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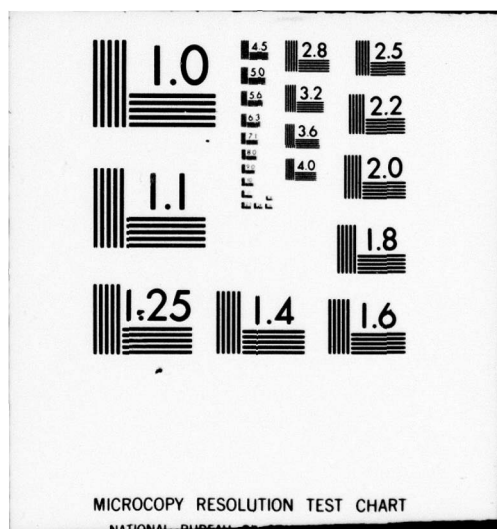
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SUSQUEHANNA RIVER BASIN
BEAR RUN, CLEARFIELD COUNTY

PENNSYLVANIA

PIKE TOWNSHIP
MUNICIPAL AUTHORITY
DAM

NDS I. D. No. PA-00916
PENNDER I. D. No.17-111

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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PREPARED FOR

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

PREPARED BY

GAI CONSULTANTS, INC.
570 BEATTY ROAD
MONROEVILLE, PENNSYLVANIA 15146
APRIL 1979

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6 National Dam Inspection Program.
Pike Township Municipal Authority Dam
(NDS-ID-PA-00916, PennDER ID-17-111),
Susquehanna River Basin, Bear Run,
Clearfield County, Pennsylvania. Phase
I Inspection Report.

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.

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.

15 DACW 31-79-C-0013

10 Bernard M. Mihalcin

11 Apr 79

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

ABSTRACT

Pike Township Municipal Authority Dam: NDS I.D. No. PA-00916
(Bear Run Dam)

<u>Owner:</u>	Pike Township Municipal Authority
<u>State Located:</u>	Pennsylvania (PennDER I.D. No. 17-111)
<u>County Located:</u>	Clearfield County
<u>Stream:</u>	Bear Run
<u>Inspection Date:</u>	15 November 1978
<u>Inspection Team:</u>	GAI Consultants, Inc. 570 Beatty Road Monroeville, Pennsylvania 15146

The visual inspection, operational history, and hydrologic/hydraulic analysis indicate that the facility is in fair condition. No formal operational procedures, maintenance manuals, or emergency plans are available for the facility. Deficiencies in the facility are primarily spillway related and consist of severe erosion of the spillway channel (an unlined open cut) and instability of the sidewall slopes. A construction road built to provide access to the downstream spillway channel during subsequent remedial repair has also reduced the spillway capacity. It should be noted that the owner, at the time of inspection, was having the spillway problem evaluated by an experienced consultant.

Based on the recommended guidelines, the Spillway Design Flood (SDF) for this facility is considered to be one-half of the Probable Maximum Flood (1/2 PMF). Hydrologic and hydraulic calculations indicate that the facility, as observed at the time of inspection, will pass and/or store only 54 percent of the SDF (27 percent of the PMF). Therefore, as the hazard rating is significant, the spillway is deemed inadequate, but not seriously inadequate.

It is recommended that the owner:

- a. Immediately remove the access road obstruction from the spillway.

b. Complete the current spillway evaluation and take appropriate remedial measures to ensure both the structural and hydraulic adequacy of the system.

c. Monitor the movement of the slide on the left abutment. If movement becomes excessive, remedial measures are warranted for protection of the spillway channel.

d. Attempt to verify that the embankment was, in fact, constructed in compliance with contract specifications and develop as-built drawings for the facility (if sufficient data are available) in order to have a record of as-built conditions available for future reference.

e. Develop formal manuals of operation and maintenance for the facility.

f. Develop a warning system to advise owners of downstream developments of possible flooding in the event of a potential embankment failure. Included in the plan should be provisions for around-the-clock surveillance during periods of unusually heavy rainfall.

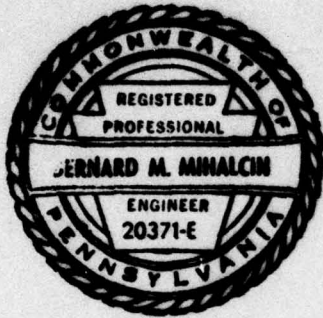
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GAI Consultants, Inc.

Approved by:

Bernard M. Mihalcin
Bernard M. Mihalcin, P.E.

G. K. Withers
G. K. WITHERS
Colonel, Corps of Engineers
District Engineer



Date 3 May 1979

Date 5 Jun 79



OVERVIEW PHOTOGRAPH
V

TABLE OF CONTENTS

	<u>Page</u>
PREFACE.	i
ABSTRACT	ii
OVERVIEW PHOTOGRAPH.	v
TABLE OF CONTENTS.	vi
SECTION 1 - GENERAL INFORMATION.	1
1.0 Authority.	1
1.1 Purpose.	1
1.2 Description of Project	1
1.3 Pertinent Data	2
SECTION 2 - ENGINEERING DATA	6
2.1 Design	6
2.2 Construction Records	7
2.3 Operational Records.	7
2.4 Other Investigations	8
2.5 Evaluation	8
SECTION 3 - VISUAL INSPECTION.	9
3.1 Observations	9
3.2 Evaluation	10
SECTION 4 - OPERATIONAL PROCEDURES	11
4.1 Normal Operational Procedures.	11
4.2 Maintenance of Dam	11
4.3 Maintenance of Operating Facilities.	11
4.4 Warning Systems.	11
4.5 Evaluation	11
SECTION 5 - HYDROLOGIC/HYDRAULIC EVALUATION.	12
5.1 Design Data.	12
5.2 Experience Data.	12
5.3 Visual Observations.	12
5.4 Method of Analysis	12
5.5 Summary of Analysis.	12
5.6 Spillway Adequacy.	13
SECTION 6 - EVALUATION OF STRUCTURAL INTEGRITY	14
6.1 Visual Observations.	14
6.2 Design and Construction Techniques	14
6.3 Past Performance	14
6.4 Seismic Stability.	15
SECTION 7 - ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES.	16
7.1 Dam Assessment	16
7.2 Recommendations/Remedial Measures.	16

TABLE OF CONTENTS

APPENDIX A - CHECK LIST - ENGINEERING DATA
APPENDIX B - CHECK LIST - VISUAL INSPECTION
APPENDIX C - HYDRAULICS/HYDROLOGY
APPENDIX D - PHOTOGRAPHS
APPENDIX E - GEOLOGY
APPENDIX F - FIGURES
APPENDIX G - REGIONAL VICINITY AND WATERSHED BOUNDARY MAPS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM
(BEAR RUN DAM)
NDI# PA-00916, PENNDER# 17-111

SECTION 1
GENERAL INFORMATION

1.0 Authority.

The 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.

1.1 Purpose.

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

1.2 Description of Project.

a. Dam and Appurtenances. Bear Run Dam is an earth embankment approximately 42 feet high and 415 feet long (including spillway). *Abstract*

The dam is provided with an unlined trapezoidal channel spillway cut into the left abutment. ~~(see Overview Photo-graph)~~ The spillway contains a short concrete control slab adjacent to the embankment crest. The downstream channel of the spillway is comprised of unvegetated granular material. The outlet works consists of a 16-inch diameter ductile iron pipe (blowoff) with a sluice gate located at the inlet and controlled by a manual operator from the dam crest. An 8-inch diameter ductile iron pipe with a perforated vertical intake riser serves as the supply line from the facility. Both the blowoff and supply lines are equipped with two gate valves that are manually operated from the crest and downstream slope.

b. Location. → Bear Run Dam is located on Bear Run in Pike Township, Clearfield County, Pennsylvania, about 4-1/2 miles west of the community of Bridgeport (located along Anderson Creek) and about 6 miles west of the community of Curwensville. ~~(see Figure 2)~~ The dam, reservoir, and watershed are contained within the Elliot Park, Pennsylvania, 7.5 minute series U.S.G.S. topographic quadrangle. The coordinates of the dam are N41° 01.2' and W78° 34.2' (see Regional Vicinity Map, Appendix G).

Abstract 1

c. Size Classification. Intermediate (42 feet high, maximum storage capacity 40 acre-feet).

d. Hazard Classification. Significant (see Section 3.1.e).

e. Ownership. Pike Township Municipal Authority
State and Thompson Streets
Curwensville, Pennsylvania 16833

f. Purpose. Water supply.

g. Historical Data. Bear Run Dam was constructed during 1974 and 1975 by C&W Contracting of State College, Pennsylvania. The facility was designed and the construction monitored by Lee-Simpson Associates of DuBois, Pennsylvania. Bi-weekly construction reports (check list format) contained in PennDER files indicate no construction problems; however, a memorandum dated August 22, 1975, implies otherwise and describes deficiencies with the pedestals supporting the drawdown gate stem. Current litigation procedures also support the inference that the construction of the facility was not without problems.

1.3 Pertinent Data.

a. Drainage Area (square miles). 3.8

b. Discharge at Dam Site. Discharge records are not available. The maximum flood of record reportedly occurred in June 1977, with an estimated flow over the control slab of 6 to 8 inches.

c. Elevation (feet above mean sea level). The following elevations were obtained from the contract drawings and field measurements based on the spillway control section at elevation 1642.0 feet (see Figure 4).

Top of Dam	1646
Spillway Crest	1642
Normal Pool	1642
Maximum Pool of Record	1642.7 (June 1977)
Outlet Upstream Invert	1623
Outlet Downstream Invert	1604
Streambed at Dam Centerline	1615
Maximum Tailwater	Not Known

d. Reservoir Length (miles).

Normal Pool	0.1
Top of Dam	0.1

e. Storage (acre-feet).

Spillway Crest	25
Top of Dam	40

f. Reservoir Surface (acres).

Normal Pool	3.0
Top of Dam	4.5

g. Dam.

Type	Homogeneous earth with pervious toe.
------	---

Length	415 feet (field measured)
--------	------------------------------

Height	42 feet (field measured)
--------	-----------------------------

Top Width	14 feet (design, actual crest width obscured by excess fill.
-----------	---

Upstream Slope	3H:1V
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Downstream Slope	Approximately 6 percent grade due to placement of excess fill (see Figure 1).
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Zoning	The embankment was reportedly constructed with the most impervi- ous soil in the central upstream portion of the fill and the more pervious materials placed so that the permeability gradually increases toward the upstream and downstream slopes.
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Impervious Core	See "Zoning" above.
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Cutoff	A cutoff trench having a bottom width of 8 feet excavated to sound rock.
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	Grout Curtain	None.
h.	<u>Diversion Canal.</u>	None.
i.	<u>Outlet Conduit.</u>	
	Type	16-inch diameter, mechanical joint, ductile iron pipe on a concrete cradle with concrete cutoff collars.
	Closure	Discharge through the outlet conduit is controlled by a sluice gate operated from the embankment crest and two gate valves located along the conduit.
	Access	All control mechanisms are readily acces- sible from the embankment crest and downstream slope.
j.	<u>Spillway.</u>	
	Type	Trapezoidal-shaped, open channel with an 8-foot wide control section abutting the embankment crest at the left abutment (see Overview Photo- graph).
	Channel Width	80 feet (design) 60 feet (field measured)
	Channel Length	400 feet from control slab to original stream.
	Crest Elevation	1642
	Upstream Channel	Cut in soil.

Downstream Channel

Large sandstone slabs to approximately 50 feet from control slab.

Remainder of channel is lined with gravel to boulder-sized rock fragments of unknown thickness (see Photographs 5 and 8).

SECTION 2 ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources.

1. Hydrology and Hydraulics. No formal design reports are available. Some design data may exist; however, all of the designer's files (Lee-Simpson Associates) were not available for review as the project work is under litigation.

2. Embankment. No formal design reports are available. Some laboratory test results are available in PennDER files. Very few design calculations were observed in the designer's files, however, additional data may be available as discussed above.

3. Appurtenant Structures. See Section 2.1.a.1 (above).

b. Design Features.

1. Embankment. Contract drawings and specifications indicate the structure was designed as an earthfill dam with the most impervious borrow placed in the central upstream portion and the remainder placed with increasing permeability toward the upstream and downstream slopes. Design slopes were 3H:1V and a cutoff trench having an 8-foot wide base was to be excavated to sound rock.

The design crest width was 14 feet and riprap was to be provided from approximately one foot below normal pool to the crest. The design length of the embankment (excluding the spillway) was about 300 feet and the design height from the streambed to the crest at the centerline was 30 feet (see Figures 3 and 4). Note: The above design data, obtained from PennDER files, does not necessarily represent actual field measured conditions (see Section 1.3, "Pertinent Data").

2. Appurtenant Structures. Contract drawings indicate the outlet works consist of a 16-inch diameter, mechanical joint ductile iron pipe placed on a concrete cradle along the base of the embankment. Inlet control is provided by a 16-inch diameter Rodney Hunt sluice gate which is operated manually from the dam crest. Water distribution is provided through an 8-inch ductile iron supply pipe fitted with a perforated PVC riser pipe. Two gate valves

(one along the centerline of the dam and the other near the downstream design toe) provide control of the supply line flow.

The spillway is an open trapezoidal channel cut in the left abutment. Contract drawings indicate the spillway adjacent to the embankment may be in weathered rock or if not should be riprap-lined for a distance of about 55 feet downstream of the concrete control section (see Figure 3). The control section is designed as an 8-foot wide, reinforced concrete slab (9 inches thick) with cutoff walls extending 3.5 feet into unweathered rock (see Figures 3 and 4).

c. Design Data and Procedures.

1. Hydrology and Hydraulics. Correspondence in PennDER files indicates that the spillway was sized in accordance with Pennsylvania "C" Curve requirements.

2. Embankment. Actual design parameters and/or procedures could not be determined from available data. Laboratory test results are available from PennDER files indicating some testing was undertaken to establish soil strength, compaction, and seepage parameters. Review of the available correspondence indicates that the angle of internal friction obtained by direct shear test was unusually high (possibly due to particle size) and that the grain-size distribution curve lacked continuity from the mechanical to the hydrometer portions of the curve. A soil survey of the site was conducted by the local Soil Conservation Service, results of which are available in PennDER files. No drilling program was conducted in conjunction with this study.

3. Appurtenant Structures. No specific design data were contained in the information made available to the inspection team for review.

2.2 Construction Records.

Contract drawings, specifications, bi-weekly construction reports (check list format), and five construction photographs are available from PennDER files. No actual records of field testing during construction were available for review.

2.3 Operational Records.

Formal operational records are not available. Discussions with Municipal Authority personnel indicate that

serious problems have occurred in the distribution (supply) system and spillway erosion has been persistent.

