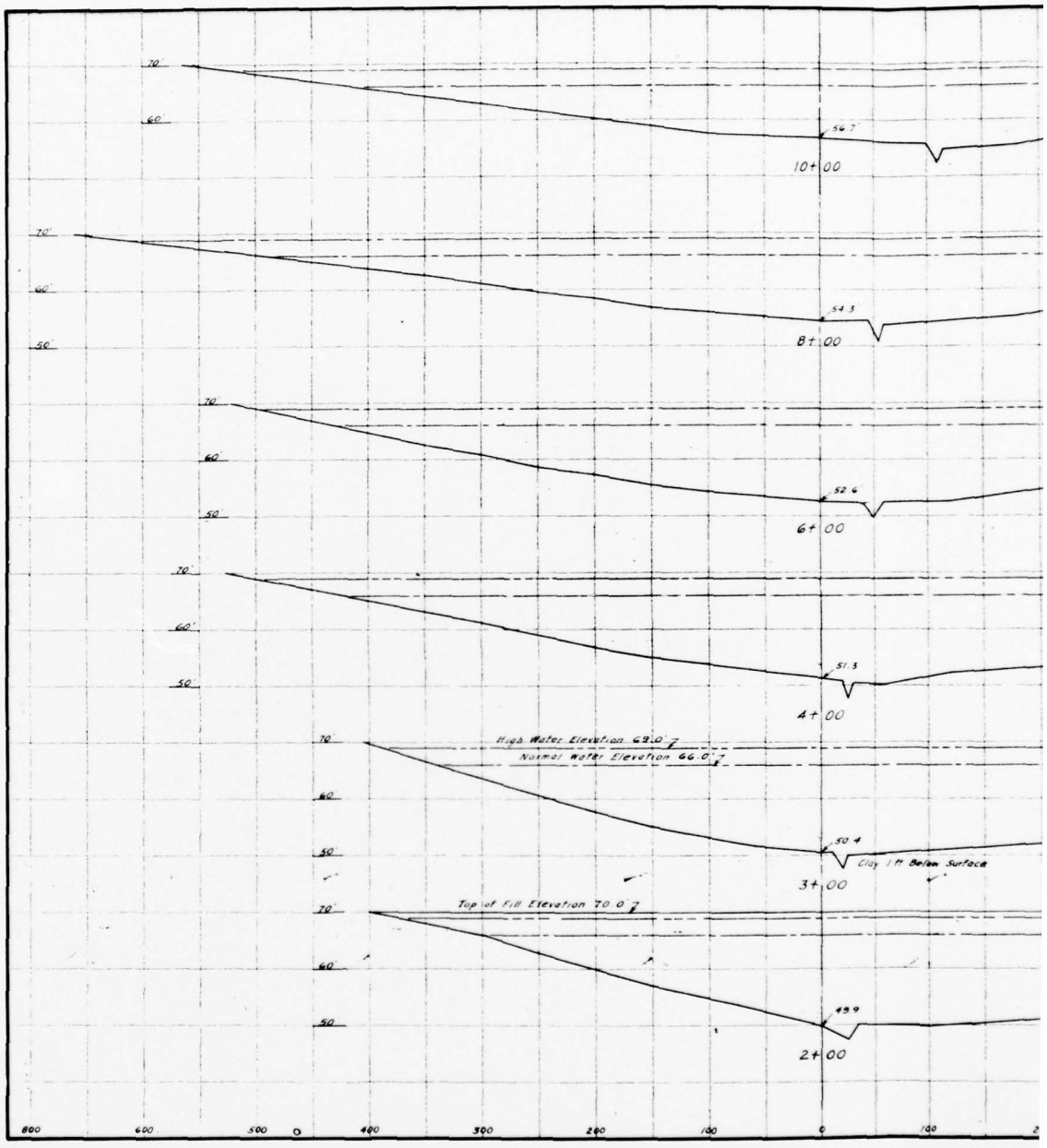


PLATE 4

2

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	7-24-79	DRAWING NUMBER	7L 67-B178
	6-13-79	APPROVED BY	JWP	7/27/79		



