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NATIONAL DAM SAFETY PROGRAM. AQUIA DAM. INVENTORY NUMBER: VA-17--ETC(U)
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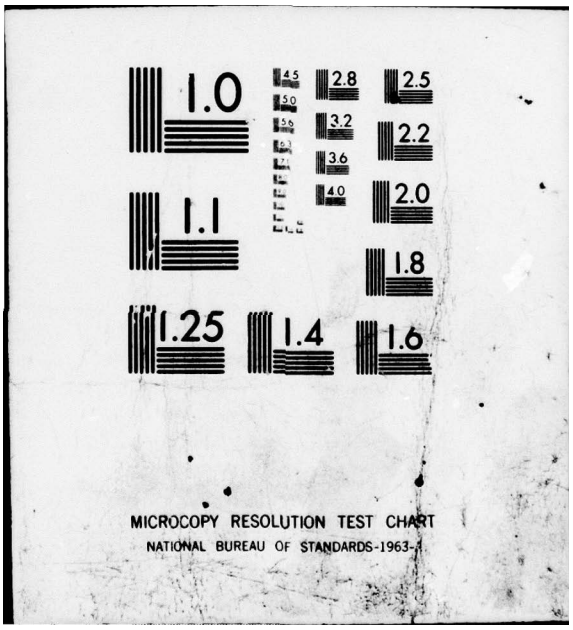
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Name Of Dam: AQUIA DAM
Location: STAFFORD COUNTY
Inventory Number: VA. 17911

LEVEL II

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Aquia Dam. Inventory Number: VA-17911.
Potomac River Basin. Stafford County, Virginia.
Phase I Inspection Report.

Final rept.,

Paul /Seiler

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PREPARED FOR

NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

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WILLIAMSBURG, VIRGINIA

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by 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 conditions 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.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

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Dam Safety
Dam Inspection

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

AQUIA DAM - LAKE SMITH IMPOUNDMENT
STAFFORD COUNTY, VIRGINIA
INVENTORY NO. VA 17911

POTOMAC RIVER BASIN

Name of Dam: Aquia Dam - Lake Smith Impoundment
Location: Stafford County
Inventory Number: VA 17911

PHASE I INSPECTION REPORT

National Dam Safety Program

Prepared for

NORFOLK DISTRICT CORPS OF ENGINEERS
803 Front Street
Norfolk, Virginia 23150

By

Deward M. Martin & Associates, Inc.
January 1979

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 the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

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

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

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 (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the design flood should not be interpreted as necessarily posing a highly inadequate condition. The design flood provides a measure of relative spillway capacity and serves as an aide 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.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	:	Aquia Dam, Lake Smith Impoundment
State	:	Virginia
County	:	Stafford
Stream	:	Aquia Creek
Date of Inspection	:	December 4, 1978

Aquia Creek Dam, creating Smith Lake, owned by Aquia Sanitary District, Stafford County, is an earth embankment 1,600 feet long and 65 feet high located a half mile west of I-95 near Garrisonville, Virginia. The principal spillway is a weir riser with a 60-inch diameter outlet pipe. The concrete ogee emergency spillway, built in 1973, is 160 feet wide with 7-foot high walls. Visual inspection revealed toe drains rusted and silted with clay, erosion under the concrete emergency spillway, and rock debris in the downstream channel. The 1972 Tropical Storm Agnes passed through Aquia Creek causing loss of earth at the left end of the dam including the emergency spillway.

Sufficient geological data are not available to evaluate the stability of the embankment. The emergency spillway will pass 51.2 percent of PMF and is rated seriously inadequate. Overtopping of the emergency spillway will begin at 19 percent of the PMF and will cause failure of the adjacent embankment.

The owner should, at his expense, have soil samples taken of the embankment and analysed to determine the stability of the embankment, establish the design, provide for protection of the embankment adjacent to the emergency spillway, repair toe drains to operate as intended, and provide a warning system to alert downstream residents in case of emergencies. The owner should provide a schedule for the above items within a period of three (3) months after date of the release of this report, and have the work completed within twelve (12) months thereafter.

Submitted By:

Original signed by
JAMES A. WALSH

JAMES A. WALSH, P.E.
Chief, Design Branch

Prepared By:

Paul Seiler P.E.