2.4 Other Investigations.

According to Municipal Authority personnel, the distribution system and spillway are currently being studied by L. Robert Kimball, Consulting Engineers of Ebensburg, Pennsylvania.

2.5 Evaluation.

Engineering data in the form of contract drawings (not as-built), specifications, and construction reports (check list format) are available from PennDER files. Minimal design data and calculations are available from the designer (Lee-Simpson Associates, DuBois, Pennsylvania) and some laboratory testing data are contained in PennDER files.

Available data indicates that the embankment materials appear adequate from a stability standpoint. The spillway design is questionable; however, it is currently being re-evaluated. It is noted that as-built drawings are not available and that substantial modifications were made to the embankment which are not indicated on available drawings.

SECTION 3 VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the facility suggests that it is in fair condition.

b. Embankment. The upstream face of Bear Run Dam is well aligned and protected by durable sandstone riprap (see Photograph 3). The downstream slope and crest are not clearly defined as excess excavated material (probably from within the reservoir area) was placed along the downstream slope resulting in a final slope of about 6 percent. The slope is seeded and supports a good vegetative cover.

No seepage was observed along the abutment-embankment contacts and no instability of the embankment materials was observed.

c. Appurtenant Structures.

1. Spillway. A single structure has been provided for the facility which operates as both the service and emergency spillway. Visual inspection indicated that it is in poor condition having deep erosion gullies (8 feet deep) immediately downstream of the heavily riprapped segment (see Figures 1 and 3). Active sliding of the left channel wall is also evident and is possibly related to loss of toe support from spillway downcutting. The slide is shown in Photographs 7 and 8.

In addition, in order to restore the original spillway grade after serious erosion occurred in June 1977, an access road was built along the left bank of the reservoir and across the spillway control section. This has effectively reduced the spillway width by about 20 feet.

2. Outlet System. Discharges through both the supply and blowoff conduits are controlled by a system of gate valves, all of which are manually operated from the crest (see Figure 1). There are two gate valves on each line located approximately 140 feet apart. In addition, the blowoff conduit is equipped with a sluice gate that is controlled by a manual operator, also accessible from the crest. The operator appeared to be in an open position and its condition appeared satisfactory. The outlet end of the discharge pipe is capped with a flap valve and is also in satisfactory condition. No deficiencies were noted that would indicate the system could not operate satisfactorily, if required.

d. Reservoir Area. The reservoir is surrounded by steep, heavily forested slopes which, except for along the spillway channel, appear relatively stable. Sedimentation does not appear to be significant.

e. Downstream Area. Discharge from Bear Run Dam is confined in a steep, narrow, and heavily forested valley containing Bear Run for approximately one mile until it is discharged into Anderson Creek. Anderson Creek then flows easterly through the communities of Bridgeport and Curwensville located 4-1/2 and 6 miles, respectively, from the confluence with Bear Run (see Regional Vicinity Map and Figure 2). Based on the distance to the nearest downstream developments and the low storage capacity of Bear Run Reservoir, a sudden failure of the dam could cause appreciable economic damage to a railroad, industrial complex, and downstream communities; however, loss of life is not expected. Therefore, the hazard classification of the facility is considered to be "significant."

3.2 Evaluation.

The overall appearance of the facility indicates that it is in fair condition. Erosion of the spillway channel and instability of the cut slope forming the left channel wall require evaluation and remedial action. The spillway capacity has also been reduced by the installation of a road that provides access (through the spillway) to the downstream channel.

SECTION 4 OPERATIONAL PROCEDURES

4.1 Normal Operational Procedures.

There are no formal operational procedures for the facility. Excess inflow passes through the open trapezoidal spillway channel located at the left abutment. About 450,000 GPD (gallons per day) is also drawn off through the distribution system.

4.2 Maintenance of Dam.

There is no formal maintenance program for the facility, although the Municipal Authority's new manager indicated plans to formalize procedures.

4.3 Maintenance of Operating Facilities.

See "Maintenance of Dam" above.

4.4 Warning Systems.

No formal warning system is in effect.

4.5 Evaluation.

No formal procedures are available for any aspects of the facility. The spillway and distribution system are currently being evaluated by a consultant to the owner and it is suggested that formalization of operations, maintenance, and warning systems also be considered during this study.

SECTION 5 HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

Minimal spillway design data are available. Correspondence indicates that the spillway was designed to pass a peak flow of 4,100 cubic feet per second in accordance with PennDER criteria.

5.2 Experience Data.

No records of daily discharge are available. Discussions with Municipal Authority personnel indicate the maximum flood of record occurred in June 1977, with a depth of flow through the spillway of 6 to 8 inches. This flow and subsequent smaller flows have caused substantial erosion of the spillway channel below the designed riprap protected section.

5.3 Visual Observations.

On the date of inspection, severe erosion was observed in the spillway channel as well as instability of the natural slope that forms the left wall of the spillway. In addition, an access road has been constructed through the spillway along the left abutment thereby reducing the spillway capacity.

5.4 Method of Analysis.

The facility has been analyzed in accordance with the procedures and guidelines established by the U. S. Army Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed utilizing a modified version of the HEC-1 program developed by the U. S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California. Analytical capabilities of the program are briefly outlined in the preface contained in Appendix C.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). In accordance with procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I investigations, the Spillway Design Flood (SDF) for the Pike Township Municipal Authority Dam ranges between the 1/2 PMF (Probable

Maximum Flood) and the PMF. This classification is based on the relative size of the dam (intermediate), and on the potential hazard of dam failure to downstream developments (significant). Due to the small storage capacity of the reservoir and to the small probability of significant breaching of the earth embankment occurring, the SDF for this facility is considered to be the 1/2 PMF.

b. Results of Analysis. The Pike Township Municipal Authority Dam was evaluated under normal operating conditions. That is, the reservoir pool was initially at its normal or spillway crest elevation of 1642.0 feet (MSL), with the 16-inch low level outlet pipe closed. The normal pool storage capacity was assumed to be about 25 acre-feet, although the Authority contended that the capacity was much higher (see Note 1, Sheet 1, Appendix C). Also, the spillway was evaluated according to its present condition which includes the loss of 20 feet of the original spillway length due to the placement of an earthfill road over the left portion of the spillway crest. All pertinent engineering calculations relative to the evaluation of this facility are provided in Appendix C.

Overtopping analysis (using the Modified HEC-1 computer program) indicated that the discharge/storage capacity of the Pike Township Municipal Authority Dam could accommodate only about 27 percent of the PMF (or about 54 percent of the SDF) prior to overtopping of the dam (Appendix C, Summary Input/Output Sheets, Sheet D). The peak 1/2 PMF (SDF) inflow of about 3030 cfs was virtually unaffected by the discharge/storage capabilities of the dam and reservoir since the corresponding peak outflow was about 3030 cfs (Summary Input/Output Sheets, Sheets B and C). Under the 1/2 PMF, the embankment was overtopped for approximately 6.8 hours, with a maximum depth of inundation equal to about 0.9 feet (Summary Input/Output Sheets, Sheet D).

5.6 Spillway Adequacy.

Although the Pike Township Municipal Authority Dam could not accommodate its SDF (the 1/2 PMF), the possible downstream consequences of embankment failure due to overtopping were not evaluated. Breaching analysis of the dam was not performed since the hazard classification of the facility was not considered to be high. Therefore, since the Pike Township Municipal Authority Dam cannot handle a 1/2 PMF-size flood, its spillway is considered to be inadequate, but not seriously inadequate.

SECTION 6 EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Based on the visual inspection, the embankment appeared to be in good condition. No signs of seepage or slope distress were observed. It is noted that the downstream slope has been substantially modified and no "as-built" drawings are available.

b. Appurtenant Structures. The open channel spillway system has been troublesome since completion. At the time of inspection, severe erosion was evident in the spillway channel and instability of the slope forming the left channel wall was observed (see Figure 1).

An access road to correct previous erosion has been constructed through the spillway considerably reducing its discharge capacity. The outlet works system appears to be in good condition although it was not operated in the presence of the inspection team.

6.2 Design and Construction Techniques.

Little design and construction data were available for review. PennDER files indicate that a soils study was performed by the local Soils Conservation Service; however, no drilling program was conducted. Some laboratory test results are also available indicating that engineering studies were performed.

Detailed construction specifications were prepared although no actual field testing results were available to confirm specification compliance.

6.3 Past Performance.

Field observations and discussions with Municipal Authority personnel indicate poor past performance of the facility. The spillway is presently in need of repair due to erosion of the downstream channel and instability of the cut slope forming its left wall.

A study of distribution system problems and the spillway is currently in progress.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and is subject to minor earthquake induced dynamic forces. As the dam is unusually broad-based and constructed of relatively well-graded soil, the static stability is thought to be sufficient to withstand minor earthquake forces. No calculations or investigations, however, were performed to confirm this opinion.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The visual inspection, operational history, and hydrologic/hydraulic analysis indicate that the structure is in fair condition. No formal operations, maintenance, or warning systems are in effect. Deficiencies in the facility are primarily spillway related and consist of severe erosion of the spillway channel and instability of its left sidewall slope. A construction road to provide access to the downstream spillway channel during subsequent remedial repair has also reduced the spillway capacity.

Hydrologic and hydraulic calculations indicate that the spillway system as observed on the day of inspection will pass and/or store only 54 percent of the recommended Spillway Design Flood (SDF) which for this facility is considered to be the 1/2 PMF. This corresponds to about 27 percent of the PMF. Therefore, the spillway system is considered inadequate but not seriously inadequate.

b. Adequacy of Information. The available data, contract drawings, specifications, and miscellaneous correspondence, are considered sufficient to make a reasonable Phase I assessment. The owner should attempt to verify compliance to the contract specifications and should develop as-built drawings for future reference (if sufficient data are available).

c. Urgency. Remedial spillway repairs, including slope stabilization, should proceed without undue delay to preclude possible undercutting and/or discharge over the downstream toe of the embankment.

d. Necessity for Additional Investigation. A necessary evaluation of the spillway system is currently in progress.

7.2 Recommendations/Remedial Measures.

It is recommended that the owner:

a. Immediately remove the access road obstruction from the spillway.

b. Complete the current spillway system evaluation and take appropriate remedial measures to ensure both the structural and hydraulic adequacy of the system.

c. Monitor the movement of the slide on the left abutment. If movement becomes excessive, remedial measures are warranted for protection of the spillway channel.

d. Attempt to verify that the embankment was constructed in compliance with contract specifications and develop as-built drawings for the facility (if sufficient data are available) in order to have a record of as-built conditions available for future reference.

e. Develop formal manuals of operations and maintenance for the facility.

f. Develop a warning system to advise owners of downstream developments of possible damages in the event of potential embankment failure. Included in the plan should be provisions for around-the-clock surveillance during periods of unusually heavy rainfall.

APPENDIX A

CHECK LIST - ENGINEERING DATA

Pike Township Municipal
NAME OF DAM: Authority Dam

CHECK LIST
ENGINEERING DATA
PHASE I

PAGE 1 OF 5

NDI#: 00916 PENNDR#: 17-111

ITEM	REMARKS	NDI# PA - 916
PERSONS INTERVIEWED AND TITLE	a. Nov. 15, 1978 1. Wayne Neeper (Manager, Pike Twp. Municipal Auth.). 2. Leroy Neeper (Chairman of Authority Board). Dec. 1, 1978 3. F. B. Chiriboga (Env. Engr. - L. R. Kimball). 4. S. Speilgelmier (Eng. - Lee-Simpson Assoc., DuBois, PA).	
REGIONAL VICINITY MAP	a. Figure 2, Appendix F. b. U.S.G.S. 7.5 minute series topographic quadrangle, Elliott Park, PA (see Regional Vicinity Map, Appendix G).	
CONSTRUCTION HISTORY	Bi-weekly construction status reports in PennDER files. Constructed in 1974 and 1975 by C&W Contracting of State College, PA. Construction monitored by Robert Wingert, Resident Engineer (Lee-Simpson Assoc.).	
AVAILABLE DRAWINGS	Complete set of nine contract drawings available from owner and/or L. Robert Kimball Engineers - Not as-built.	
TYPICAL DAM SECTIONS	See Figure 4, Appendix F.	
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	Figure 3, Appendix F. Figures 5 and 6, Appendix F. No rating curves.	

ITEM	REMARKS	NDI# PA - 916
SPILLWAY: PLAN SECTION DETAILS	Figure 3, Appendix F. Figures 5 and 6, Appendix F. Figures 5 and 6, Appendix F.	
OPERATING EQUIPMENT PLANS AND DETAILS	Figures 5 and 6, Appendix F.	
DESIGN REPORTS	No formal report available. Pertinent design features are discussed in PennDER review report of January 22, 1974.	
GEOLOGY REPORTS	No formal report available.	
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	Project presently in litigation and all files of designer were not made available to the inspection team for review. One box of material was available and indicated some hydraulics/hydrology and seepage calculations were performed.	
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	<ul style="list-style-type: none"> a. Soil survey performed by USDA Soil Conservation Service (in PennDER files). b. Results of laboratory testing by Lee-Simpson Associates (in PennDER files). c. Bi-weekly construction status reports to PennDER indicate field testing but no test data are available. 	

ENGINEERING DATA (CONTINUED)

PAGE 3 OF 5

ITEM	REMARKS	NDI# PA - 916
BORROW SOURCES	Borrow taken from spillway cut, from within reservoir and from the right abutment.	
POST CONSTRUCTION DAM SURVEYS	None performed.	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	L. Robert Kimball Engineers presently studying water distribution system and spillway of dam.	
HIGH POOL RECORDS	June 1977; estimated 6 to 8 inches of flow over spillway control slab.	
MONITORING SYSTEMS	None.	
MODIFICATIONS	<ol style="list-style-type: none">1. Access road to spillway added along left shoreline.2. Added diversion ditch above cut slope along left abutment and spillway cut.3. Modified riser pipe on supply intake.	

ENGINEERING DATA (CONTINUED)

PAGE 4 OF 5

ITEM	REMARKS	NDI#	PA
PRIOR ACCIDENTS OR FAILURES	1. June 1977 flood caused serious erosion of spillway channel. Repairs with federal relief funds required identical reconstruction. 2. Spring floods in 1978 again caused erosion - same problem.	PA 916	
MAINTENANCE: RECORDS MANUAL	No manual or records to date (Nov. 1978). The Municipal Authority has recently hired a new manager and plan to formalize procedures.		
OPERATION: RECORDS MANUAL	No manual or operations records. Water usage about 450,000 GPD.		
OPERATIONAL PROCEDURES	Unregulated flow through spillway.		
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	No formal system.		
MISCELLANEOUS	Excess excavation from within impoundment was to be hauled off site, however, contractor was permitted to place material at downstream toe. Therefore, as-built configuration is quite different from design.		