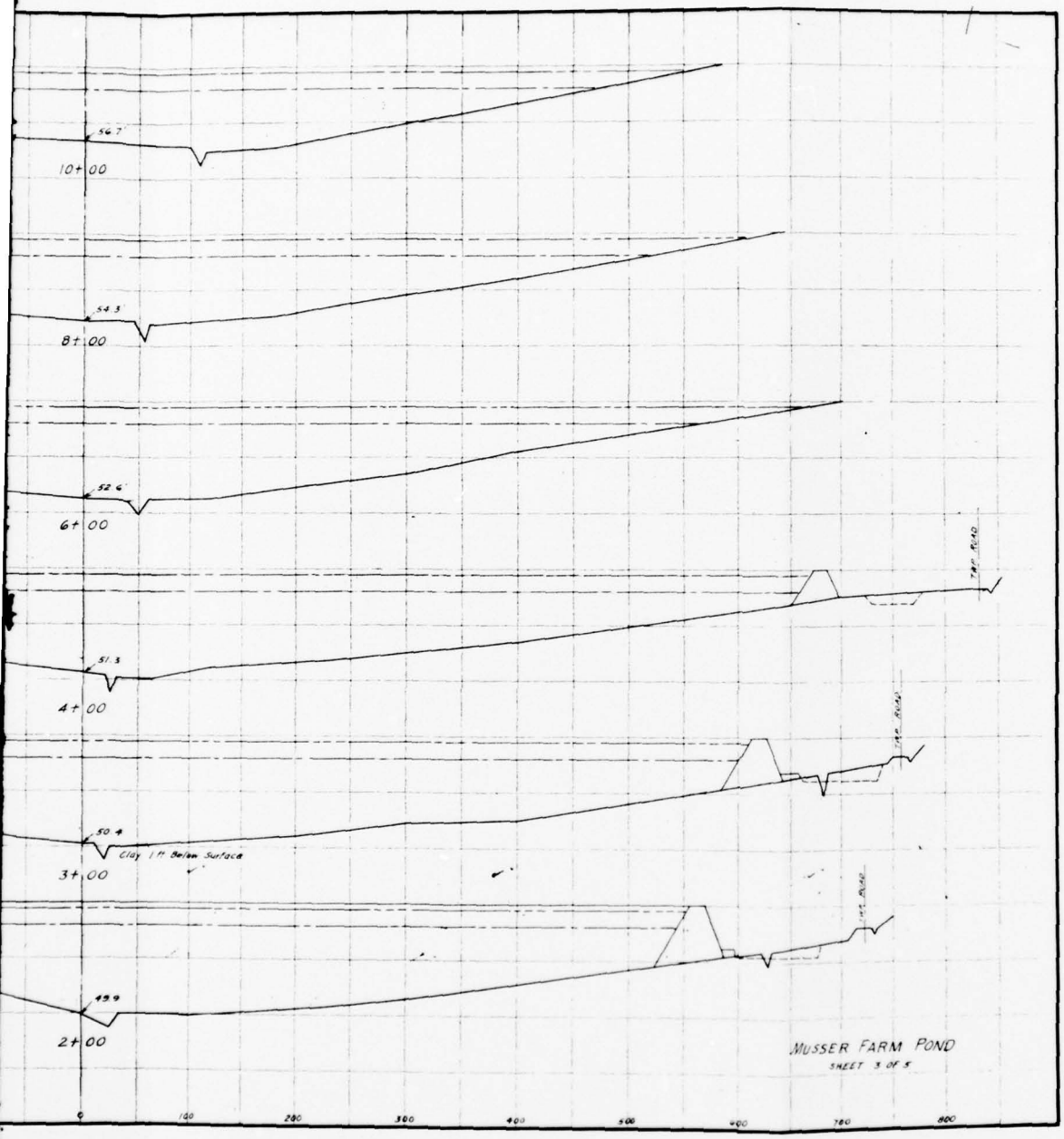
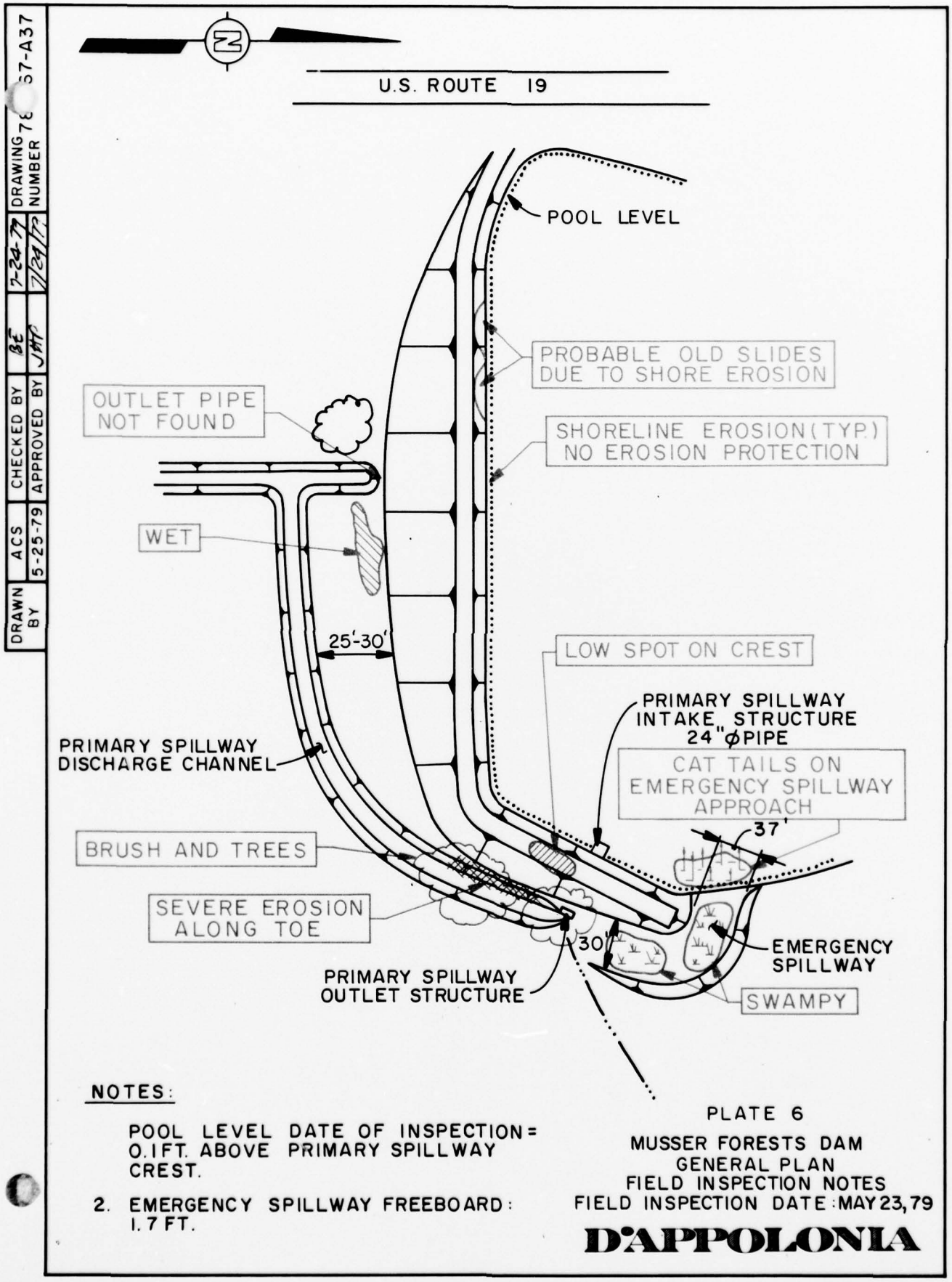


PLATE 5

2

D'APPOLONIA



NOTES:

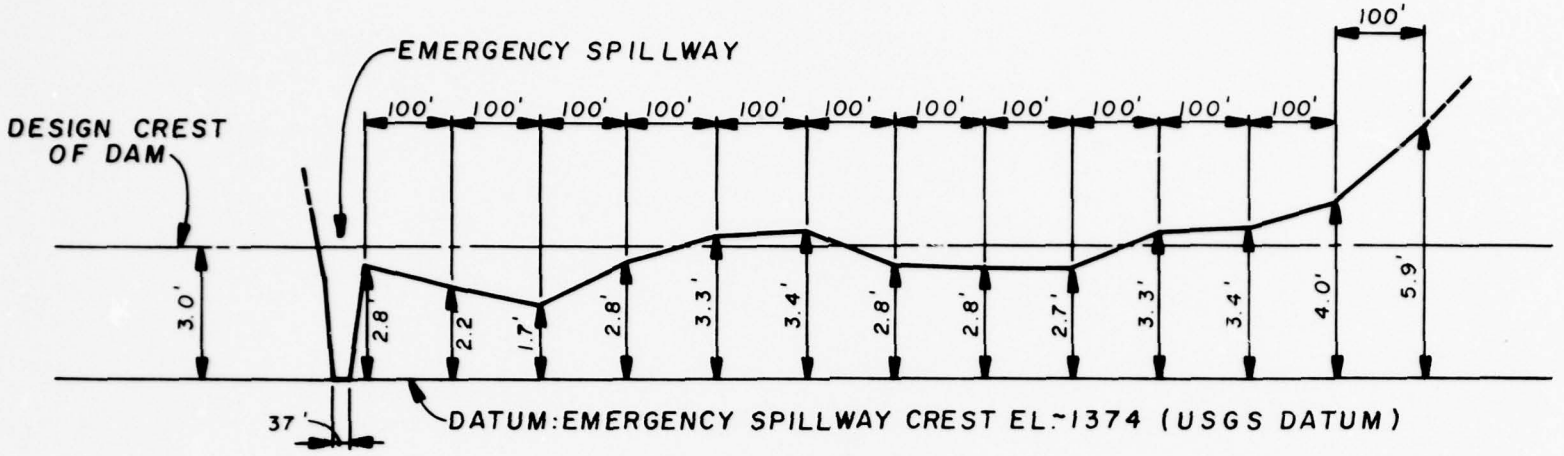
1. POOL LEVEL DATE OF INSPECTION = 0.1 FT. ABOVE PRIMARY SPILLWAY CREST.
2. EMERGENCY SPILLWAY FREEBOARD: 1.7 FT.

PLATE 6

MUSSER FORESTS DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: MAY 23, 79

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	7-24-79	DRAWING NUMBER 78-[redacted]-A44
	6-28-79	APPROVED BY	JAP	7/29/79	



DAM CREST PROFILE

(LOOKING DOWNSTREAM)

NOTE:

DAM CREST IS SURVEYED RELATIVE TO EMERGENCY SPILLWAY CREST LEVEL

PLATE 7

MUSSER FORESTS DAM
DAM CREST SURVEY
FIELD INSPECTION DATE: MAY 23, 1979

D'APPOLONIA

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Musser's Nursery Dam COUNTY Indiana STATE Pennsylvania ID# NDI I.D. PA-287 DER I.D. 32-65

TYPE OF DAM Earth HAZARD CATEGORY High

DATE(S) INSPECTION May 23, 1979 WEATHER Rainy TEMPERATURE 50s

POOL ELEVATION AT TIME OF INSPECTION 1373± M.S.L. TAILWATER AT TIME OF INSPECTION 1348± M.S.L.

INSPECTION PERSONNEL:	REVIEW INSPECTION PERSONNEL: (May 25, 1979)
Bilgin Erel	L. D. Andersen
Wah-Tak Chan	J. H. Poellot
	B. Erel

Bilgin Erel RECORDER

VISUAL INSPECTION
PHASE I
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	Severe erosion along the toe of the dam near the left abutment caused by flows through the primary spillway discharge channel.	The erosion problem should be evaluated by a professional engineer and the toe of the dam should be protected against erosion.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The crest of the dam is irregular. The crest levels range between 1.7 to 5.8 feet above the emergency spillway crest level. The low spot on the crest is located in the vicinity of the primary spillway.	Regrading of the crest should be considered in conjunction with further hydrologic and hydraulic studies.
RIPRAP FAILURES	There is no riprap on the upstream face of the dam.	Need for placing erosion protection on the upstream face of the dam should be considered.

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No signs of distress.	
ANY NOTICEABLE SEEPAGE	A wet area is located along the toe of the dam at the center of the main embankment. No measurable seepage is associated with this wet area.	This area should be closely examined during periodic inspections.
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	(The outlet works for the dam are reported to be an 8-inch steel pipe through the embankment. The pipe could not be located.)	
INTAKE STRUCTURE	Not applicable.	
OUTLET STRUCTURE	Not applicable.	
OUTLET CHANNEL	Not applicable.	
EMERGENCY GATE	Could not be located.	

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The emergency spillway has no concrete structures.	
APPROACH CHANNEL	The emergency spillway approach channel is partially obstructed by cattails and high grass.	
DISCHARGE CHANNEL	Trapezoidal earth channel. Obstructed by trees and brush downstream from the primary spillway discharge point.	Trees and brush should be cleared from the emergency spillway discharge channel.
BRIDGE AND PIERS	None.	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Not applicable.	
BRIDGE PIERS	Not applicable.	
GATES AND OPERATION EQUIPMENT	Not applicable.	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

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

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Reservoir slopes are gentle. A portion of the shoreline along the west side of the reservoir is being filled for the construction of new greenhouses.	
SEDIMENTATION	Unknown.	
UPSTREAM RESERVOIRS	None.	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The emergency and primary spillway discharge channel is obstructed by trees and brush.	Trees and brush in the primary and emergency spillway discharge channel should be cleared.
SLOPES	Severe erosion in the primary spillway discharge channel along the embankment toe.	This erosion problem should be evaluated by a professional engineer and the embankment toe should be protected against erosion.
APPROXIMATE NUMBER OF HOMES AND POPULATION	One commercial building approximately 1/2 mile downstream from the dam and at least ten homes in the remaining one-mile reach. Population: approximately 50.	

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
AND HYDROLOGIC AND HYDRAULIC
PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Musser's Nursery Dam
ID# NDI I.D. PA-287
DER I.D. 32-65

ITEM	REMARKS
AS-BUILT DRAWINGS	Available in state files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was designed by the Soil Conservation Service and was constructed by the owner with completion in 1951.
TYPICAL SECTIONS OF DAM	See Plate 3.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plate 3.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not recorded.
DESIGN REPORTS	Not available.
GEOLOGY REPORTS	Not available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	See Plate 2.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None conducted.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported.
BORROW SOURCES	Reservoir area.
MONITORING SYSTEMS	None.
MODIFICATIONS	None reported.
HIGH POOL RECORDS	Not formally recorded. The owner reported that the highest pool level in recent years occurred during the passage of Tropical Storm Agnes in 1972. The emergency spillway was not activated.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported.
MAINTENANCE OPERATION RECORDS	Not maintained.
SPILLWAY PLAN SECTIONS DETAILS	See Plate 2.
OPERATING EQUIPMENT PLANS AND DETAILS	Not available.