PAUL SEILER, P.E.
Deward M. Martin & Associates, Inc.

Recommended By:

Original signed by
ZANE M. GOODWIN

ZANE M. GOODWIN, P.E.
Chief, Engineering Division

Approved By:
Original signed by:
Douglas L. Haller

MAR - 3 1979

DOUGLAS L. HALLER
Colonel, Corps of Engineers
District Engineer

Top of Dam
(Looking North)

Downstream Face of Dam

AQUIA CREEK DAM
(SMITH LAKE)

TABLE OF CONTENTS

AQUIA CREEK DAM
(SMITH LAKE)

SECTION 1. PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 Aug 72 authorized the Secretary of the Army, through the Corps of Engineers to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Appendix VI, Reference 1). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Project Description:

1.2.1 Dam and Appurtenances: Aquia Creek Dam, impounding Smith Lake, is an earth embankment approximately 1600 feet long and 65 feet high from the top of dam at elevation 90 to the outlet invert at the toe at elevation 25.2. The top of the dam is 20 feet wide. Side slopes of the dam are both 3:1. Located at the left abutment, there is a concrete emergency spillway 160 feet wide with side walls 7 feet high. The inverts of the emergency spillway are elevation 76.5 at the upper end and elevation 31.5 at the lower end. There are 8-inch diameter corrigated metal drain pipes at the toe of dam which are silted shut.

The normal flow through the principal spillway is through a concrete weir riser intake structure located approximately 100 feet behind the dam. This structure contains the lake drain valve operated manually. The normal overflow leaves this structure through a 60-inch diameter pipe outletting at the toe of the slope toward the left end of the dam.

The downstream outlet channel is Aquia Creek, a stream about 50 feet wide with a high bank to the north side and a bank approximately 4 feet high to the south. This bank has additional height due to the location of an embankment dam structure for the sewage lagoon. These sludge ponds are to be removed in the near future. About 1,500 feet downstream from the dam is Interstate Route 95 which spans the stream. The community of Aquia, Virginia, is approximately 3,000 feet downstream from the dam where the stream has a sharp turn just before it touches the community.

1.2.2 Location: Aquia Creek Dam is located west of I-95 and north of the Garrisonville exit on Route 610. Follow Route 610 for 0.8 miles to Route 659 immediately west and adjacent to Moncure School. Turn to the right onto Route 659. This leads to the entrance to Lake Smith at the Water Treatment Plant, a distance of approximately 1.3 miles.

1.2.3 Size Classification: This dam is classified in the intermediate category by height (65 feet) and storage capacity (5,598 Acre feet).

1.2.4 Hazard Classification: This dam is located 1/3 mile upstream from I-95 structures over Aquia Creek and 0.6 miles upstream from Aquia, Virginia, a community in excess of 70 homes. The classification of this dam is in the high hazard classification in accordance with Section 2.1.2 of the Recommended Guidelines for Safety Inspection of Dams, published by the Department of the Army, Office of the Chief of Engineers. The hazard classification used to categorize the dams is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: Aquia Sanitary District, Stafford County, Virginia.

1.2.6 Purpose of Dam: The dam creates Lake Smith, the source of water for the Water Treatment Plant of the Aquia Sanitary District, Stafford County, Virginia.

1.2.7 Design and Construction History: The Aquia Dam was designed by Martin, Clifford & Associates, Stafford, Virginia, now known as Gilbert W. Clifford & Associates, Consultants from Fredericksburg, Virginia. Plans are on file with the County, however, no calculations are available. The dam was constructed about 1969 and a concrete spillway was added as a repair measure, after Tropical Storm Agnes, in about 1973.

1.2.8 Normal Operating Procedure: The County employees maintain a surveillance of the dam in the course of their duties of operation of the water treatment plant. There is no record of observations available. The drain valve for the lake has not been opened for about 8 years and was not operated by the owner during the inspection due to the concern that it might not close completely.

1.3 Pertinent Data:

1.3.1 Drainage Area: The dam controls a drainage area of 55.29 square miles.

1.3.2 Discharge of Dam Site: Maximum known flood at the dam was at the time of the Tropical Storm Agnes in 1972.

1.3.3 Emergency Spillway: Pool level at the top of the spillway is 76.5 MSL. The discharge with water at the top of the dam is 26,600 cfs.