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00916
PENN DER ID # 17-111
PAGE 5 OF 5

SIZE OF DRAINAGE AREA: 3.8 square miles
ELEVATION TOP NORMAL POOL: 1642 STORAGE CAPACITY: 25 acre-feet
ELEVATION TOP FLOOD CONTROL POOL: - STORAGE CAPACITY: -
ELEVATION MAXIMUM DESIGN POOL: - STORAGE CAPACITY: -
ELEVATION TOP DAM: 1646 STORAGE CAPACITY: 40 acre-feet

SPILLWAY DATA

CREST ELEVATION: 1642
TYPE: Partially riprapped trapezoidal channel with concrete control section.
WIDTH: 80 feet (design); 60 feet (measured)
LENGTH: 400 feet (from control slab to original stream)
SPILLOVER LOCATION: left abutment
NUMBER AND TYPE OF GATES: None

OUTLET WORKS

TYPE: 16-inch diameter mechanical joint ductile iron pipe
LOCATION: along dam axis at base of embankment
ENTRANCE INVERTS: 1623 (estimated from site plan)
EXIT INVERTS: 1604 (field measured)
EMERGENCY DRAWDOWN FACILITIES: Rodney Hunt sluice gate system

HYDROMETEOROLOGICAL GAGES

TYPE: none
LOCATION: N/A
RECORDS: N/A

MAXIMUM NON-DAMAGING DISCHARGE: Not known. Normal flow causing erosion.

APPENDIX B

CHECK LIST - VISUAL INSPECTION

CHECK LIST
VISUAL INSPECTION
PHASE 1

PAGE 1 OF 8

Pike Township Municipal
Authority Dam

COUNTY Clearfield

STATE Pennsylvania

PENNDER# 17-111

TYPE OF DAM Earth (zoned)

SIZE Intermediate

HAZARD CATAGORY Significant

DATE(S) INSPECTION 15 November 1978

WEATHER Cold with rain

TEMPERATURE 40° @ 3:00 p.m.

POOL ELEVATION AT TIME OF INSPECTION 1642.1

M.S.L.

TAILWATER AT TIME OF INSPECTION N/A

M.S.L.

INSPECTION PERSONNEL

OWNER REPRESENTATIVES

OTHERS

B. Mihalcin

Wayne Neeper (Auth. Manager)

Fernando Chiriboga-

W. Veon, Jr.

Leroy Neeper (Water Auth.)

Environmental Engr.

E. Mannella

Board Chairman)

(L. Robert Kimball)

J. Nairn

RECORDED BY J. Nairn

EMBANKMENT

PAGE 8 OF 8

ITEM	OBSERVATIONS AND/OR REMARKS	NDI# PA - 916
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed on embankment. Severe erosion in spillway channel. Large slide obvious above left abutment and spillway cut. Slide about 175 feet in length and approximately 30 feet downstream of spillway control section.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal alignment good. Vertical alignment of upstream crest line is good. Downstream crest line is obscured by excess fill.	
RIPRAP FAILURES	None observed. Riprap is durable, well graded sandstone.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good. No problems observed.	

EMBANKMENT

PAGE 3 OF 8

NDI# PA - 916

ITEM	OBSERVATIONS AND/OR REMARKS
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	None observed.
ANY NOTICEABLE SEEPAGE	None observed.
STAFF GAGE AND RECORDER	None.
DRAINS	None observed.
	Excess borrow from within the impoundment has been placed along the downstream face of the dam, obscuring the downstream crest line and resulting in a downstream slope of about 6 percent.

OUTLET WORKS

ITEM	OBSERVATIONS AND/OR REMARKS	NDI# PA - 916.
INTAKE STRUCTURE	Submerged.	
OUTLET CONDUIT (CRACKING AND SPALL- ING OF CONCRETE SURFACES)	N/A (Ductile steel pipe with flap valve at outlet).	
OUTLET STRUCTURE	Concrete endwall in good condition.	
OUTLET CHANNEL	Rock-lined channel - no apparent problems.	
GATE(S) AND OPERA- TIONAL EQUIPMENT	<p>Blowoff Line - Controlled at inlet by Rodney Hunt sluice gate with bench stand and 1-1/8-inch diameter steel stem (appears to be open). Also two gate valves on blowoff line within embankment.</p> <p>Supply Line - 8-inch supply line valved at two locations within embankment (see Figure 1, Appendix F).</p>	

EMERGENCY SPILLWAY

PAGE 5 OF 8

ITEM	OBSERVATIONS AND/OR REMARKS	NDI# PA - 916
TYPE AND CONDITION	Open channel cut into soil along left abutment. Large slabs of sandstone evident (erosion protection) for first 55 feet downstream of concrete control section. Granular fill downstream of this section contains erosion ditches as deep as 8 feet.	
APPROACH CHANNEL	Unlined natural approach.	
SPILLWAY CHANNEL AND SIDEWALLS	Originally cut into natural soil. Channel eroded and restored with granular fill - also eroding severely.	
STILLING BASIN PLUNGE POOL	None.	
DISCHARGE CHANNEL	Discharges into natural stream.	
BRIDGE AND PIERS	None.	
EMERGENCY GATES	None.	

SERVICE SPILLWAY

PAGE 6 OF 8

NDI# PA - 916

OBSERVATIONS AND/OR REMARKS

ITEM	
TYPE AND CONDITION	N/A
APPROACH CHANNEL	N/A
OUTLET STRUCTURE	N/A
DISCHARGE CHANNEL	N/A
	N/A

INSTRUMENTATION

PAGE 7 OF 8

NDI# PA - 916

ITEM	OBSERVATIONS AND/OR REMARKS
MONUMENTATION SURVEYS	None.
OBSERVATION WELLS	None.
WEIRS	None.
PIEZOMETERS	None.
OTHERS	

RESERVOIR AREA AND DOWNSTREAM CHANNEL

PAGE 8 OF 8
NDI# PA -916

ITEM	OBSERVATIONS AND/OR REMARKS
SLOPES: RESERVOIR	Steep and heavily wooded.
SEDIMENTATION	Minor - No surveys performed to gage actual amount.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Unobstructed.
SLOPES: CHANNEL VALLEY	Channel slope is relatively steep. Valley slopes steep and heavily wooded.
APPROXIMATE NUMBER OF HOMES AND POPULATION	Bear Run enters Anderson Creek from the east about one mile from the dam. No dwellings are located along this reach, however, a railroad line is located along the west bank of Anderson Creek which could be affected by a breach of Bear Creek Dam. Anderson Creek passes under U. S. Rte. 322 at Bridgeport about 4-1/2 miles downstream of its confluence with Bear Run and about 1-1/2 miles west of Curwensville.
	Minor damage to industrial and residential property could possibly result from a breach of Bear Run Dam. Therefore, the hazard rating is considered significant.

APPENDIX C
HYDRAULICS/HYDROLOGY

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

- a. Development of an inflow hydrograph(s) to the reservoir.
- b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

- a. Development of an inflow hydrograph(s) to the reservoir.
- b. Routing of the inflow hydrograph(s) through the reservoir.
- c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.
- d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevations of failure hydrographs for each location.

SUBJECT DAM SAFETY INSPECTION

PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM

BY DLB DATE 1-25-79 PROJ. NO. 78-617-916

CHKD. BY WJV DATE 3-29-79 SHEET NO. 1 OF 13



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DAM STATISTICS

EMBANKMENT HEIGHT \approx 42 FEET

[FIELD MEASURED FROM BLOWOFF
OUTLET TO TOP OF DAM]

MAXIMUM POOL STORAGE CAPACITY \approx 40 AC-FT

[OBTAINED FROM
HEC-1 OUTPUT]

NORMAL POOL STORAGE CAPACITY \approx 25 AC-FT

(SEE NOTE 1)

DRAINAGE AREA \approx 3.8 sq. mi.

[PLANIMETERED OFF U.S.G.S
7.5 MINUTE SERIES QUAD
ELLIOT PARK, PA.]

NOTE 1: THE STORAGE CAPACITY VALUE OBTAINED FROM A REPORT CONTAINED IN PENNDER FILES ENTITLED "REPORT UPON THE APPLICATION OF THE PIKE TOWNSHIP MUNICIPAL AUTHORITY, DATED 1-22-74 WAS ABOUT 8,000,000 GALLONS. HOWEVER, THE AUTHORITY CONTENDS THAT SOME ADDITIONAL EXCAVATION WAS DONE IN THE RESERVOIR AREA SO THAT THE PRESENT STORAGE CAPACITY IS 30,000,000 GALLONS. BASED ON ORIGINAL DESIGN INFORMATION IT SEEMS HIGHLY UNLIKELY THAT THE CAPACITY COULD BE INCREASED TO 30 MG WITHOUT EXTENSIVE EXCAVATING AND POSSIBLY REDESIGNING OF THE DAM. SINCE THE AUTHORITY'S CLAIM COULD NOT BE CONFIRMED THE 8 MG WILL BE ASSUMED CORRECT FOR THIS ANALYSIS

DAM CLASSIFICATION

DAM SIZE - INTERMEDIATE

(REF 1, TABLE 1)

HAZARD RATING - SIGNIFICANT

(FIELD OBSERVATION)

REQUIRED SDF - $\frac{1}{2}$ PMF TO PMF

(REF 1, TABLE 3)

SUBJECT

DAM SAFETY INSPECTIONPIKE TOWNSHIP MUNICIPAL AUTHORITY DAMBY DLB

DATE

1-25-79

PROJ. NO.

78-617-916CHKD. BY WJV

DATE

3-27-79

SHEET NO.

2 OF 13Engineers • Geologists • Planners
Environmental SpecialistsHYDROGRAPH PARAMETERSLENGTH OF LONGEST WATERCOURSE (L) \approx 4.2 MILESLCA \approx 1.7 MILES (MEASURED ALONG LONGEST WATERCOURSE FROM DAM CREST TO BASIN CENTER)NOTE 2: VALUES OF L AND LCA ARE MEASURED FROM U.S.G.S.
7.5 MINUTE SERIES QUAD ELLIOT PARK, PA. $C_e = 1.84$ $C_p = 0.45$ SUPPLIED BY COF E;
ZONE 19, SUSQUEHANNA
RIVER BASIN $t_p = \text{SNYDER'S STANDARD LAG} = 1.84 (L \times LCA)^{0.3}$ $t_p = (1.84) [(4.2)(1.7)]^{0.3} = 3.32 \text{ HR}$ RESERVOIR SURFACE AREASS.A. (SURFACE AREA) @ NORMAL POOL EL 1642.0 \approx 3.0 ACRES (SEE NOTE 3)S.A. @ EL 1645.0 \approx 4.2 ACRESS.A. @ EL 1640.0 \approx 8.3 ACRESPLANIMETERED OFF U.S.G.S. 7.5
MINUTE QUAD ELLIOT PARK, PA $\Delta \text{AREA} / \text{FT} \approx (8.3 - 4.2) \text{ ACRES} / (1640 - 1645) \text{ FEET} \approx 0.27 \text{ AC/FT}$ S.A. @ TOP OF DAM EL 1646.0 \approx 4.2 ACRES + 1 FT (0.27 AC/FT) = 4.5 ACRESNOTE 3: SURFACE AREAS WERE OBTAINED BY PLANIMETERING THOSE
CONTOURS SHOWN OF DRAWG 2 OF 8, ENTITLED "STORAGE RESERVOIR
SITE PLAN" by LEE-SIMPSON ASSOCIATES, INC. OF DUBOIS, PA.,
DATED JULY, 1972 (SEE FIG 2, APPENDIX F).

SUBJECT

DAM SAFETY INSPECTIONPIKE TOWNSHIP MUNICIPAL AUTHORITY DAM

BY

DLB

DATE

1-26-79

PROJ. NO.

78-617-916

CHKD. BY

WJV

DATE

3-27-79

SHEET NO.

3

OF

13Engineers • Geologists • Planner
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$$\text{NORMAL POOL VOLUME} = \frac{1}{3} HA = 25 \text{ AC-FT}$$

(CONIC METHOD)

$$\text{S.A. @ NORMAL POOL EL 1642.0} \approx 3.0 \text{ ACRES}$$

(SHEET 2)

$$H = \frac{(3)(25 \text{ AC-FT})}{(3.0 \text{ ACRES})} = 25 \text{ FT}$$

$$\text{ZERO VOLUME ELEVATION} = 1642.0 - 25.0 \approx 1617.0 \text{ FT}$$

STORAGE - ELEVATION RELATIONSHIP

COMPUTED INTERNALLY BY THE HEC-1 PROGRAM BASED
ON GIVEN SURFACE AREA VS ELEVATION INFORMATION
(SEE SUMMARY INPUT/OUTPUT SHEETS)

SUBJECT DAM SAFETY INSPECTION
PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM
 BY DLB DATE 1-26-79 PROJ. NO. 78-617-916
 CHKD. BY WJV DATE 3-27-79 SHEET NO. 4 OF 13



PMP CALCULATIONS

STANDARD RAINFALL INDEX = 22.2 INCHES
 (CORRESPONDING TO A DURATION OF 24 HRS
 AND AN AREA OF 200 SQ. MI.)

(REF 9, FIG 2)

GEOGRAPHIC ADJUSTMENT FACTOR = 103% (REF 9, FIG 1)
 (CORRESPONDING TO A LONGITUDE 79° 34'
 AND A LATITUDE OF 41° 01')

CORRECTED RAINFALL INDEX = (22.2 INCHES)(1.03) = 22.9 INCHES

DRAINAGE AREA ≈ 3.8 SQ. MI. < 10 SQ. MI. \Rightarrow ASSUME 10 SQ. MI. DATA
 CAN EFFECTIVELY
 REPRESENT THE 3.8 SQ.
 MI. AREA.