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 0.35 square miles (farmland)

ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 1373 (140 acre-feet)

ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: 1375.7 (240± acre-feet)

ELEVATION; MAXIMUM DESIGN POOL: 1376 (as designed)

ELEVATION; TOP DAM: 1375.7 (measured low spot adjacent to primary spillway)

SPILLWAY: Emergency Spillway

a. Elevation 1374

b. Type Earth open channel

c. Width 37 feet (perpendicular to flow)

d. Length 500± feet

e. Location Spillover Adjacent to primary spillway

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 8-inch steel pipe

b. Location At the center of the main embankment

c. Entrance Inverts Unknown

d. Exit Inverts Unknown

e. Emergency Draindown Facilities 8-inch steel pipe

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location None

c. Records None

MAXIMUM NONDAMAGING DISCHARGE: Spillway capacity (300± cfs)

APPENDIX C

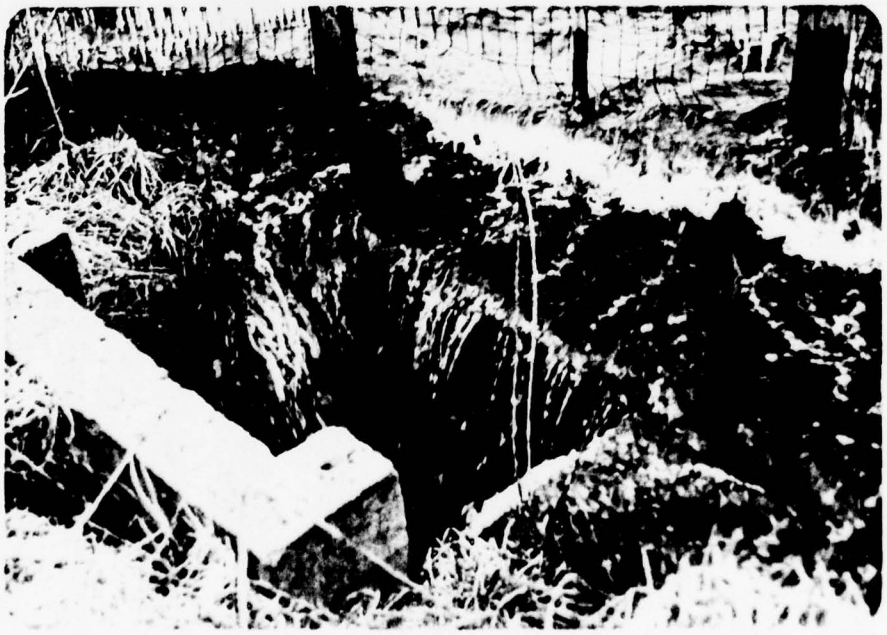
PHOTOGRAPHS

LIST OF PHOTOGRAPHS
MUSSER FORESTS DAM
NDI I.D. NO. PA-287
MAY 23, 1979

PHOTOGRAPH NO.	DESCRIPTION
1	Crest (looking east).
2	Primary spillway intake structure.
3	Primary spillway outlet structure.
4	Emergency spillway approach channel. Note cattails and high grass.
5	Emergency spillway discharge channel. Note brush and trees.
6	Primary spillway discharge channel. Note erosion along the toe of the dam.
7	Shoreline erosion.

Photograph No. 1

Crest (looking east).

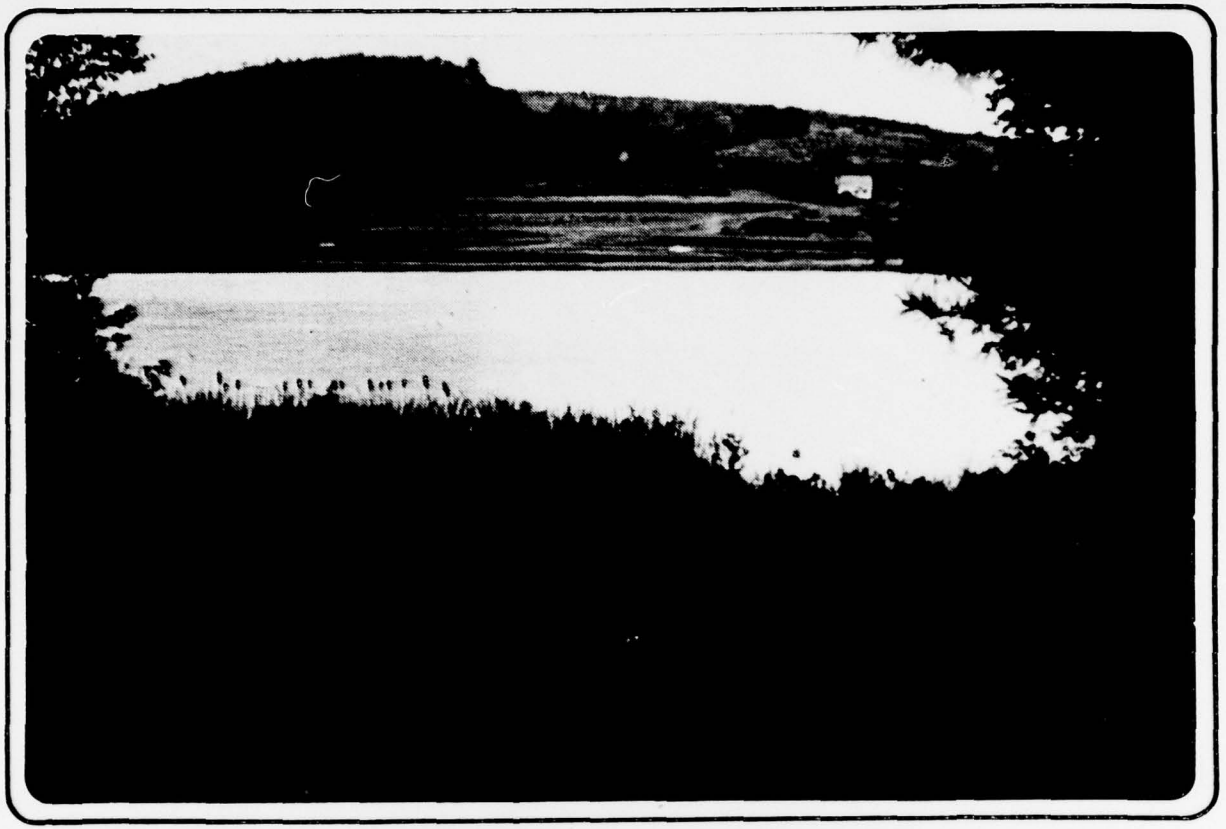


Photograph No. 2

Primary spillway intake structure.