1.3.4 Dam and Reservoir Data:

Data Pertinent to the dam and reservoir are shown in the following table:

Table 1.1 DAM AND RESERVOIR DATA

ITEM	RESERVOIR				
			Capacity		
	Elevation Ft., msl	Area Acres	Acre Feet	Watershed Inches	Length Miles
Top of Dam	90	241	5598	1.90	3.8
Emergency Spillway	76.5	172	3938	1.34	2.7
Principal Spillway Crest	70	141	2938	1.00	2.3
Stream bed elevation downstream	25±				

SECTION 2. ENGINEERING DATA

2.1 Design: The owner furnished plans of the concrete spillway and the plans for the original dam. There are no design calculations, specifications or boring logs available.

*2.1.1 Geologic Setting of the Dam Site: The dam is located near the "Fall Line" between the Coastal Plain and Piedmont Physiographic Provinces. The upper soil strata in the area generally consists of arkosic sands, gravels and clays of the Patuxent Formation. These Coastal Plain deposits are underlain by metamorphosed igneous intrusions of quartz.

2.2 Construction: The dam was constructed by Moore, Kelly and Reddish Contractors, no longer in business. There are no data available on the construction.

2.3 Operation: Stafford County does not have an employee assigned full time to operate the dam. The treatment plant pumps water for treatment from Smith Lake. Any other operations are handled as needed. The lake drain valve was not operated at the time of inspection and has not been operated for 8 years according to the representative of the Owner at the time of inspection.

2.4 Evaluation: Engineering design data was not obtained. Since a geotechnical investigation was either not performed or the results of one, if performed, are no longer available, there is a total lack of information concerning the foundation conditions and the materials comprising the dam. In addition, there are no construction records available. Therefore, additional data, as described in Section 7.2, should be obtained.

* Information provided by Law Engineering Associates of Virginia

SECTION 3. VISUAL INSPECTION

3.1 Findings: Observations during the visual inspection are outlined in Appendix IV.

*3.1.1 Dam and Abutments: Aquia Dam is underlain by phyllite with igneous intrusions of quartz. The phyllite strikes approximately parallel to the longitudinal axis of the dam with near vertical foliation. The phyllite is exposed on the left abutment (looking downstream), but was not observed at the right abutment. The slate is in a highly weathered state along the left abutment (above the pool elevation).

Several 8-inch diameter corrugated metal pipes were located at the base of the dam. The drains are located at the toe of the dam and extend horizontally into the dam embankment for an unknown distance. According to plans in Appendix IV, the drains extend to gravel-filled chimneys on the downstream face of the core. The metal drains were completely rusted through and were also filled with a silty clay. Attempts were made to unplug the pipes by probing the pipes with rods. At one location, the probing resulted in partial unplugging and a subsequent water flow estimated at three gallons/minute.

The seepage of clear water of approximately one-half gallon per minute was observed on the right abutment, approximately halfway up the embankment, however, it could not be ascertained whether this seepage resulted from the earlier rainstorms or from seepage from the pool.

There was no evidence of settlement of the crest of the dam or bulging of the downstream slope of the dam.

3.1.2 Inspection revealed the following items:

1. Toe drains were silted shut.

2. 60-inch diameter outflow pipe was partially submerged. Riprap at the outlet was not visible. Erosion was noted under the pipe cradle.

3. Erosion has occurred under the lower end on the concrete emergency spillway, which is opposite and downstream from the 60-inch diameter outflow pipe.

4. Rock debris in the downstream channel tends to obstruct normal flow.

5. Junction of the embankment and the spillway have approximately 4 cubic feet of erosion in the upstream side of the embankment.

3.2 Evaluation: The visual inspection revealed items which need remedial action as follows:

The toe drains do not function and therefore do not serve the intended purpose of the design. The silty clay material may come from the core. The drains must be opened and repaired. The source of the silty clay material must be determined.

The 60-inch diameter principal spillway outlet pipe is located in such a position that together with the lack of sufficient riprap, the discharge erodes under the emergency spillway structure. The outlet area needs protection against discharge erosion by an addition of riprap.

The earth erosion at the junction of the dam embankment and the upper end of the emergency spillway as well as other minor erosions need maintenance to avoid future problems.