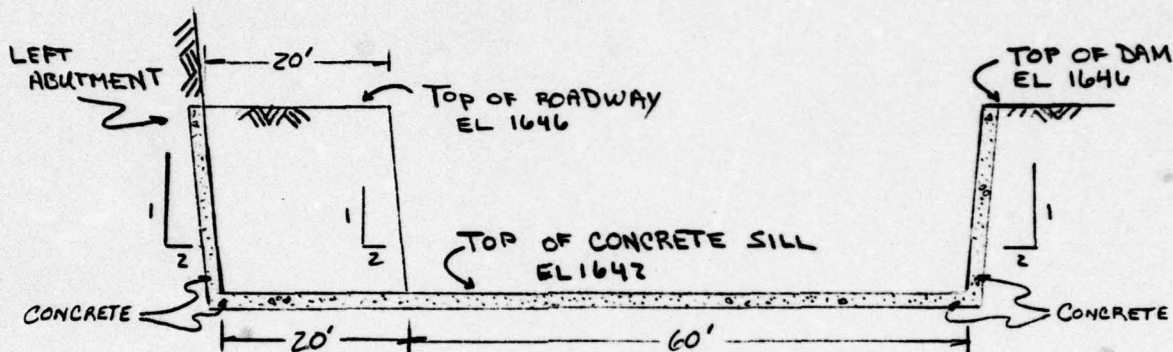
DURATION (HRS)	PERCENT OF INDEX RAINFALL (%)
6	117.5
12	127.0
24	136.0
48	142.5
72	145.0

- HOP BROOK FACTOR (ADJUSTMENT FOR BASIN SHAPE, AS WELL AS FOR THE
 LESSER LIKELIHOOD OF A SEVERE STORM HITTING A SMALLER BASIN)
 FOR $DA \approx 3.8$ MI² (< 10 MI²) $\Rightarrow 0.80$ (REF 4, PG 4A)

SUBJECT DAM SAFETY INSPECTION
PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM
 BY DLB DATE 1-26-79 PROJ. NO. 78-617-916
 CHKD. BY WJV DATE 3-27-79 SHEET NO. 5 OF 13

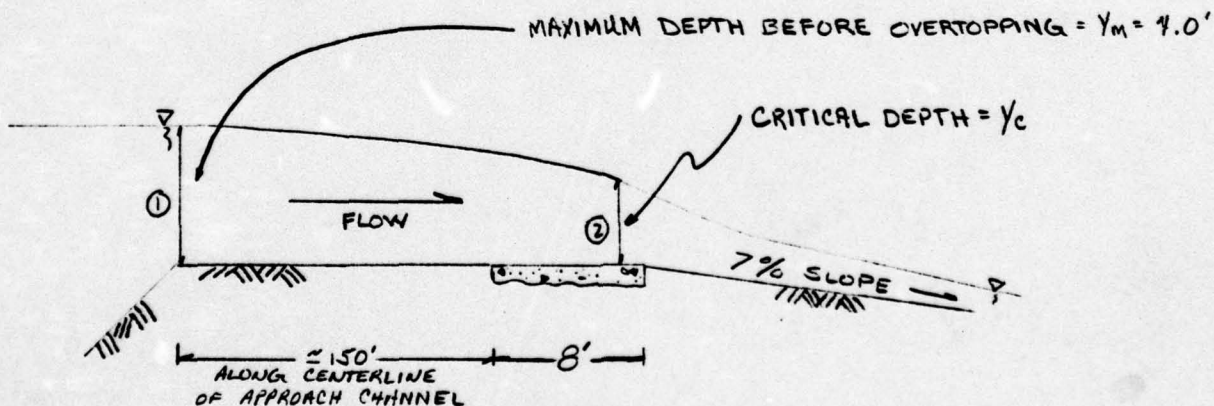
gai
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EMERGENCY SPILLWAY CAPACITY



SCALE: 1 in = 20 FT HORIZONTAL
 1 in = 5 FT VERTICAL

CROSS-SECTION AT CONTROL



SPILLWAY PROFILE (NOT TO SCALE)

NOTE 4: THE ABOVE DRAWINGS WERE SKETCHED BASED ON MEASUREMENTS TAKEN DURING THE FIELD INSPECTION

SUBJECT

DAM SAFETY INSPECTION

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DATE

1-26-79

PROJ. NO.

78-617-916

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DATE

3-27-79

SHEET NO.

6

OF 13



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ENERGY BALANCE BETWEEN ① AND ②

$$Y_m + \frac{V_m^2}{2g} = Y_c + \frac{V_c^2}{2g} + H_L \quad \text{where}$$

H_L = HEAD LOSS BETWEEN
① AND ② ≈ 0

V_R = RESERVOIR VELOCITY
(ASSUMED TO BE NEGLIGIBLE)

V_c = CRITICAL VELOCITY

AT CRITICAL DEPTH $V_c^2/2g = \Delta_c/z$ (REF 7, PG 43)

where Δ_c = HYDRAULIC DEPTH = $\frac{\text{AREA OF FLOW}}{\text{TOP WIDTH}} = A_c/W_c$

$$A_c = 60y_c + 2y_c(y_c) = 2y_c^2 + 60y_c$$

$$W_c = 60 + 4y_c$$

} DEFINED BY THE GEOMETRY
@ SECTION ②

$$\therefore Y_m = y_c + \frac{2y_c^2 + 60y_c}{2(60 + 4y_c)} \quad \text{where } Y_m = 4'$$

$$4'(120 + 8y_c) = 120y_c + 8y_c^2 + 2y_c^2 + 60y_c$$

$$480 + 32y_c = 10y_c^2 + 180y_c$$

$$\therefore 0 = 10y_c^2 + 148y_c - 480$$

$$y_c = \frac{-148 + \sqrt{(148)^2 - 4(10)(-480)}}{2(10)} = 2.74' \quad (\text{QUADRATIC EQUATION})$$

SINCE, $V_c^2/2g = \frac{2y_c^2 + 60y_c}{120 + 8y_c} = [2(2.74')^2 + 60(2.74')]/[120 + 8(2.74')]$

$$V_c^2/2g = 1.26$$

$$V_c = 9.0 \text{ fps}$$

SUBJECT DAM SAFETY INSPECTION

PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM

BY DLB DATE 1-29-79 PROJ. NO. 78-617-916

CHKD. BY WJV DATE 3-27-79 SHEET NO. 7 OF 13



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THE SPILLWAY CAPACITY IS GIVEN BY:

$$Q_c = \text{CRITICAL DISCHARGE} = V_c \cdot A_c$$

$$A_c = 2y_c^2 + 60y_c$$

(SHEET 6)

$$= 2(2.74')^2 + 60'(2.74') = 179.4 \text{ FT}^2$$

$$Q_c = (9.0 \text{ FT/SEC})(179.4 \text{ FT}^2)$$

$$Q_c = 1615 \text{ CFS} \quad \text{SAY } 1620 \text{ CFS}$$

SUBJECT DAM SAFETY INSPECTION
PIKE TOWNSHIP MUNICIPAL AUTHORITY
 BY DLB DATE 1-29-79 PROJ. NO. 78-617-916
 CHKD. BY WJV DATE 3-27-79 SHEET NO. 8 OF 13



SPILLWAY RATING CURVE

CRITICAL DEPTH RATING CURVE FOR PREVIOUSLY SKETCHED
 TRAPEZOIDAL SPILLWAY CONTROL SECTION (SHEET 5) BASED
 ON THE PROCEDURE FOLLOWED ON SHEETS 6 & 7.

$$Y_m = Y_c + V_c^2 / 2g$$

where $V_c^2 / 2g = \Delta_c / z$

where $\Delta_c / z = (A_c / W_c) / z$

$$A_c / W_c = \frac{2y_c^2 + 60y_c}{4y_c + 60}$$

$$Y_m = Y_c + \frac{2y_c^2 + 60y_c}{2(4y_c + 60)}$$

where $Y_m = H$ = HEIGHT OF RESERVOIR ABOVE
 SPILLWAY IN FEET.

NOTE: THE ABOVE PROCEDURE IS GOOD ONLY FOR $Y_c \leq 4.0$ FT
 DUE TO THE ACTUAL SHAPE OF THE SPILLWAY SECTION (SHEET 5)

ELEVATION (FEET)	H (FEET)	Q (CFS)
SPILLWAY CREST → 1642.0	0	0
1642.5	0.5	70
1643.0	1.0	190
1643.5	1.5	350
1644.0	2.0	550
1644.5	2.5	770
1645.0	3.0	1030
1645.5	3.5	1310
1646.0	4.0	1620
1646.5	4.5	1950
1647.0	5.0	2310
1647.5	5.5	2690

FOR $Y_c \leq 4.0$ FT

SUBJECT

DAM SAFETY INSPECTION

PIKE TOWNSHIP MUNICIPAL AUTHORITY

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DATE

1-29-79

PROJ. NO.

78-617-916

CHKD. BY WJV

DATE

3-27-79

SHEET NO.

9

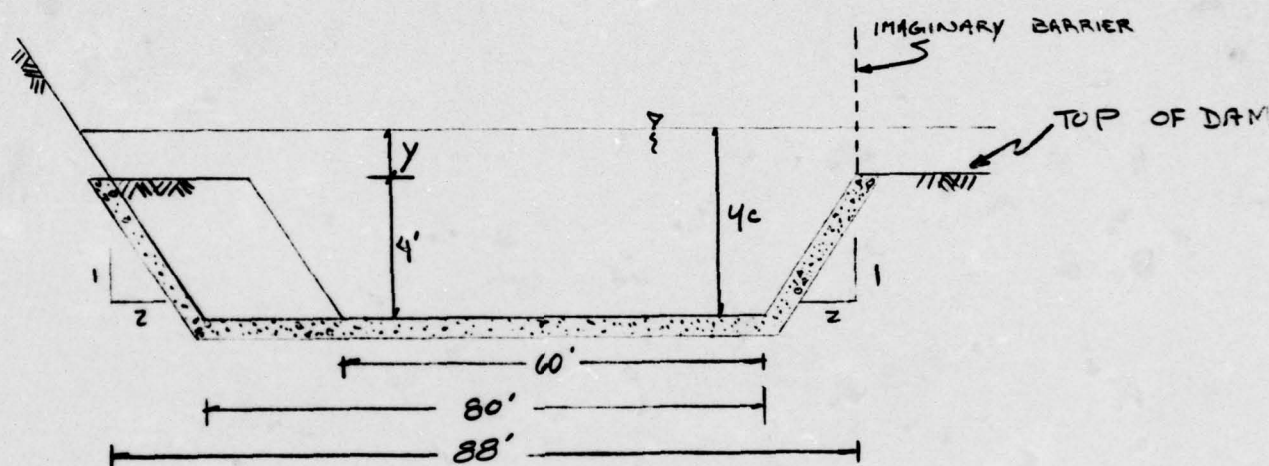
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13

FOR $y_c > 4.0 \text{ FT}$:

$$y_m = y_c + v_c^2 / 2g$$

(SHEET 6)

SPILLWAY CROSS-SECTION
(NOT TO SCALE)where $v_c = Q / A_c$

$$A_c = [2(y_c)^2 + 60(y_c)] + \left[\frac{88 + (2y_c + 88)}{2} (y_c) \right]$$

(FROM ABOVE SKETCH)

$$\therefore y_m = (y_c + y) + \frac{Q^2}{2g} \left\{ \frac{1}{272 + \left[\frac{88 + (2y_c + 88)}{2} (y_c) \right]} \right\}^2$$

ALSO @ CRITICAL DEPTH $1 = \frac{Q^2 w_c}{g A_c^3}$

(REF 13, Pg 14)

where $w_c = \text{TOP WIDTH} = 88 + 2y_c$

SUBJECT DAM SAFETY INSPECTION

PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM

DLD DATE 3-26-79 PROJ. NO. 78-617-916

CHKD. BY WJV DATE 3-27-79 SHEET NO. 10 OF 13



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$$Q^2 = 3Ac^3/Wc$$

$$Q = (3Ac^3/Wc)^{1/2}$$

$$Q = \sqrt{\frac{9 \left\{ 272 + \left[\frac{88 + (88 + 24)}{2} (4) \right] \right\}^3}{88 + 24}}$$

ELEVATION (FEET)	* H (FEET)	Q (CFS)
1648.0	6.0	3120
1648.5	6.5	3590

* AS DEFINED ON SHEET 8

SUBJECT DAM SAFETY INSPECTION

PIKE TOWNSHIP MUNICIPAL AUTHORITY

BY DLB DATE 1-29-79 PROJ. NO. 78-617-916

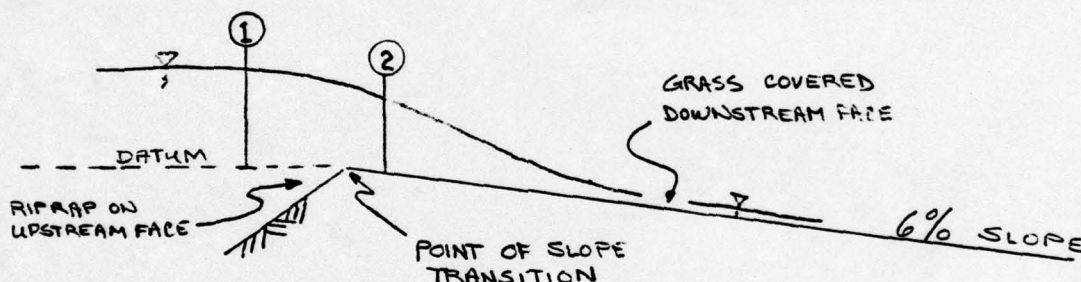
CHKD. BY WJV DATE 3-27-79 SHEET NO. 11 OF 13



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EMBANKMENT RATING CURVE

ACCORDING TO AVAILABLE DATA, THE TOP OF DAM IS AT ELEVATION 1646. THIS IS THE POINT WHERE OVERTOPPING OF THE DAM STARTS. FIELD MEASUREMENTS INDICATE THE LENGTH OF THE DAM, EXCLUDING THE SPILLWAY, IS APPROXIMATELY 310 FEET. THE EMBANKMENT WAS CONSTRUCTED WITHOUT A FLAT CREST SECTION AND IS TRIANGULAR IN CROSS-SECTION AS SHOWN BELOW.