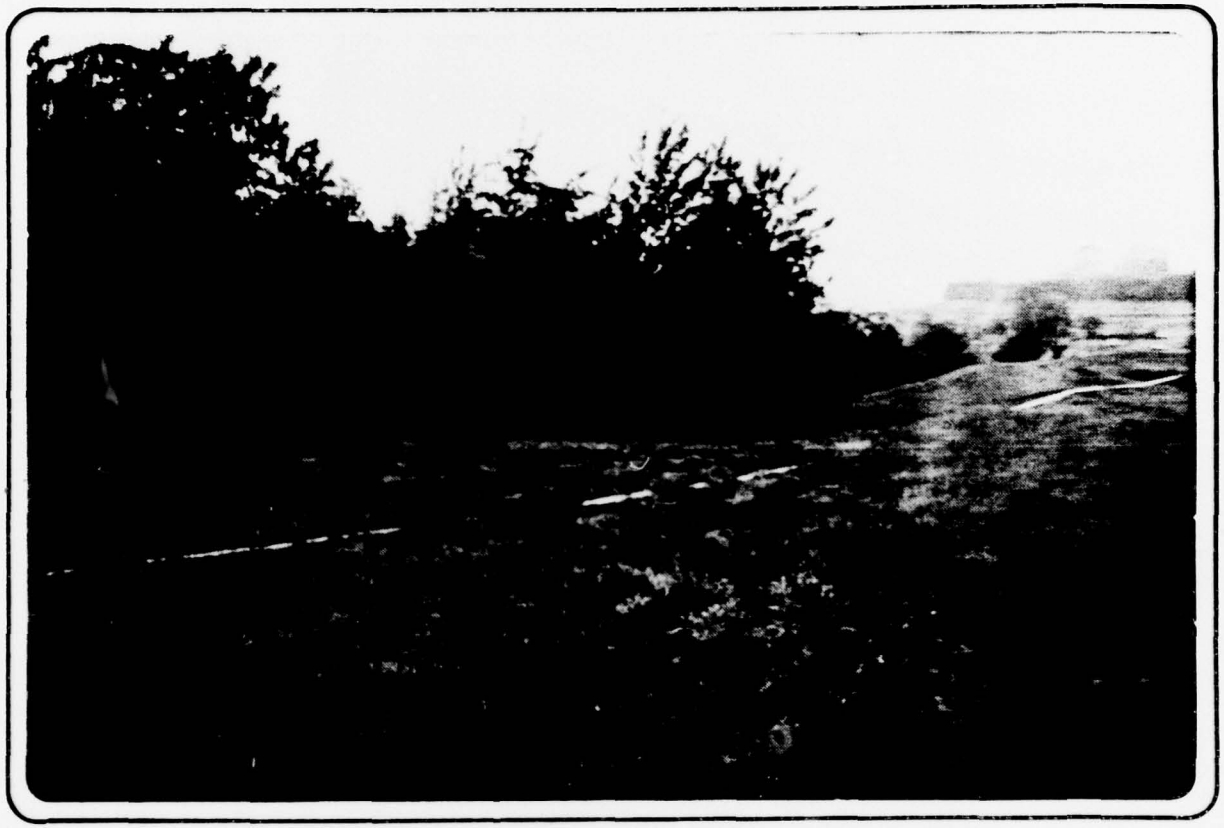
Photograph No. 3

Primary spillway outlet structure.



Photograph No. 4

Emergency spillway approach channel. Note cattails and high grass.



Photograph No. 5

Emergency spillway discharge channel. Note brush and trees.

Photograph No. 6

Primary spillway discharge channel. Note erosion along the toe of the dam.

Photograph No. 7

Shoreline erosion.

APPENDIX D

CALCULATIONS

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Musser Forests Dam (NDI I.D. PA-287)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.7 INCHES/24 HOURS[1]

STATION	1	2	3	4	5
Station Description	Lake	Dam			
Drainage Area (square miles)	0.35	-			
Cumulative Drainage Area (square miles)	0.35	0.35			
Adjustment of PMF for Drainage Area (%)[2]					
6 Hours	102	-			
12 Hours	120	-			
24 Hours	130	-			
48 Hours	140	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone[3]	24	-			
C_p/C_t[4]	0.45/1.6	-			
L (miles)[5]	0.6	-			
L_{ca} (miles)[5]	0.01	-			
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	0.33	-			
Spillway Data		Primary / Emergency			
Crest Length (ft)	-	8.3 / 37' Trap. with 3:1 side slope			
Freeboard (ft)	-	2.7 / 1.8			
Discharge Coefficient	-	3.22 / Varies			
Exponent	-	1.5 / 1.5			

(1) Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

(2) Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

(3) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).

(4) Snyder's Coefficients.