The downstream channel rock debris blocks the normal flow from the principal spillway pipe. Clean channel to permit free flow of discharge.

*Information provided by Law Engineering Associates of Virginia

SECTION 4. OPERATIONAL PROCEDURES

4.1 Procedures and Maintenance: Regular operating procedures are limited to pumping water for treatment from the lake to the treatment plant and emptying trash cans. Any additional work is done as needed. The water treatment plant has records of volume of water treated each day. There are no records of other work done for operation or maintenance.

4.2 Warning System: There is no warning system established for this dam by the Owner.

4.3 Evaluation: The present use of the dam does not require daily maintenance and operational procedure. Logs of both maintenance and operations should be started by the Owner and carefully kept on a regular basis for the future. A warning system procedure should be established by the Owner.

HYDRAULICS/HYDROLOGY

5.1 Design: General hydraulic and hydrologic design data supplied for analysis is as follows:

a) Design Plans for repairs to the emergency spillway from Gilbert & Clifford Associates, Inc., no date, partial set.

b) Design Plans for "Aquia Sanitary District Water Works Project", dated March 1968, partial set.

5.2 Hydrologic Records: None available.

5.3 Flood Experience: No detailed flooding experience is available, however, eye witnesses were present during the Agnes Flood in 1972. At that time it was observed that the water level in the reservoir came to within approximately six (6) feet of the crest of the dam. The earthen emergency spillway was washed away and has been replaced by a concrete emergency spillway with a discharge rating of approximately 15,800 cfs.

5.4 Flood Potential: Assuming the pool elevation to be at the principal spillway crest, the PMF, ½ PMF and the 100 year Flood were developed and routed through the reservoir and outlet works which consist of the principal spillway and emergency spillway.

5.4.1 The PMF, Probable Maximum Flood, was developed from data in Hydrometeorological Report 33 (Reference No. 1).

The inflow hydrographs were constructed utilizing the unit hydrograph concept. The unit hydrograph was developed using a one-hour duration of excess precipitation and Synder's parameters (Reference No. 2). The HEC-I program then distributed excess precipitation in time and amount. The distribution thus derived was modified by revising the per cent hourly distribution within the maximum 6 hour precipitation to more closely conform to that used in TP 40 for the 100 year rainfall. Results of this analysis are presented in Table 5.1.

5.5 Reservoir Regulation: Aquia Dam has an uncontrolled 60-inch diameter pipe outlet with crest at elevation 70.0 msl which serves as the principal spillway. The emergency spillway is an uncontrolled concrete chute type located at the left abutment, with crest elevation at 76.44 msl, and is 160 feet wide. Side walls extend upward for 7 feet, then earthen slopes extend to the top of the dam, elevation 90.0 msl. There is a 36-inch square slide gate at elevation 26.0 msl to empty the reservoir.

5.5.1 Reservoir storage capacity above the principal spillway was calculated using contours from USGS maps, planimetering areas and converting to volume. Spillway capacity was computed by combining orifice flow through the principal spillway with weir flows through the emergency spillway.

5.6 Overtopping Potential: The PMF, ½ PMF and 100 year flood inflow hydrographs were routed through the reservoir using the modified Puls method option of the HEC-I computer program with storage-outflow. Results of this routing are shown in Table 5.1.

5.6.1 A tailwater rating curve was not available for this dam. The tailwater elevation observed during field observation was approximately 25.0 msl with an assumed flow of 200 cfs. The 200 cfs was used as the starting base flow when routing the storms through the system.

5.7 Reservoir Emptying Potential: To empty the dam, there is a 36-inch x 36-inch slide gage with an invert elevation, 26 msl, and a discharge of 283 cfs at normal water surface elevation, 70 msl.

5.7.1 The above information was inputted to the HEC-I program, with 55 cfs inflow and a developed storage vs. outflow curve. Under these conditions, the dam can be emptied in ten (10) days.

5.8 Evaluation: Summarizing Table 5.1, the following data resulted from this study:

a) Based on the high hazard, intermediate category of this dam, the outlet works should be capable of passing the PMF which is 51,637 cfs maximum inflow with the maximum outflow of 51,637 cfs. With the reservoir pool at the top of the dam, the outflow capacity is 26,600 cfs or 51.2 percent of the PMF.

b) All hydrologic considerations presented in this report are based on present conditions and no allowances have been made for future development.