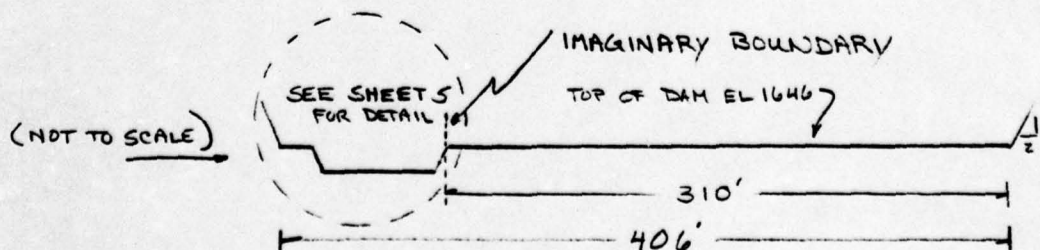
DUE TO THE EMBANKMENT CONFIGURATION, CRITICAL DEPTH IS EXPECTED TO CONTROL THE EMBANKMENT FLOWS. THE CONTROL SECTION WILL LIKELY BE LOCATED NEAR THE POINT OF SLOPE TRANSITION

AGAIN,

$$Y_M = Y_c + \frac{V_c^2}{2g} \quad (\text{SEE NOTE BELOW})$$

$$\text{AT CRITICAL DEPTH} \quad \frac{V_c^2}{2g} = \Delta_c / 2$$

$$\text{where } \Delta_c = \text{HYDRAULIC DEPTH} = \frac{\text{AREA OF FLOW}}{\text{TOP WIDTH}} = A_c / W_c$$



NOTE: Y_M IS NOW DEFINED AS THE POOL LEVEL ABOVE THE POINT OF SLOPE TRANSITION @ SECTION 1 WHEREAS Y_c AND V_c ARE DEFINED @ SECTION 2

SUBJECT

DAM SAFETY INSPECTION

PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM

DLB

DATE 3-26-79

PROJ. NO. 78-617-916

CHKD. BY WJV

DATE 3-27-79

SHEET NO. 12 OF 13

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$$A_c = \left[\frac{310 + (310 + 2y_c)}{2} \right] (y_c) = (310 + y_c)(y_c) = 310y_c + y_c^2$$

$$W_c = 310 + 2y_c$$

$$\text{AND } V_c^2 / 2g = \Delta_c / 2 = 310y_c + y_c^2 / (2(310 + 2y_c))$$

$$\therefore y_m = y_c + \frac{310y_c + y_c^2}{620 + 4y_c} \quad ; \quad \text{AND } Q = A_c V_c \quad \left(\text{WHERE } A_c \text{ AND } V_c \text{ ARE FOUND FROM THE ABOVE RELATIONSHIPS TO } y_c \right)$$

ELEVATION (FEET)	* H (FEET)	Q (CFS)
1646.0	0	0
1646.5	0.5	340
1647.0	1.0	960
1647.5	1.5	1760
1648.0	2.0	2720
1648.5	2.5	3810

* WHERE $H = y_m$

SUBJECT DAM SAFETY INSPECTION
PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM
E DLB DATE 3-26-79 PROJ. NO. 78-617-916
CHKD. BY WJV DATE 3-27-79 SHEET NO. 13 OF 13

gai
CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

TOTAL DAM FACILITY RATING CURVE

$$\text{TOTAL } Q = \text{SPILLWAY } Q + \text{EMBANKMENT } Q$$

ELEVATION (FEET)	SPILLWAY Q (CFS)	EMBANKMENT Q (CFS)	TOTAL Q (CFS)
1642.0	0	-	-
1642.5	70	-	70
1643.0	190	-	190
1643.5	350	-	350
1644.0	550	-	550
1644.5	770	-	770
1645.0	1030	-	1030
1645.5	1310	-	1310
1646.0	1620	-	1620
1646.5	1950	340	2290
1647.0	2310	960	3270
1647.5	2690	1760	4450
1648.0	3120	2720	5840
1648.5	3590	3810	7400

SUBJECT DAM SAFETY INSPECTION
PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM
 BY WJV DATE 4-11-79 PROJ. NO. 78-617-916
 CHKD. BY DLB DATE 4-11-79 SHEET NO. A OF D



SUMMARY INPUT/OUTPUT SHEETS

DAM SAFETY INSPECTION
 PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM ***** OVERLAPPING ANALYSIS *****
 15-MINUTE TIME STEP AND 72-HOUR STORM DURATION

JOH SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	15	0	0	0	0	0	0	0
			JUPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
 MPLAN= 1 NRTIO= 5 LRTIO= 1
 RTIO= .20 .30 .40 .50 1.00

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISIAQ	ICOMP	IECUN	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNUW	ISAME	LOCAL
1	1	3.80	0.00	3.80	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	N48	R72	R96
0.00	22.90	117.50	127.00	136.00	142.50	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LROPT	STRKR	DLTKR	RTIOL	FRAIN	SINKS	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= 3.32 CP= .45 NTA= 0

RECESSION DATA

STRIQ= -1.50 QRCSE= -.05 RTIO= 2.00
 APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=13.91 AND R=20.89 INTERVALS

DAM SAFETY INSPECTION

PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM

BY WJV

DATE 4-11-79

PROJ. NO. 73-617-916

CHKD. BY DLE

DATE 4-11-79

SHEET NO. B OF D



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UNIT	HYDROGRAPHIC	END-OF-PERIOD ORDNATES, LAGE	3.35 HOURS, CPE	.45	LOSS	EXCS	COMP Q
6.	24.	49.	79.	341.	331.	112.	149.
314.	331.	342.	342.	215.	133.	87.	51.
249.	237.	226.	215.	133.	87.	51.	33.
154.	147.	140.	133.	87.	51.	33.	20.
95.	91.	87.	83.	79.	75.	72.	65.
59.	56.	54.	51.	49.	47.	44.	42.
37.	35.	33.	32.	30.	29.	27.	26.
23.	22.	21.	20.	19.	18.	17.	16.
14.	13.	13.	12.	11.	11.	11.	10.
9.	8.	8.	8.	7.	7.	7.	6.

MO. DA	HR. MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW			MO. DA	HR. MN	PERIOD	MAIN	EXCS	LOSS	COMP Q
						6-HOUR	24-HOUR	72-HOUR							
RESERVOIR															
INFLOW															
HYDROGRAPHIC															
						PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME					
						6068.	5053.	2295.	804.	231577.					
						172.	143.	65.	23.	6558.					
						INCHES	12.37	22.47	23.62	23.62					
						MM	314.19	570.83	599.96	599.96					
						AC-FT	2506.	4552.	4785.	4785.					
						THOUS CU M	3091.	5615.	5902.	5902.					
PME															
						PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME					
						1214.	1011.	459.	161.	46315.					
						34.	29.	13.	5.	1312.					
						INCHES	2.47	4.49	4.72	4.72					
						MM	62.84	114.17	119.99	119.99					
						AC-FT	501.	910.	957.	957.					
						THOUS CU M	618.	1123.	1180.	1180.					
0.2 PME															
						PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME					
						1920.	1516.	689.	241.	69473.					
						52.	43.	19.	7.	1967.					
						INCHES	3.71	6.74	7.09	7.09					
						MM	94.26	171.25	179.99	179.99					
						AC-FT	752.	1366.	1435.	1435.					
						THOUS CU M	927.	1685.	1771.	1771.					
0.3 PME															
						PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME					
						3034.	2527.	1148.	402.	115788.					
						86.	72.	32.	11.	3279.					
						INCHES	6.18	11.24	11.81	11.81					
						MM	157.10	285.41	299.98	299.98					
						AC-FT	1253.	2270.	2392.	2392.					
						THOUS CU M	1545.	2808.	2951.	2951.					
0.5 PME (SDF)															

SUBJECT

DAM SAFETY INSPECTION

PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM

BY WJV

DATE

4-11-79

PROJ. NO.

78-617-486

CHKD. BY DLB

DATE

4-11-79

SHEET NO.

C OF D

Engineers • Geologists • Planners
Environmental Specialists

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

STAGE	1642.00	1642.50	1643.00	1643.50	1644.00	1644.50	1645.00	1645.50	1646.00
FLUM	0.00	70.00	190.00	350.00	550.00	770.00	1030.00	1310.00	1620.00
SURFACE AREA	0.	3.	4.	5.	8.				
CAPACITY	0.	25.	36.	40.	128.				
ELEVATION	1617.	1642.	1645.	1646.	1660.				

SURFACE AREA

CAPACITY

ELEVATION

DAM DATA

TUPEL	COOD	EXPD	DAMWID
1646.0	0.0	0.0	0.

PEAK OUTFLOW IS 6066. AT TIME 43.00 HOURS

PMF

RESERVOIR

OUTFLOW

HYDROGRAPHS

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
6066.	5053.	2295.	804.	231567.
172.	143.	65.	23.	6557.
	12.37	22.47	23.62	23.62
	314.18	570.83	599.94	599.94
	2506.	4552.	4784.	4784.
	3091.	5615.	5902.	5902.

PEAK OUTFLOW IS 3033. AT TIME 43.00 HOURS

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
3033.	2526.	1148.	402.	115786.
86.	72.	32.	11.	3279.
	6.18	11.24	11.81	11.81
	157.08	285.42	299.98	299.98
	1253.	2276.	2392.	2392.
	1545.	2808.	2951.	2951.

0.5 PMF

SUBJECT

DAM SAFETY INSPECTION

PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM

BY WJV

DATE

4-11-79

PROJ. NO. 79-617-916

CHKD. BY DLB

DATE

4-11-79

SHEET NO. D OF D

Engineers • Geologists • Planners
Environmental Specialists

PEAK OUTFLOW IS 1818. AT TIME 43.00 HOURS

0.2 PMF

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
1818.	1515.	689.	241.	69478.
51.	43.	19.	7.	1967.
	3.71	6.74	7.09	7.09
	94.21	171.26	180.00	180.00
	751.	1366.	1435.	1435.
	927.	1685.	1771.	1771.

PEAK OUTFLOW IS 1210. AT TIME 43.25 HOURS

0.3 PMF

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
1210.	1010.	459.	161.	46318.
34.	29.	13.	5.	1312.
	2.47	4.49	4.72	4.72
	62.79	114.17	120.00	120.00
	501.	910.	957.	957.
	618.	1123.	1180.	1180.

RESERVOIR

OUTFLOW

HYDROGRAPH:

OVERTOPPING
OCCURS @

≈ 0.27 PMF

SUMMARY OF DAM SAFETY ANALYSIS

ELEVATION STORAGE OUTFLOW	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
	1642.00	1642.00	1646.00			
	25.	25.	40.			
	0.	0.	1620.			
MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	MAXIMUM OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	
1645.32	37.	1210.	0.00	43.25	0.00	
1646.15	41.	1818.	2.25	43.00	0.00	
1646.57	43.	2427.	5.00	43.00	0.00	
1646.88	44.	3033.	6.75	43.00	0.00	
1648.07	50.	6066.	12.25	43.00	0.00	
	2.07					

RATIO
OF
PAF

.20

.30

.40

.50

1.00

LIST OF REFERENCES

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2. "Unit Hydrograph Concepts and Calculations," by Corps of Engineers, Baltimore District (L-519).
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10. Flood Hydrograph Package (HEC-1) Dam Safety Version, Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California, July 1978.
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13. Applied Hydraulics in Engineering, Morris, Henry M. and Wiggert, James N., Virginia Polytechnic Institute and State University, 2nd Edition, The Ronald Press Company, New York, 1972.
14. Standard Mathematical Tables, 21st Edition, The Chemical Rubber Company, 1973, page 15.
15. Engineering Field Manual, U. S. Department of Agriculture, Soil Conservation Service, 2nd Edition, Washington, D. C. 1969.

APPENDIX D
PHOTOGRAPHS

PHOTOGRAPH 1 View of the embankment as seen from above right abutment.

PHOTOGRAPH 2 View of the reservoir and surrounding hillsides.

PHOTOGRAPH 3 View of the riprap and sluice gate operator located along upstream slope.

PHOTOGRAPH 4 View of the outlet structure.



2



4

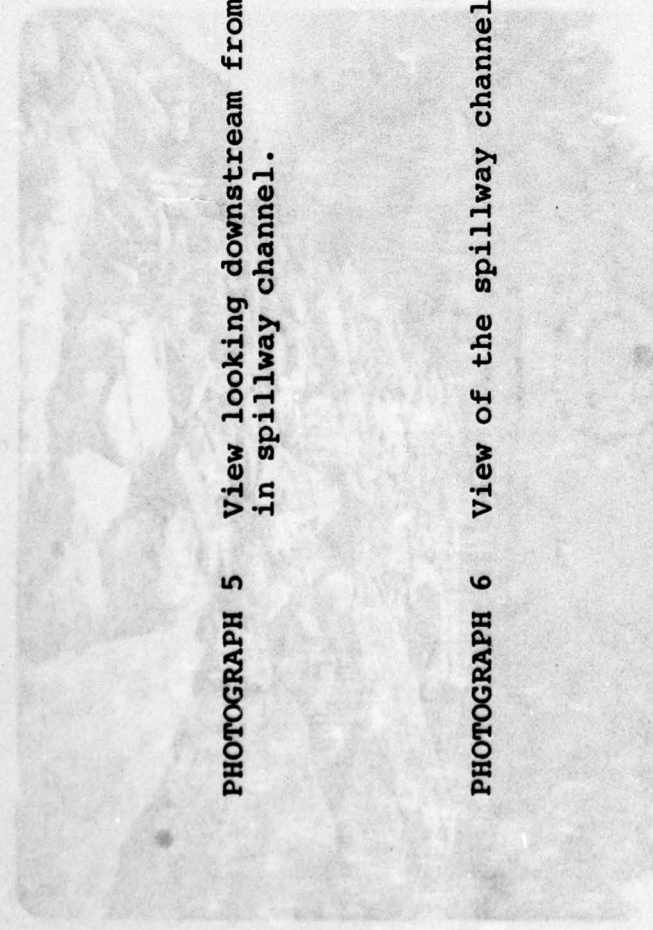


1



3

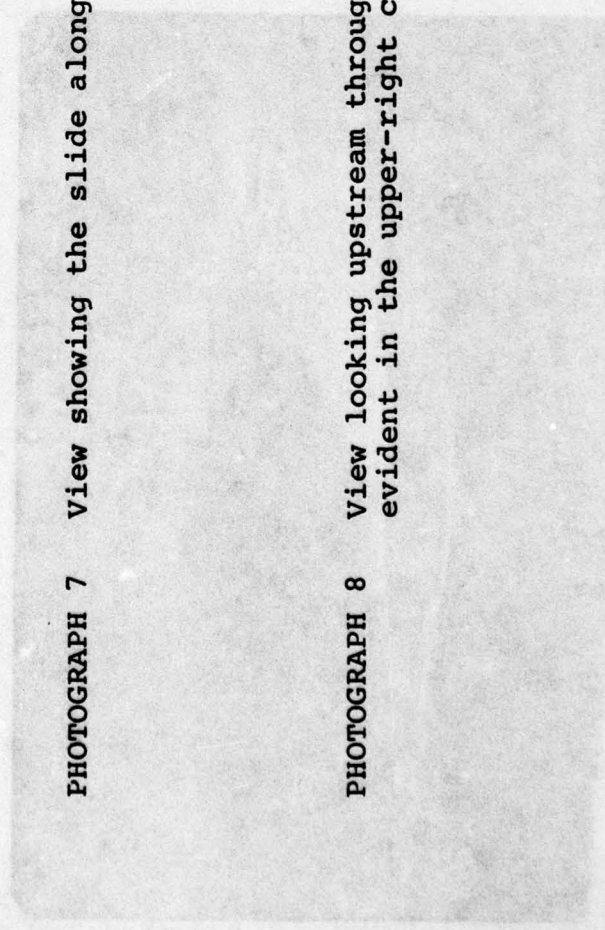
PHOTOGRAPH 5 View looking downstream from the spillway control slab showing erosion in spillway channel.