(5) L = Length of longest water course from head of reservoir to basin divide.
L_{ca} = Length of water course from head of reservoir to a point opposite the centroid of drainage area.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1                 A1       SNYDER UNIT HYDROGRAPH,FLOOD ROUTING   DAM OVERTOPPING ANALYSES
    2                 A2       MUSSER FOREST DAM,INDIANA COUNTY,NDI-I.D.PA.287     PROJECT NO.78-367-18
    3                 A3       FOR 20%,30%,40%,50%,60%,70%,80%,90%,AND 100% PMF
    4                 B     300        0      10       0       0       0       0       0      -4       0
    5                 B1      5
    6                 J       1        9       1
    7                 J1   0.20     0.30    0.40    0.50    0.60    0.70    0.80    0.90    1.00
    8                 K       0        1                                       1
    9                 K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO MUSSER FOREST LAKE
   10                 M       1        1    0.35            0.35                                    1
   11                 P               23.7     102     120     130     140
   12                 T                                                       1.0     .05             0.1027
   13                 W    0.33     0.45
   14                 X    -1.0    -0.05     2.0
   15                 K       1        2                                       1
   16                 K1       ROUTING FLOW THROUGH MUSSER FOREST DAM (NDI-I.D.PA.287)
   17                 Y                                       1       1
   18                 Y1      1                                               140.0      -1
   19                 Y41373.0  1373.5  1373.9 1374.42  1374.5  1375.0  1375.5  1376.0  1376.5  1377.0
   20                 Y5    0.0     9.5    22.9    89.0   100.1   186.3   299.7   437.2   598.6   782.9
   21                 $S    0.0   140.0   163.5   240.0   325.5
   22                 $E1356.0  1373.0  1374.0  1377.0  1380.0
   23                 $$1373.0
   24                 $D1375.7    3.08     1.5  1400.0
   25                 $L  100.    200.    300.    550.    650.    750.    950.   1050.   1150.   1200.
   26                 $V1375.7  1376.1  1376.6  1376.7  1376.8  1377.1  1377.3  1377.4  1377.9  1379.8
   27                 K      99
```

COMPUTER INPUT OVERTOPPING ANALYSIS

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 .20	RATIO 2 .30	RATIO 3 .40	RATIO 4 .50	RATIO 5 .60	RATIO 6 .70	RATIO 7 .80	RATIO 8 .90	RATIO 9 1.00
HYDROGRAPH AT	1	.35	1	353.	529.	705.	881.	1058.	1234.	1410.	1586.	1763.
	(	.91)	(	9.98)(	14.97)(	19.96)(	24.96)(	29.95)(	34.94)(	39.93)(	44.92)(	49.91)
ROUTED TO	2	.35	1	156.	267.	396.	585.	796.	995.	1204.	1410.	1603.
	(	.91)	(	4.42)(	7.57)(	11.23)(	16.56)(	22.53)(	28.18)(	34.09)(	39.94)(	45.39)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1373.00	1373.00	1375.70
STORAGE	140.	140.	207.
OUTFLOW	0.	0.	355.

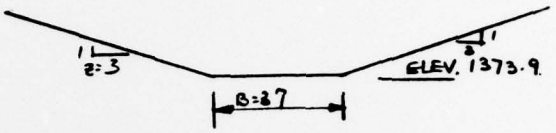
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1374.82	0.00	185.	156.	0.00	41.00	0.00
.30	1375.34	0.00	198.	267.	0.00	40.83	0.00
.40	1375.81	.11	210.	396.	1.00	40.67	0.00
.50	1376.11	.41	217.	585.	2.00	40.50	0.00
.60	1376.33	.63	223.	796.	2.50	40.33	0.00
.70	1376.51	.81	227.	995.	3.17	40.17	0.00
.80	1376.66	.96	231.	1204.	3.83	40.17	0.00
.90	1376.77	1.07	234.	1410.	4.17	40.17	0.00
1.00	1376.86	1.16	236.	1603.	4.67	40.17	0.00

OVERTOPPING ANALYSIS SUMMARY

D'APPOLONIA
CONSULTING ENGINEERS, INC.