TABLE 5.1 - RESERVOIR PERFORMANCE

	Normal Flow	100 Yr. Storm	Hydrograph 1/2 PMF	Hydrograph PMF
Peak Flow, cfs				
Inflow	200	14,263	25,818	51,637
Outflow	200	13,688	25,165	51,637
Maximum Elevation, ft., msl	70	85	89.5	92.6
Emergency Spillway (El. 76.44)				
Depth of flow, ft.	Less than 1	8.56	13.06	16.16
Duration, hours		46	80	80
Velocity, f.p.s.		9.99	12.04	13.20
Percentage Peak outflow passed		100	100	51.5
Non-Overflow Section (El. 90.00)				
Depth of flow, ft.	--	--	--	2.6
Duration, hours	--	--	--	12.0
Velocity, f.p.s.	--	--	--	6.0
Tailwater Elevation, ft., msl	25	N.A.*	N.A.*	N.A.*

* Not Available

SECTION 6. STRUCTURAL STABILITY

*6.1 Dam Foundation and Structural Stability: Sufficient geotechnical information was not obtained to allow an adequate evaluation of the adequacy of the dam foundation or the stability of the dam. However, it was evident that the filter drains that are corroded and blocked by siltation are no longer serving their intended purpose. Since the drains are not functioning, the phreatic surface within the dam could rise and exit along the downstream slope of the dam. This rise in the phreatic surface will lower the stability of the dam.

6.2 Evaluation: Soil samples and tests of the samples should be taken of the embankment, the abutments and the emergency spillway to establish the design stability. Test wells should be established to keep records of the phreatic surface in the embankment.

* Information provided by Law Engineering Associates of Virginia

SECTION 7. ASSESSMENT AND REMEDIAL MEASUREMENTS/RECOMMENDATIONS

7.1 Dam Assessment:

7.1.1 There are no geotechnical data, design, calculations or construction records available.

7.1.2 The emergency spillway has a capacity of 26,593 cfs or 51.2 percent of PMF at a depth of flow of 16.16 feet. The depth of water in excess of 7 feet, the height of the side walls of the emergency spillway, will cause erosion of the embankment and has the potential of complete destruction of much of the left end of the embankment as well as the destruction of the sewage lagoons below the dam. The spillway capacity, with the depth of flow at the top of sidewalls is 19 percent of PMF or 10,000 cfs. The emergency spillway is seriously inadequate.

7.1.3 The toe drains are completely closed by siltation and do not function. This is a serious condition since water tends to accumulate in the embankment and raise the phreatic surface.

7.1.4 There is insufficient riprap in the area around the end of the principal spillway pipe and the velocity of the discharge water is sufficient to cause erosion under the emergency spillway structure. Riprap must be installed and the erosion repaired.

7.1.4 There are minor erosion problems which need attention but were not, at the time of inspection, considered emergencies.