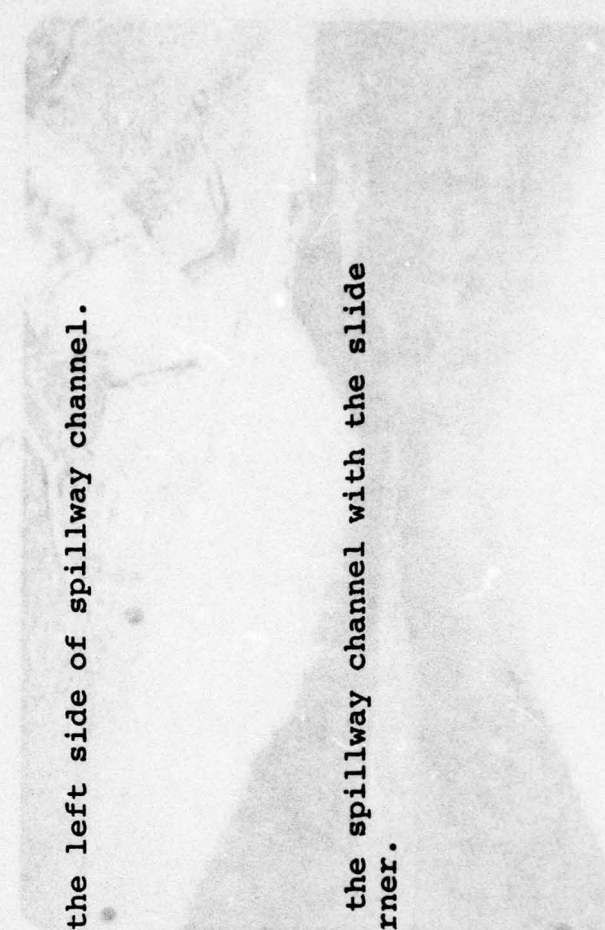
PHOTOGRAPH 6 View of the spillway channel and downstream embankment slope.



PHOTOGRAPH 7 View showing the slide along the left side of spillway channel.



PHOTOGRAPH 8 View looking upstream through the spillway channel with the slide evident in the upper-right corner.





8



7



6



5

APPENDIX E

GEOLOGY

Geology

Pike Township Municipal Authority Dam is located in the Pittsburgh Plateaus Section of the Appalachian Plateaus Physiographic Province.

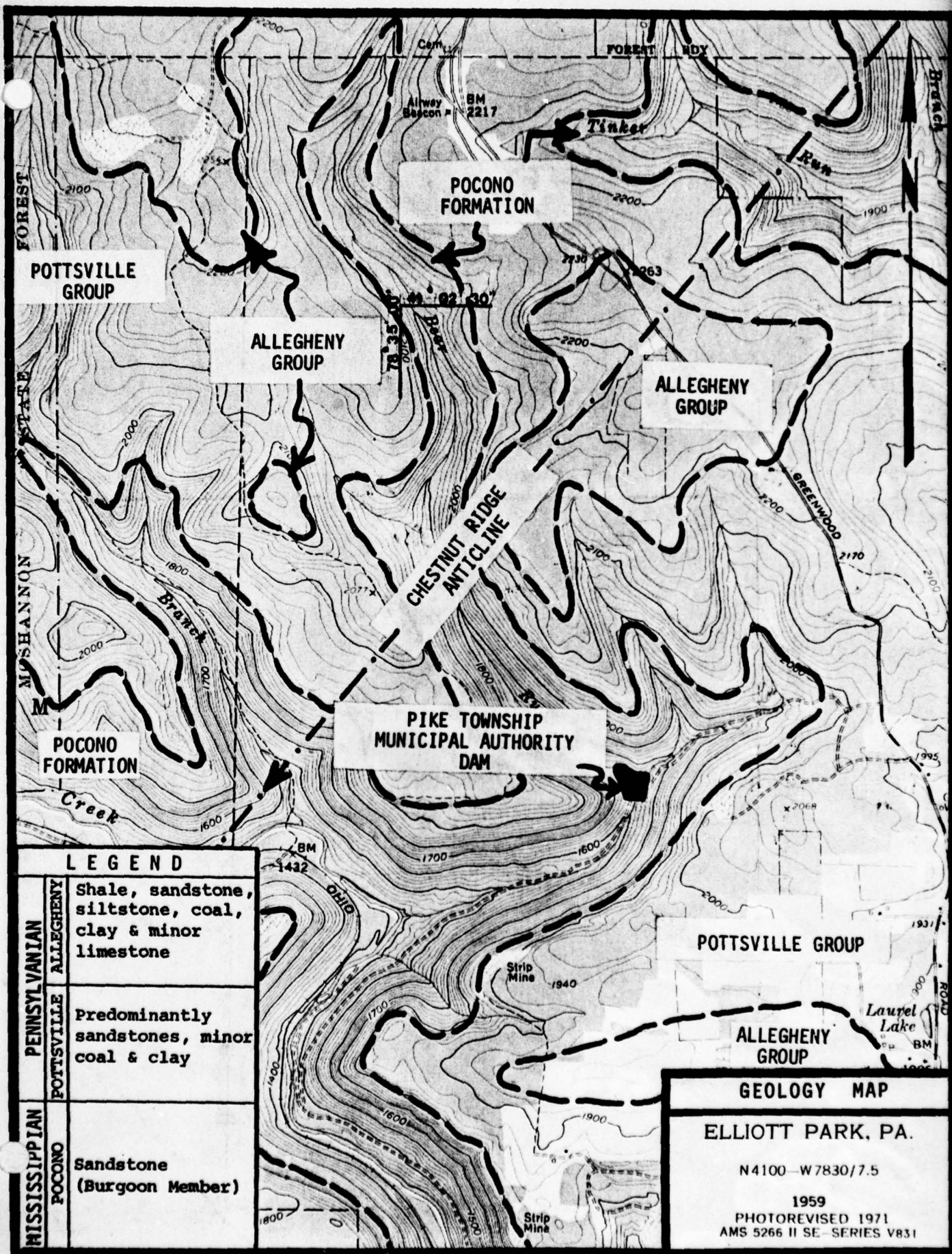
This section is characterized as a high plateau underlain by flat-lying to gently folded sedimentary rock strata of Pennsylvanian and Mississippian age.

Structurally, the site lies approximately one mile southeast of the axis of the Chestnut Ridge anticline. Consequently, the rock strata at the dam site dip to the south-southeast at approximately 300 feet per mile or about 3 degrees. The axis of the Chestnut Ridge anticline follows the regional trend which is generally in a northeast-southwest direction.

The dam is founded on sedimentary rock strata of the Mississippian age Pocono Formation. In this area, the upper 30 to 50 feet of the Pocono consist of fine to medium grained, light gray, quartzose sandstone. Bedding thickness in the upper unit ranges from a few inches to 6 feet or more. Underlying the upper sandstone is a 30- to 40-foot thick gray to black, silty shale. This shale becomes very silty and sandy toward the bottom and often included several thin beds of sandstone and siltstone. Underlying the silty shale is an 85- to 90-foot thick very fine to medium grained sandstone. Since the dam is in the valley of Bear Run, well below the Mississippian-Pennsylvanian disconformity, the

embankment is presumably founded on the lowermost sandstone and sandy shale portion of the Pocono Formation.

Two principal joint set directions are common to the area along the crest of the Chestnut Ridge anticline. The major set range from N30°W to N50°W. This set is roughly perpendicular to the trend of the major folds in the area. The strike of the secondary set ranges from N70°E to N85°E or roughly parallel to the trend of the major folds in the area. The abrupt turns made by Anderson Creek southwest of the site and by Bear Run, both below and above the dam, reflect strong joint control on the alignment of these streams.



APPENDIX F

FIGURES

LIST OF FIGURES

<u>Figure</u>	<u>Description/Title</u>
1	General Plan - Field Inspection Notes
2	Storage Reservoir, Location Map
3	Storage Reservoir, Site Plan
4	Storage Reservoir, Profile and Cross Section
5	Storage Reservoir, Details
6	Water Distribution System, Details

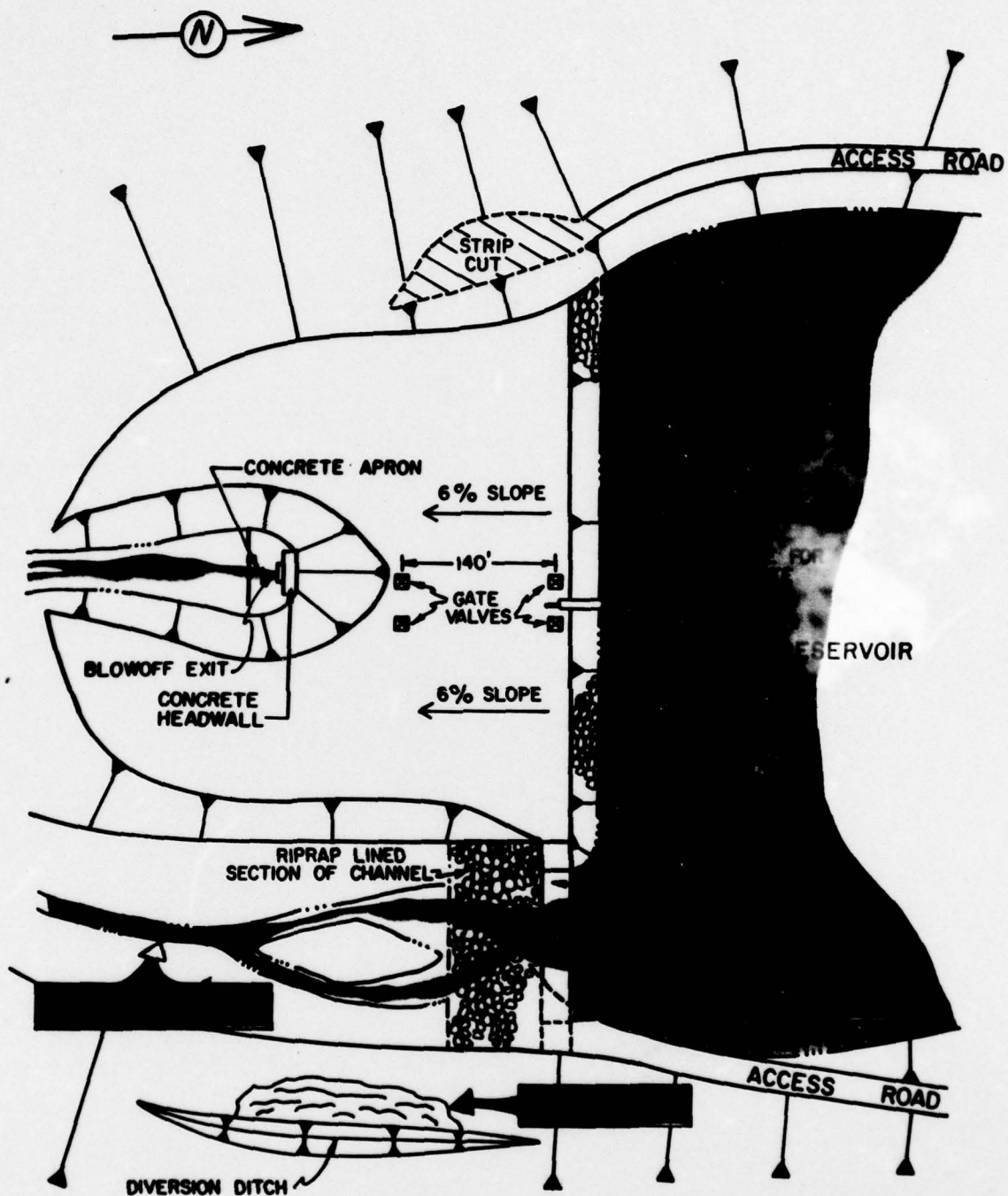


FIGURE 1 - PIKE TOWNSHIP MUNICIPAL AUTHORITY DAM
GENERAL PLAN
FIELD INSPECTION NOTES

M O S H A N N O N
S T A T E F O R E S T

P I N E
T W P.

P I K
T W P.

U N I O N
T W P.

M O S H A N N O N
S T A T E F O R E S T

PROPOSED
WATERSHED
AREA
Approx. 2496 Ac.
3.9 Sq. Mi.

PROPOSED
WATERSHED
AREA
Approx. 1608 Ac.
2.2 Sq. Mi.

B L O O M
T W P.