By WTC Date 5/29/79 Subject MUSSER FOREST DAM Sheet No. 1 of 4
Chkd. By BE Date 7/24/79 NDI - I.D. Pa287 Proj. No. 78-173-18

EMERGENCY SPILLWAY CAPACITY



$$A = \frac{1}{2}(2B + 6d_c)\,d_c$$

$$= (B + 3d_c)\,d_c$$

$$T = B + 6d_c$$

CRITICAL FLOW $\quad \frac{Q_c^2}{g} = \frac{A^3}{T} = \frac{(B+3d_c)^3 d_c^3}{(B+6d_c)}$

$$Q_c = \sqrt{\frac{[(B+3d_c)\,d_c]^3\, g}{(B+6d_c)}}$$

$$V_c^2 = \frac{[(B+3d_c)\,d_c]\,g}{B+6d_c}$$

$$\frac{V_c^2}{2g} = \frac{(B+3d_c)\,d_c}{2(B+6d_c)}$$

$$H_E = d_c + \frac{V_c^2}{2g} = d_c + \frac{(B+3d_c)\,d_c}{2(B+6d_c)}$$

BY TRIAL & ERROR

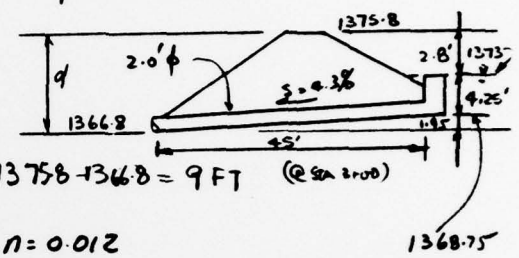
ELEV	H_e	d_c	Q_c	V_c	$\frac{V_c^2}{2g}$	Check ($d_c + \frac{V_c^2}{2g} = H_e$)
1373.9	0	—	—	—	—	
1374.42	0.520	0.349	43.9	3.31	0.170	0.519
1374.5	0.6	0.404	54.8	3.55	0.196	0.600 ok
1375.0	1.1	0.746	139.5	4.77	0.353	1.099 ok
1375.5	1.6	1.094	251.5	5.71	0.506	1600
1376.0	2.1	1.445	387.6	6.49	0.654	2.099
1376.5	2.6	1.801	547.7	7.17	0.799	2600
1377.0	3.1	2460	730.7	7.78	0.940	3.10.
1377.5	3.6	2.522	936.5	8 33	1.078	360
1378.0	4.1	2886	1164.6	8.838	1.213	4 099

D'APPOLONIA
CONSULTING ENGINEERS, INC.

By LATIC Date 3-7-79 Subject MUSSER FOREST DAM Sheet No. 2 of 4
Chkd. By BE Date 7/24/79 NDI - ID Pa 287 Proj. No. 18-367-18

CALCULATE PIPE SPILLWAY CAPACITY (PRIMARY)

Sta 3+00
- T/DAM @ EL 1375.8
- CREST @ EL 1373
- U/S END PIPE INVEL 1368.75
- D/S END PIPE INVEL 1366.8



MAX. DESIGN HEAD = H_T = 1375.8 − 1366.8 = 9 FT (@ Sta 3+00)

D = 2' ϕ TERRA COTTA PIPE; n = 0.012

L = 45 FT

Ke = 0.9

REF. DESIGN OF SMALL DAM P567

$$H_T = \left[\frac{2.5204\,(1+Ke)}{D^4} + \frac{466.18\,n^2 L}{D^{16/3}}\right]\left(\frac{Q}{10}\right)^2$$

$$9 = \left[\frac{2.5204\,(1.9)}{2^4} + \frac{(466.18)(0.012)^2(45)}{2^{16/3}}\right]\left(\frac{Q}{10}\right)^2$$

$$9 = [0.2993 + 0.0749]\left(\frac{Q}{10}\right)^2 \text{ or } \Rightarrow Q = 16.347\sqrt{H_T} \text{ cfs}$$

Q = 49 cfs

FOR W.L. @ EMERGENCY SPILLWAY LEVEL EL 1374

H_T = 1373.9 − 1366.8 = 7.1 FT

$Q = 16.347\sqrt{7.1} = 43.6$ cfs

Reported Value Q = 40 cfs OK

D'APPOLONIA
CONSULTING ENGINEERS, INC.

By WJC Date 5/29/79 Subject MUSSER FOREST DAM Sheet No. 3 of 4
Chkd. By BE Date 7/24/79 NDI - I.D. Pa 287 Proj. No. 78-367-88

COMBINED PRIMARY & EMERGENCY SPILLWAY

PRIMARY SPILLWAY

Q_1 = WEIR FLOW = $(3.22)(3' + 2'-8" + 2'-8")(W.L - 1373)^{1.5}$

$= 26.83\,(W.L - 1373)^{1.5}$

Q_2 = PIPE FULL = $16.947\sqrt{W.L.\ ELEV. - 1366.8}$ from P 1.

ELEV.	PRIMARY SPILLWAY		EMERGENCY	COMBINED
	Q_1 or Q_2	Q_2	Q_e	Q_c (Q_1 or Q_2)
	cfs	cfs	cfs	cfs
1373.0	0	0		0
1373.5	9.5	~~42.5~~		9.5
1373.9	22.9	~~53.6~~	0	22.9
1374.42	~~454~~	45.1	43.9	89.0
1374.5		45.3	54.8	100.1
1375.0		46.8	139.5	186.3
1375.5		48.2	251.5	299.7
1376.0		49.6	387.6	437.2
1376.5		50.9	547.7	598.6
1377.0		52.2	730.7	782.9
1377.5		53.5	936.5	990.0
1378.0		54.7	1164.6	1219.3

D'APPOLONIA
CONSULTING ENGINEERS, INC.

By WTC Date 3-6-79 Subject MUSSER LAKE DAM Sheet No. 4 of 4
Chkd. By ~~BE~~ Date 7/24/79 NDI - I.D. PA-287 Proj. No. 78-367-18

WATERSHED AREA (N 40°41.5' LATITUDE, W 79°05.9' LONGITUDE)

REF : U.S.G.S. TOPO MAPS "CLYMER QUADRANGLE"

WATERSHED AREA = $2.55\ IN^2 \times \left(\frac{2000}{5280}\right)^2$

= 0.37 SQ MILE

Reported A = 0.35 SQ MILE

Use 0.35 SQ MILE

LAKE AREA @ EL 1373 = $0.26\ IN^2 \times \frac{(2000)^2}{43560}$

= 23.9 ACRES

Reported A = 23 Ac

Use 23 acre

AREA @ EL 1380 ≈ $0.32\ IN^2 \times \frac{2000^2}{43560}$

≈ 29.4 say 30 acres.

Vol Vs ELEV.

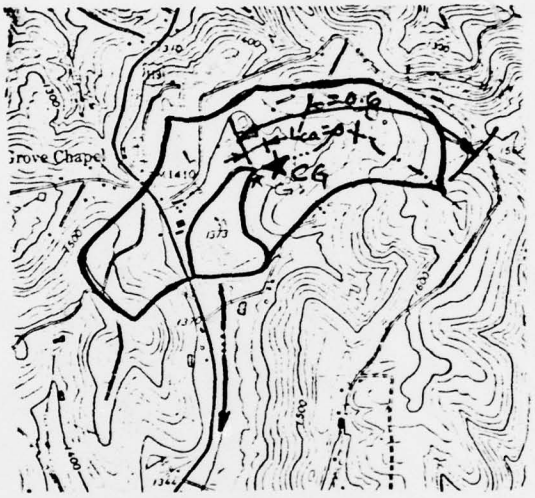