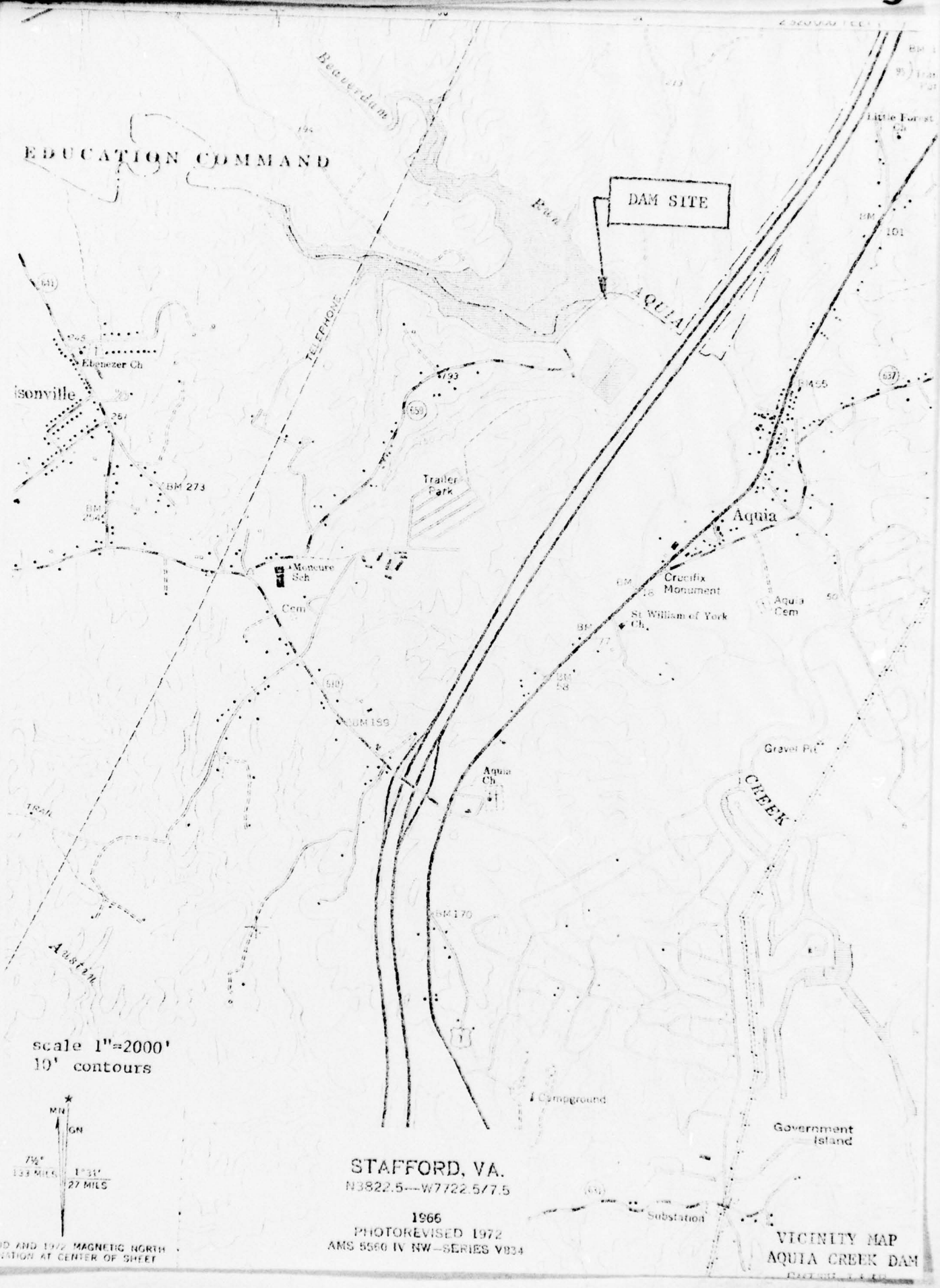
7.2 Remedial Measures/Recommendations: The spillway capacity must be increased to pass the PMF and geotechnical data obtained to establish the design and stability of the embankment. The riprap at the discharge pipe must be installed, erosion under the emergency spillway repaired, and rock debris in the downstream channel cleared.

It is recommended that the owner retain a professional engineer and establish a schedule of the work for the remedial measures, noted above, within three (3) months after the date of release of this report. The schedule should provide for completion of the work within a twelve (12) month period thereafter.