NOTES

- △ SITE LOCATION HIGHLIGHTED BY GAT
- △ NORTH ARROW ORIENTATION
CORRECTED BY GAT

Chestnut
Grove

Greenville

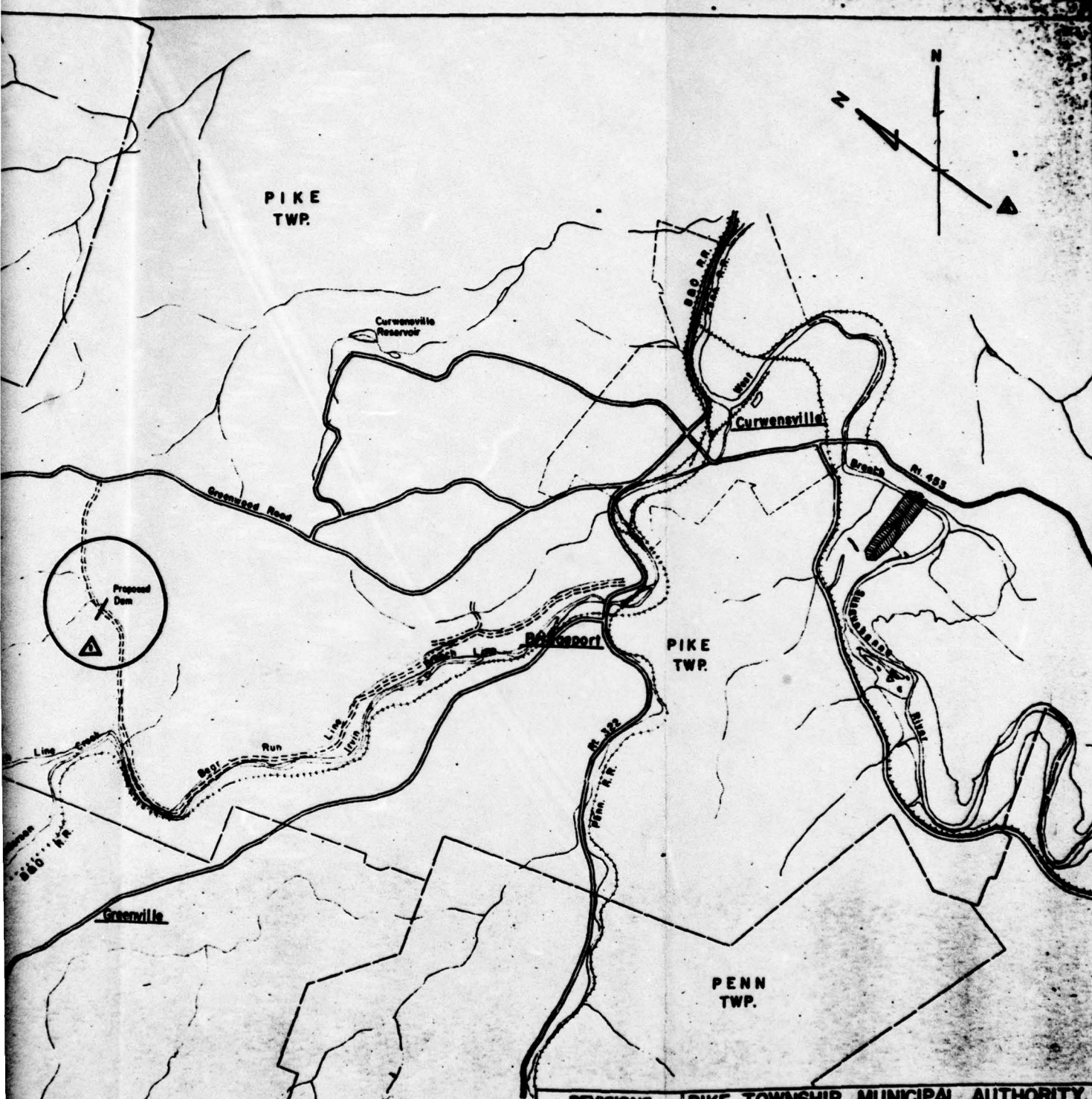
Greenwood Road

Bear Run

Irvin Branch Line Creek Run

Anderson
886 N.W.

Anderson

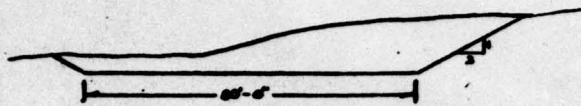


NOTES
 SECTION HIGHLIGHTED BY GAI
 SHOW ORIENTATION
 BY GAI

APPROVED: _____
 DATE: _____
 APPROVED: _____
 DATE: _____

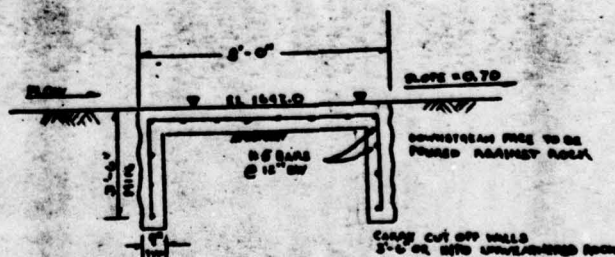
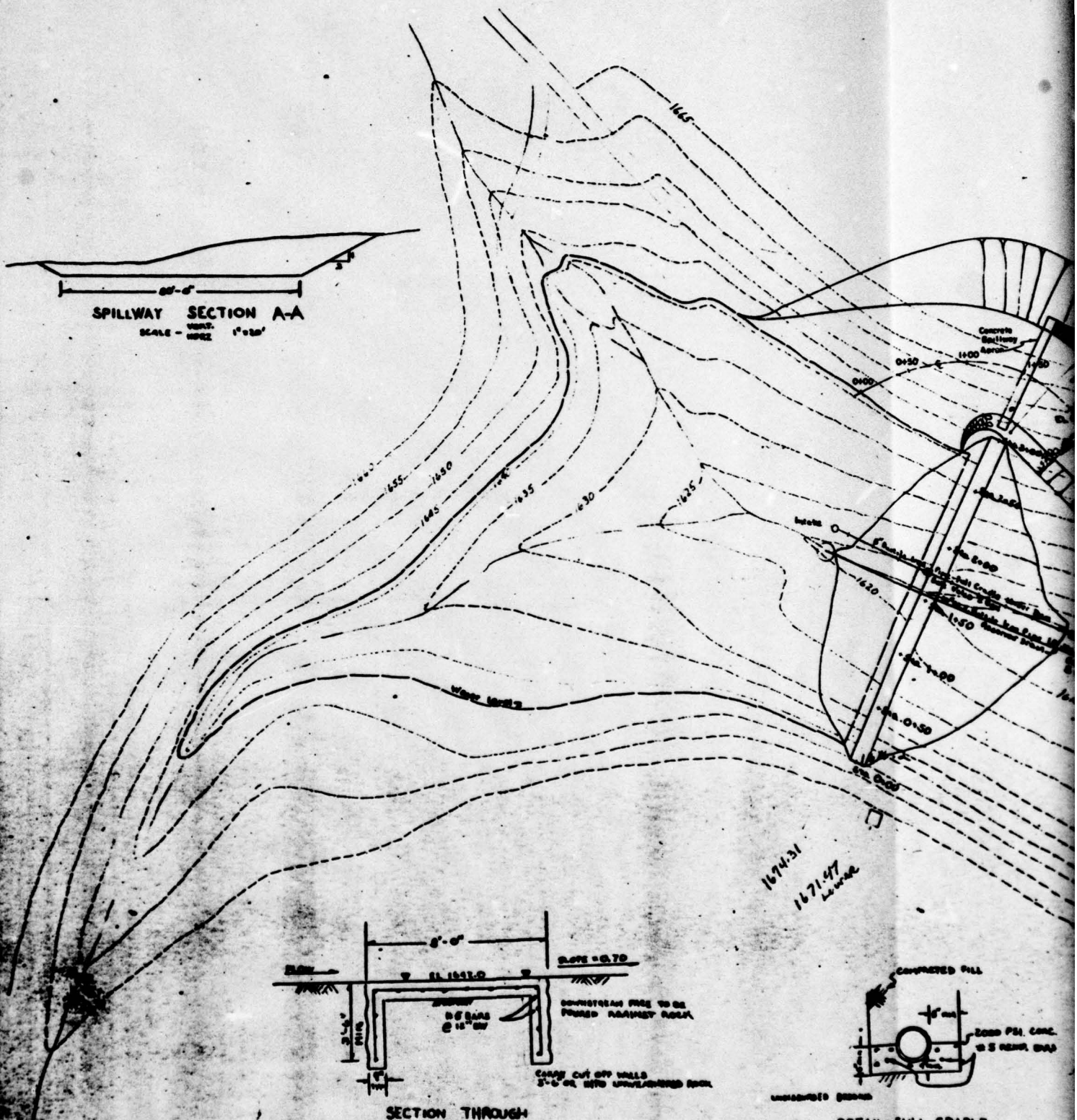
REVISIONS		
NO.	DATE	NAME

PIKE TOWNSHIP MUNICIPAL AUTHORITY CURWENSVILLE, PENNA.	
STORAGE RESERVOIR LOCATION MAP	
SCALE: 1" = 2000'	DATE: JULY 1972
LEE-SIMPSON ASSOCIATES, INC. ENGINEERS DUBOIS, PA.	FILE NO.: CW-17
FIGURE 2	

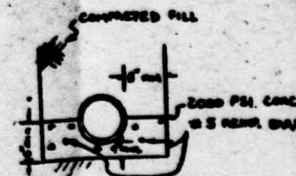


SPILLWAY SECTION A-A

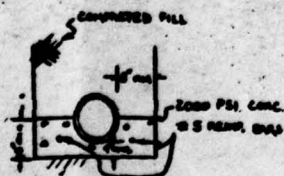
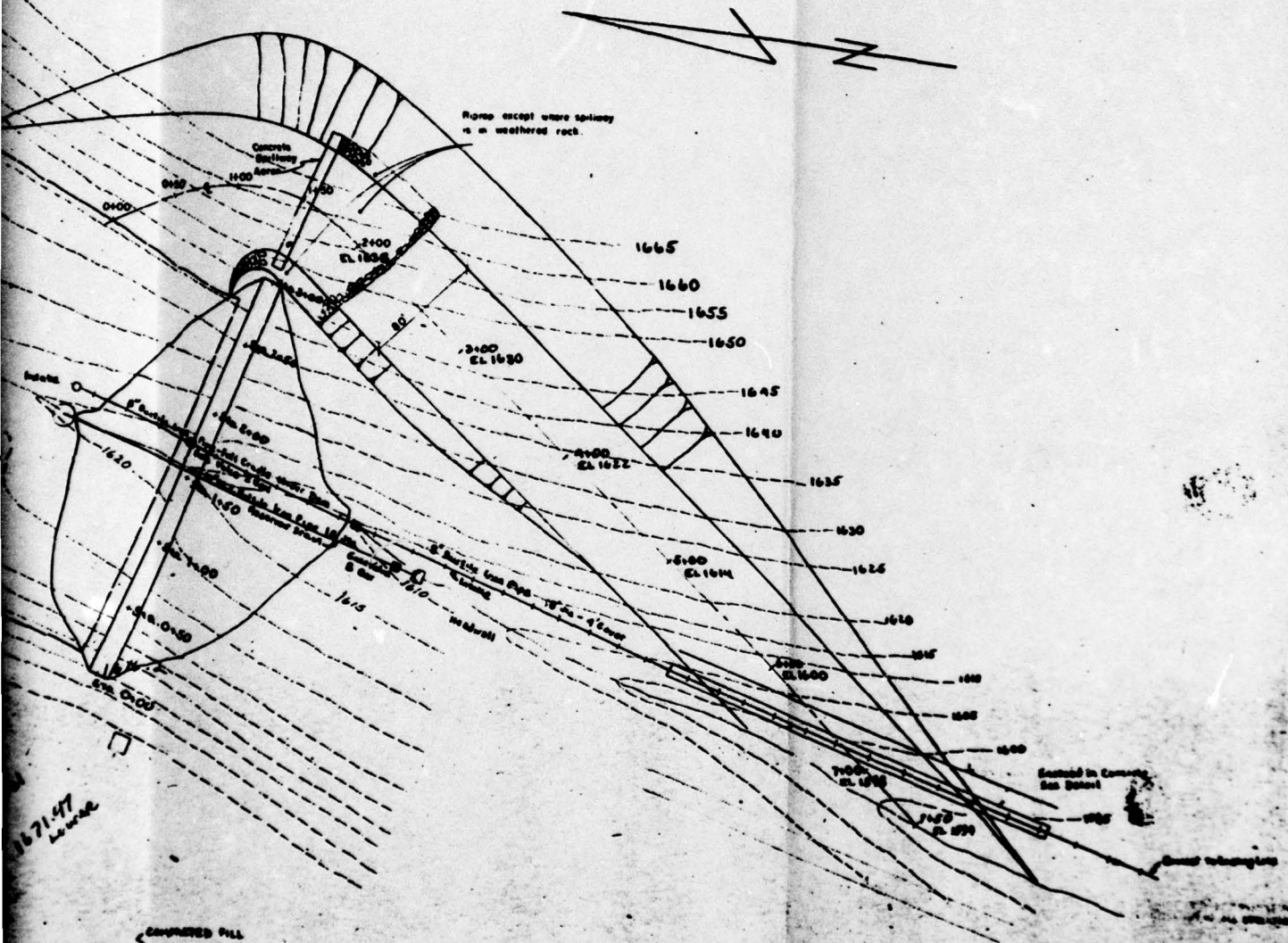
SCALE - HORIZ. 1" = 20'



SECTION THROUGH CONCRETE SPILLWAY



DETAIL - FULL CRADLE



DETAIL - FULL CRADLE

[illegible]

PIKE TOWNSHIP MUNICIPAL AUTHORITY
CURWENSVILLE, PENNA.
STORAGE RESERVOIR
SITE PLAN

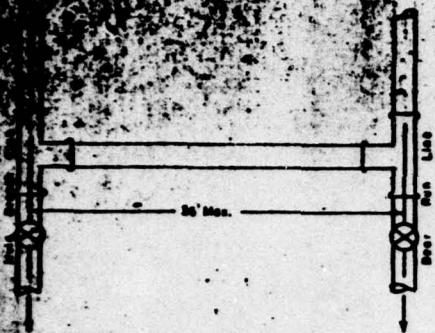
SCALE: 1" = 60'

LEE-SIMPSON ASSOCIATES, INC.
ENGINEERS
CHICAGO, ILL.

DATE: 209 1972

FILE NO: CW-17

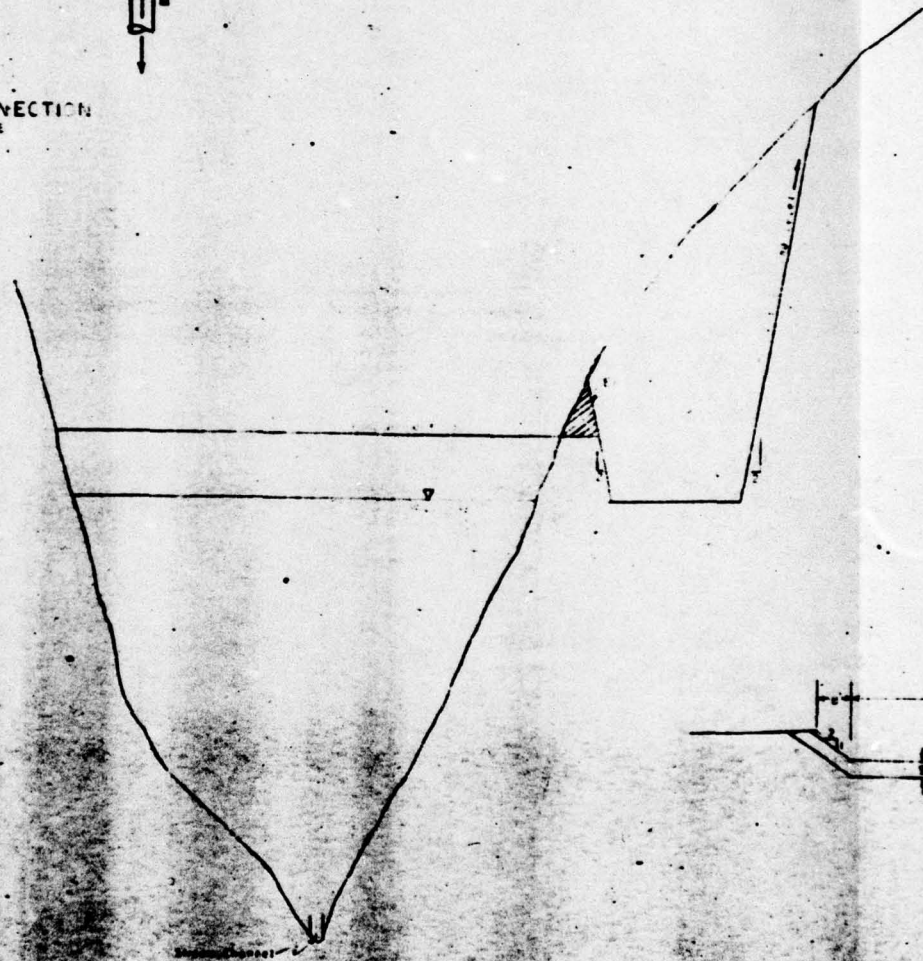
FIGURE 3



Connection Point to be determined by Auth.
 Put existing lines and install lines and gate valves.