EL	ΔH	AREA (acres)	ΔV (ac-ft)	ΣV (ac-ft)
1356 (INV. EL of 8" OUTLET PIPE)	17	≈0.1	140 **	0
1373 (PRIMARY SPILLWAY)	1	23	23.5	140.0 (46 Mgal)
1374 (EMERGENCY SPILLWAY)	3	24 *	765	1635
1377	3	27 *	85.5	240.0
1380		30		325.5

* INTERPOLATION
** FROM DER'S REPORT dated July 6, 1951

DIAMMODIONIA
CONSULTING ENGINEERS, INC

By WTC Date 7/24/79 Subject MUSSER DAM [illegible] Sheet No. 11 of 4
Chkd. By BE Date 7/24/79 Hydrology & Hydraulic Proj. No 78-367-12

Determine t_p



L = 0.6 miles

L_{ca} = 0.01 miles

ACCORDING TO COE BALTIMORE DISTRICT C_t = 1.6

$$t_p = C_t (L \cdot L_{ca})^{.03}$$

$$= 1.6 (0.6 \times 0.01)^{.03}$$

$$= 0.33 \text{ Hours}$$

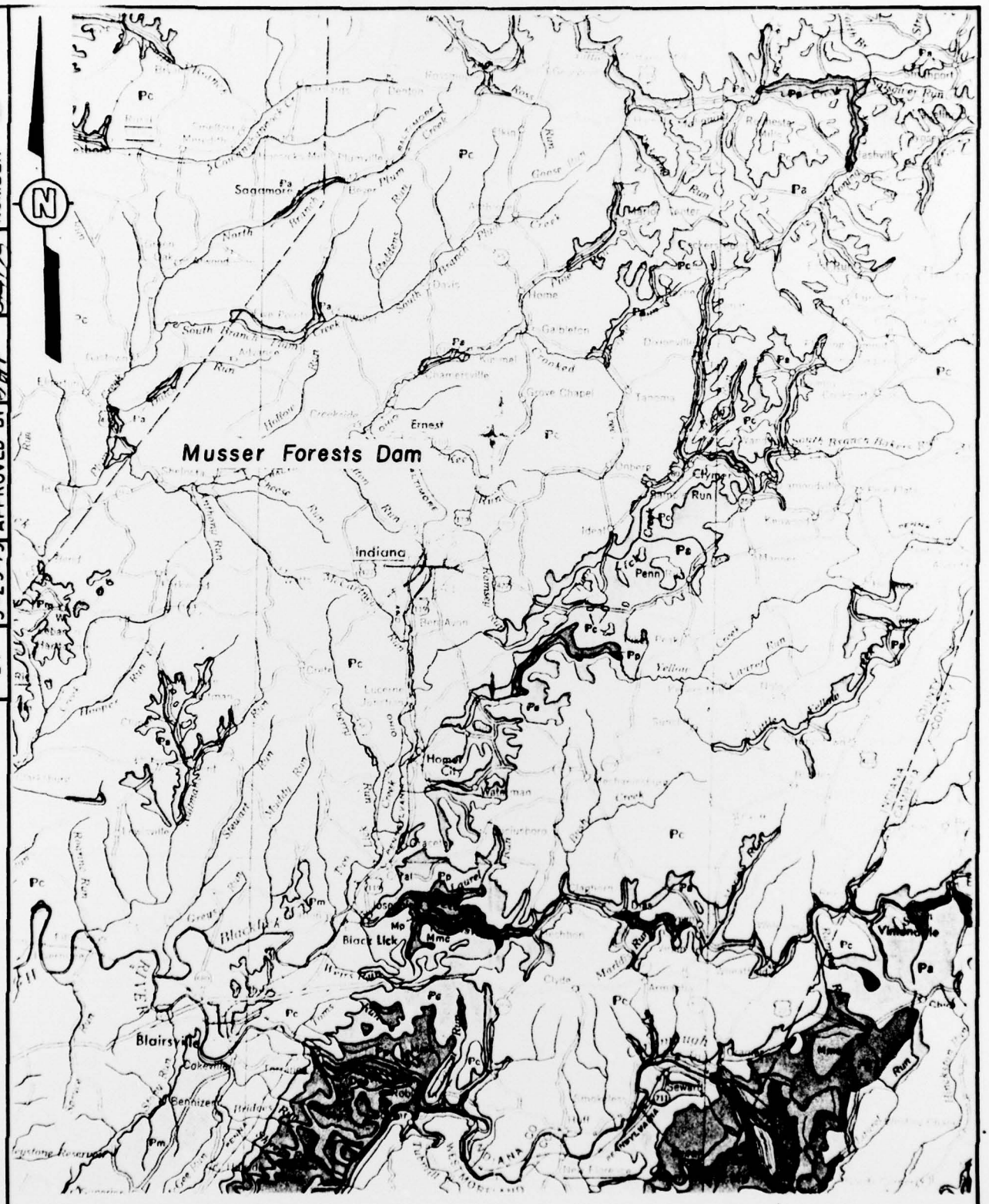
APPENDIX E

REGIONAL GEOLOGY

APPENDIX E
REGIONAL GEOLOGY

Musser Forests Dam is located on strata of the Glenshaw Formation of the Lower Conemaugh Group (Pennsylvanian Age). The site lies on the west flank of the Richmond Anticline with strata dipping slightly to the west at about 100 feet per mile.

Strata of the Glenshaw Formation consist of interbedded sandstones, siltstones, shales, and claystones. Thin coal seams may also occur locally. There are two massive sandstone units of the Glenshaw which may lie beneath the dam, the Saltsburg and Mahoning. At the base of the Conemaugh is the Upper Freeport coal. Based upon structure contours on the top of the coal, this seam lies approximately 350 feet below the dam. The Upper Freeport outcrops and has been mined along McKee Run about four miles west of the site. It is not known if deep mining has taken place in the area adjacent to the dam site. The only other coal of mining interest is the Lower Kittanning coal which lies about 200 feet below the Upper Freeport. It is doubtful that the Lower Kittanning has been deep mined in the area due to the depth and the presence of the Upper Freeport at shallower depths.



DRAWN BY	ACS	CHECKED BY	BE	DRAWING NUMBER	67-A32
	5-29-79	APPROVED BY	[illegible]		6-4-79

SCALE

0 2 4 6 8 10 miles

MUSSER FORESTS DAM

GEOLOGY MAP

REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA., DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	JE	DRAWING NUMBER	367-A22
	2-5-79	APPROVED BY	[illegible]		

GROUP	FORMATION		DESCRIPTION
	Alluvium	Qt	Sand, gravel, clay.
	Terrace deposits		Sand, clay, gravel on terraces above present rivers; includes Carmichaels Formation.
DUNKARD	Greene		Cyclic sequences of sandstone, shale, red beds, thin limestones and coals.
DUNKARD	Washington	Pw	Cyclic sequences of sandstone, shale, limestone, and coal; contains Washington coal bed at base.
DUNKARD	Waynesburg		Cyclic sequences of sandstone, shale, limestone and coal; contains Waynesburg coal bed at base.
MONONGAHELA		Pm	Cyclic sequences of shale, limestone, sandstone and coal; contains Pittsburgh coal bed at base.
P[illegible] CONEMAUGH	Casselman	Pcc	Cyclic sequence of sandstone, shale, red beds and thin limestone and coal.
P[illegible] CONEMAUGH	Ames		
P[illegible] CONEMAUGH	Glenshaw	Pcg	Cyclic sequences of sandstone, shale, red beds and thin limestone and coal; several fossiliferous limestone; Ames limestone bed at top.
ALLEGHENY	Vanport	Pa	Cyclic sequences of shale, sandstone, limestone, and coal; contains Brookville coal at base and Upper Freeport coal at top; within group are the commercial Vanport limestone and Kittanning and Clarion coals.

GEOLOGY MAP LEGEND

REFERENCE:

GREATER PITTSBURGH REGION GEOLOGIC MAP
COMPILED BY W.R. WAGNER, J.L. CRAFT, L. HEYMAN
AND J.A. HARPER, DATED 1975, SCALE 1:125000

IDAHO