APPENDIX I

MAPS

REGIONAL MAP
AQUIA CREEK DAM
SOUTH FORK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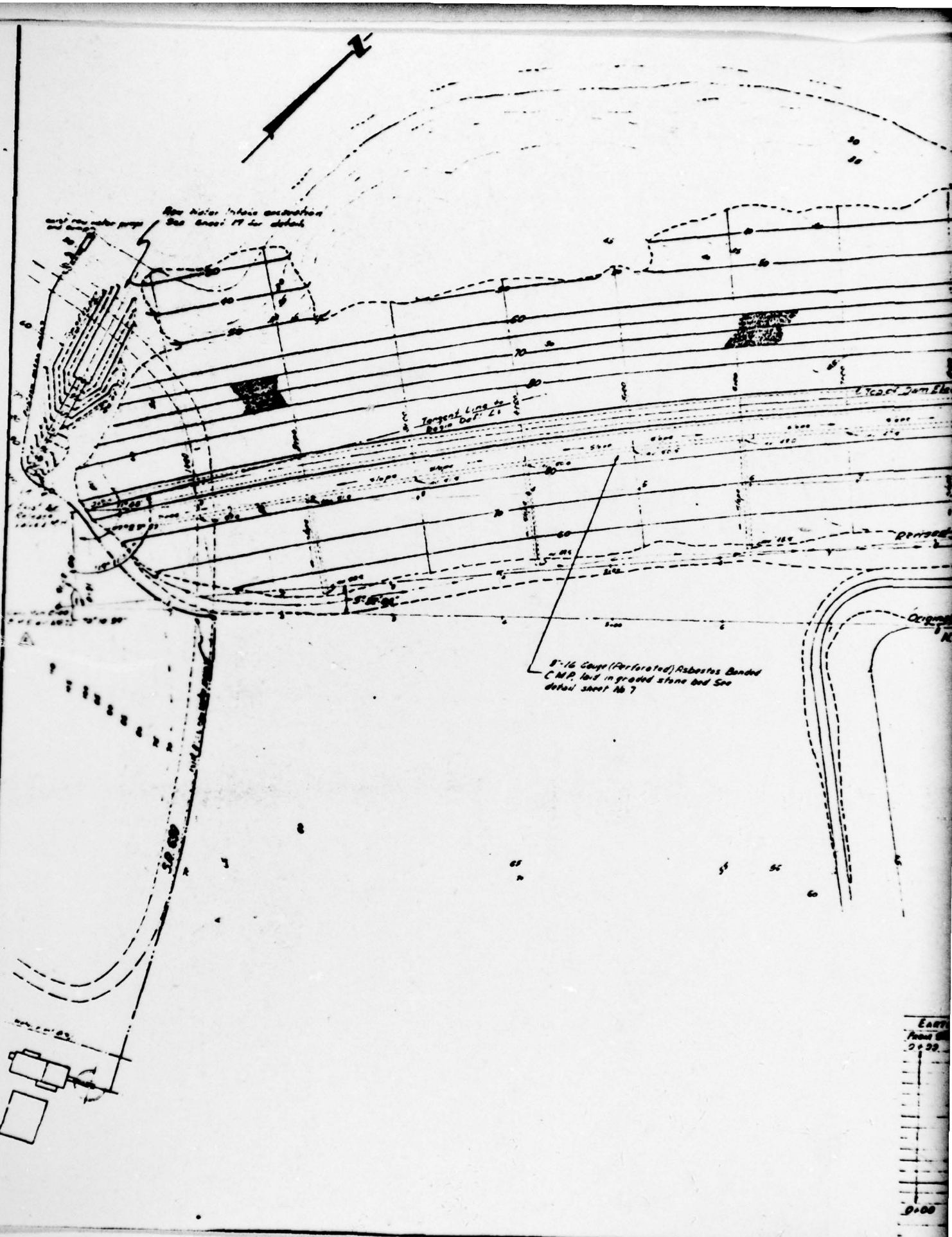
DAM SITE
Beaverdam
Run
AQUIA
TELEPHONE
Ebenezer Ch
Trailer Park
BM 273
Moncure Sch
Cem
Aquia
Crucifix Monument
St William of York Ch
Aquia Cem
Little Forest
BM 101
BM 58
Aquia Ch
Gravel Pit
CREEK
Campground
Government Island
Substation
Austin
TRAIL
scale 1"=2000'
10' contours
MN
GN
7½°
1°31'
STAFFORD, VA.
N3822.5—W7722.5/7.5
1966
PHOTOREVISED 1972
AMS 5560 IV NW—SERIES V834
VICINITY MAP
AQUIA CREEK DAM

APPENDIX II

PLANS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8'-16 Gauge (Perforated) Asbestos Bonded C.M.P. laid in grouted stone bed See detail sheet No 7