MAIN LINE CONNECTION
 NOT TO SCALE

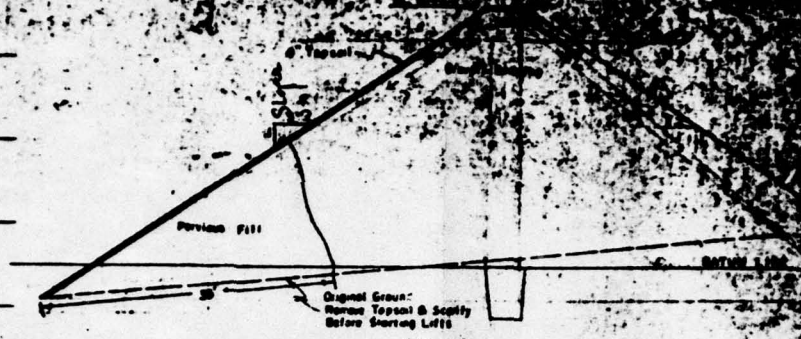
1655
 1650
 1645
 1640
 1635
 1630
 1625
 1620
 1615
 1610



MAIN LINE PROFILE

SPILLWAY

1640
1630
1620
1610



TYPICAL CROSS SECTION

SCALE HORIZ 1" = 20'
VERT 1" = 10'

NOTES

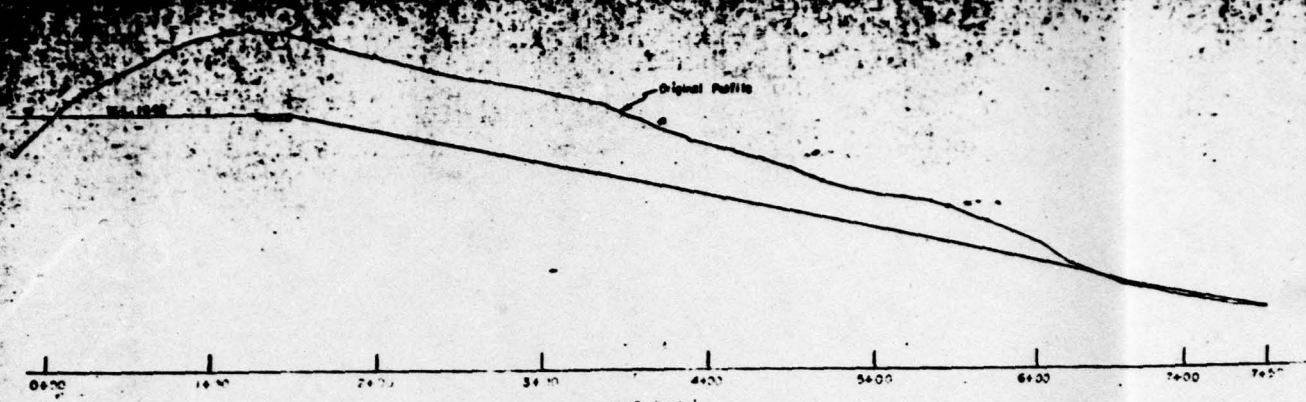
1. Pervious Material shall conform to the following requirements:
50% Type A Fine Aggregate
25% Type 20 Aggregate
25% Type 3A Course Aggregate
2. Riprap shall conform to the following requirements:
20% Between 0.75" & 3.0"
Average Wt 1200# to 2000#
25% Between 3.0" & 6.00"
3. Pervious Fill shall conform to the following requirements:
Not More Than 80% Passing A No. 8 Sieve
Not More Than 60% Passing A No. 16 Sieve
Not More Than 37% Passing A No. 40 Sieve
Not More Than 15% Passing A No. 60 Sieve
Not More Than 5% Passing A No. 100 Sieve

SPILLWAY APRON

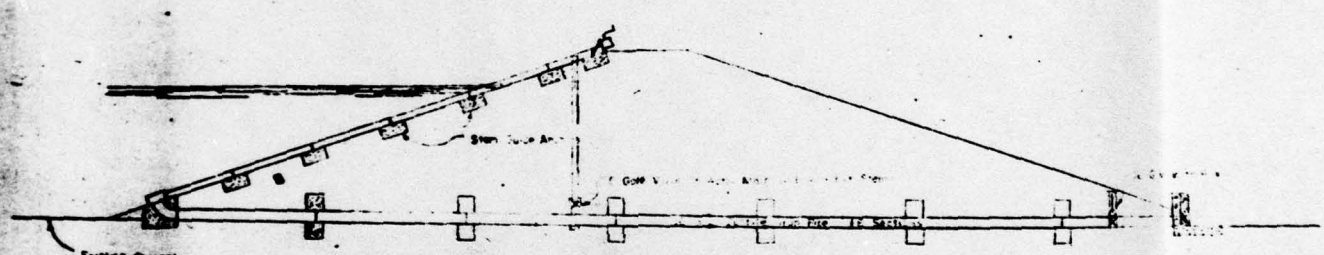
SCALE 1" = 30'

REVISIONS		
NO.	DATE	BY

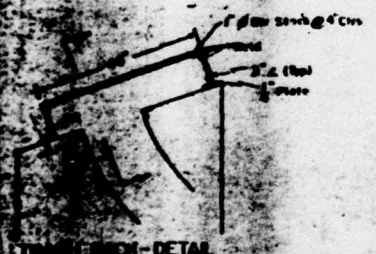
PIKE TOWN
CURWENVILLE
STORAGE
PROJECT



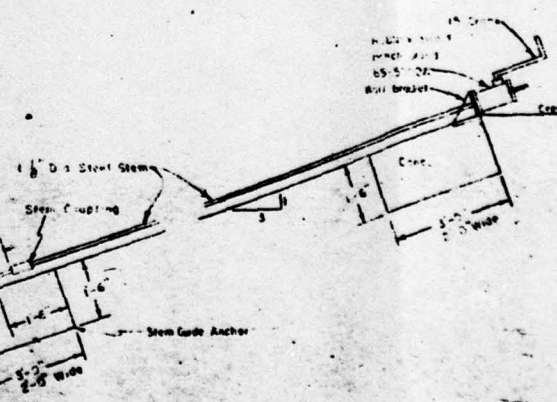
SPILLWAY PROFILE



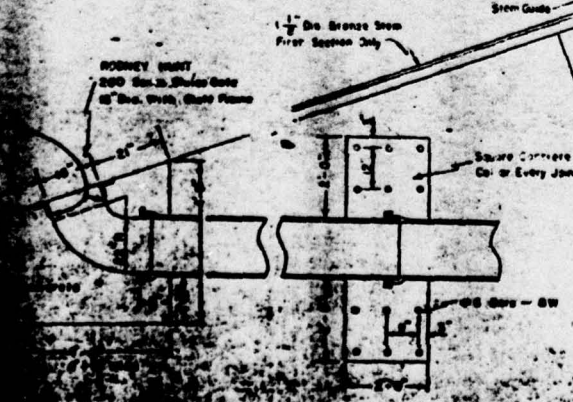
CROSS SECTION OF DRAWDOWN RATE PIPE



SECTION



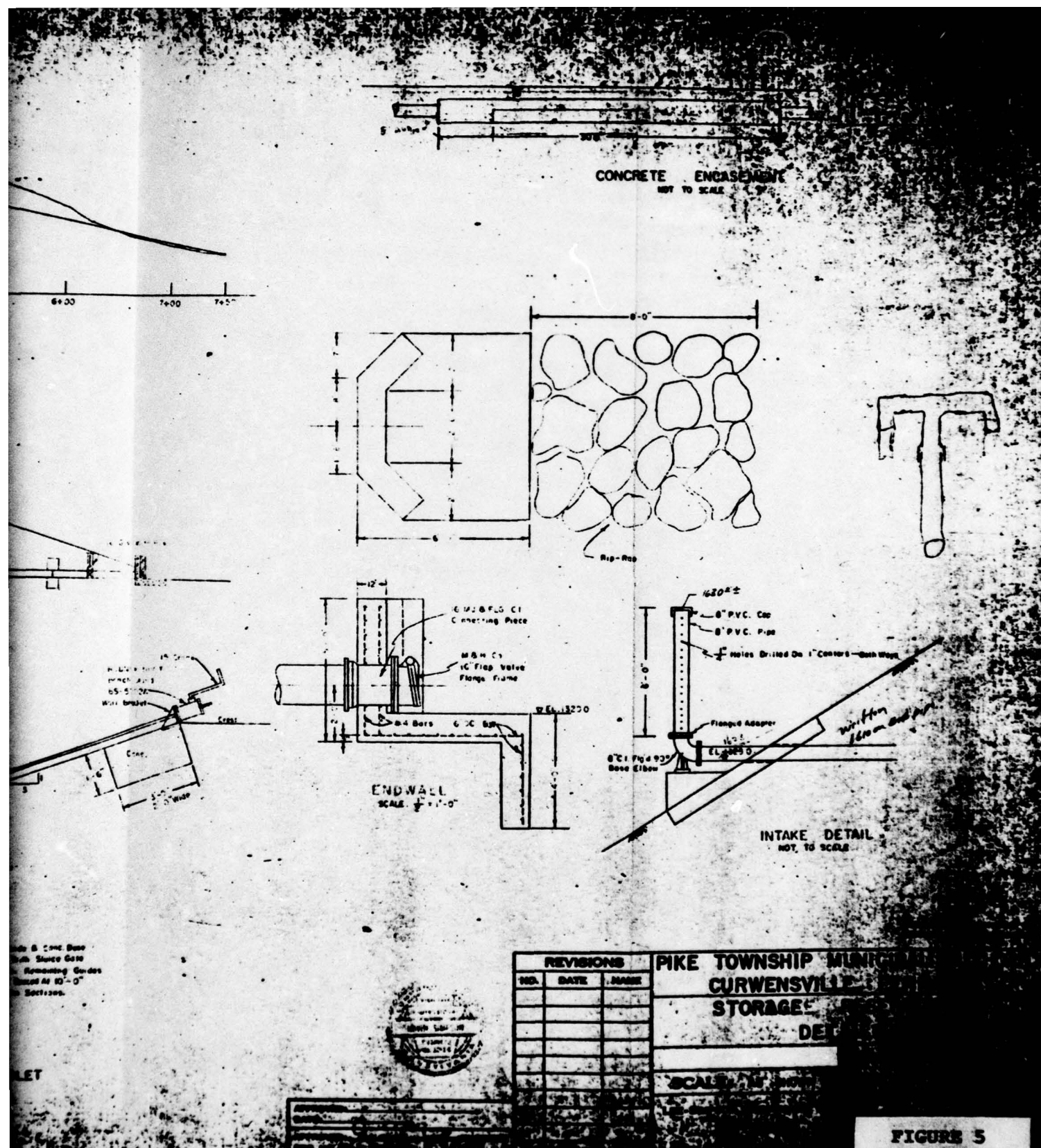
STEM GATE - DETAIL

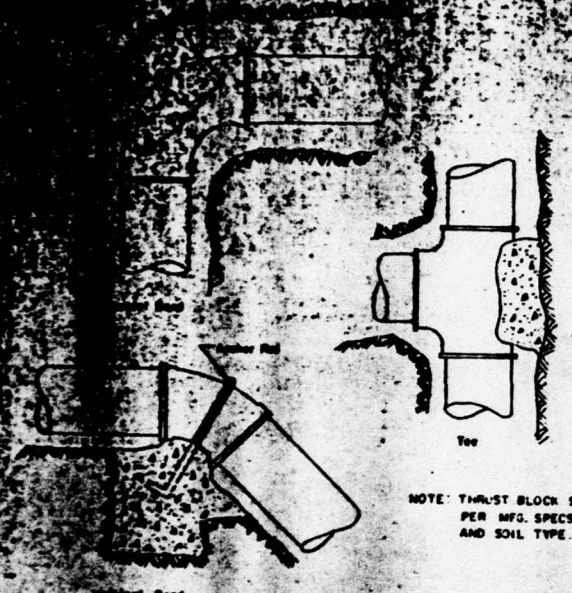


NOTE:
1. Location of First Stem Guide & Conc Base To Be Determined in Field With Sluice Gate Placed in Closed Position. Remaining Guides And Conc Bases Will Be Spaced At 10'-0" To Accommodate 10'-0" Stem Sections.

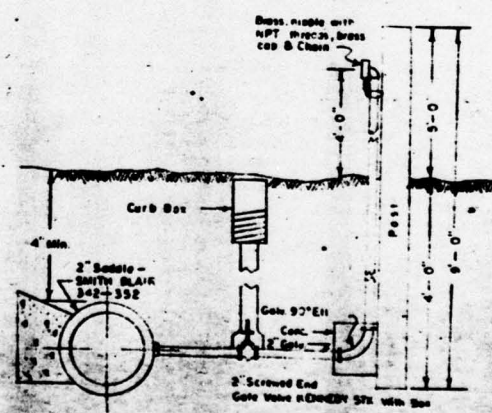
DETAIL - DRAIN INLET

SCALE 1" = 1'-0"

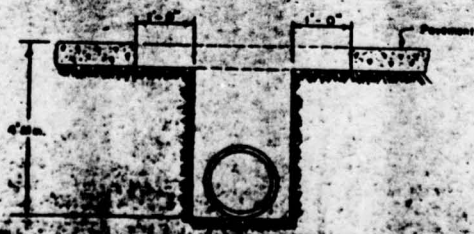




THRUST BLOCKS



BLOW OFF DETAIL
NOT TO SCALE



PAVEMENT REPLACEMENT
PIPE BEDDING DETAIL

[illegible]

APPENDIX G

REGIONAL VICINITY AND WATERSHED BOUNDARY MAPS