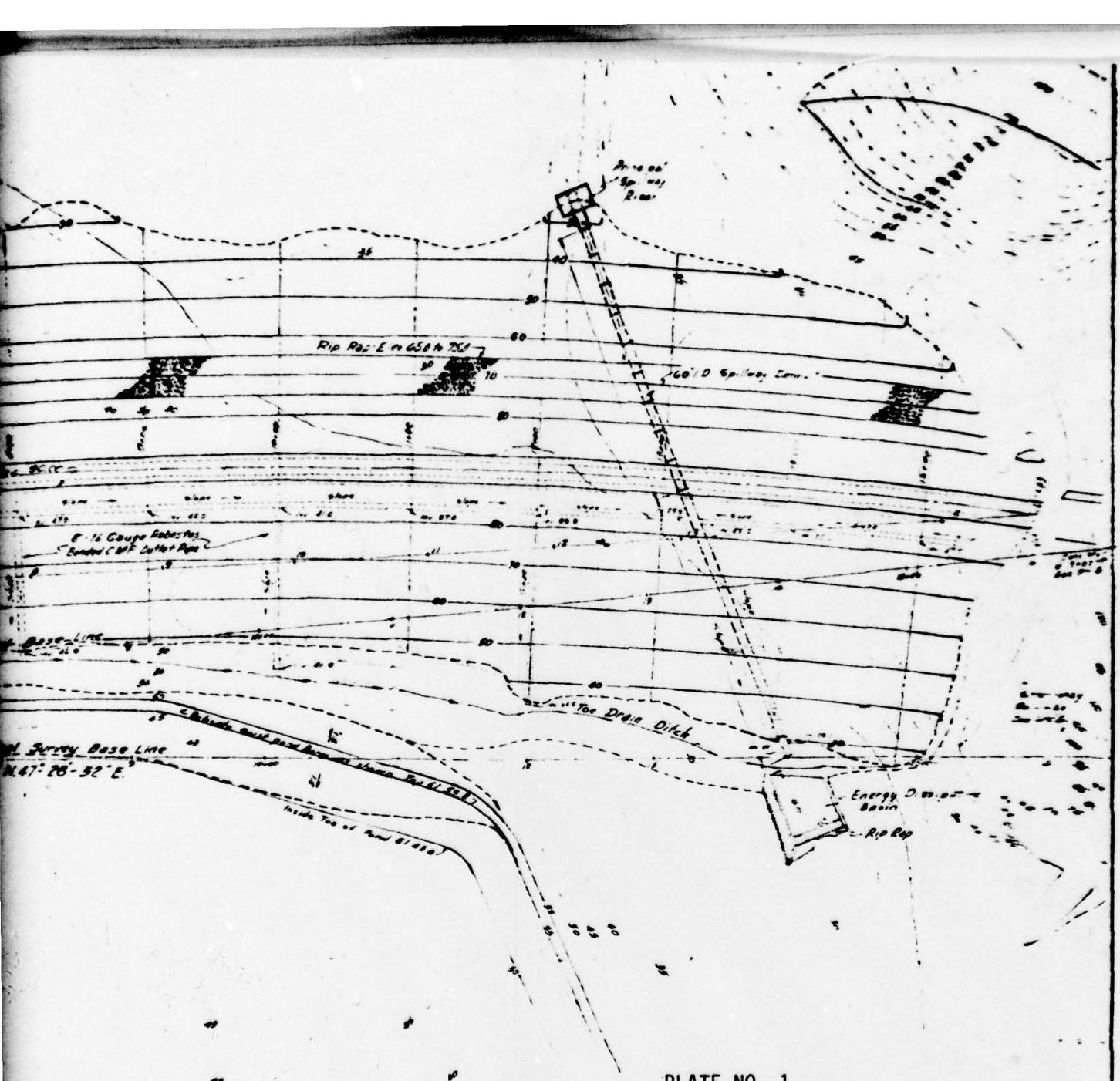


PLATE NO. 1
Reduced to Half Scale

Note: 4" of topsoil shall be placed on the Dam embankment, Emergency Spillway, the Berm at the downstream toe of the dam and all other cut and fill slopes not otherwise specified. The same areas shall be grassed as per the specifications.

Dam Centerline Data		
% Sta	Dist. L	
L+00	0+69	
2+00	1+90	
3+00	2+15	
4+00	3+00	
5+00	3+85	
6+00	4+90	
7+00	5+15	
8+00	6+00	
9+00	6+85	
10+00	7+90	
11+00	8+15	
12+00	9+00	
13+00	9+85	
14+00	10+90	
15+00	11+15	
15+79.99	11+40	

		Bench Mark Elevation	
		Description	By / Date
		Revisions	

JOHN CLIFFORD & ASSOCIATES

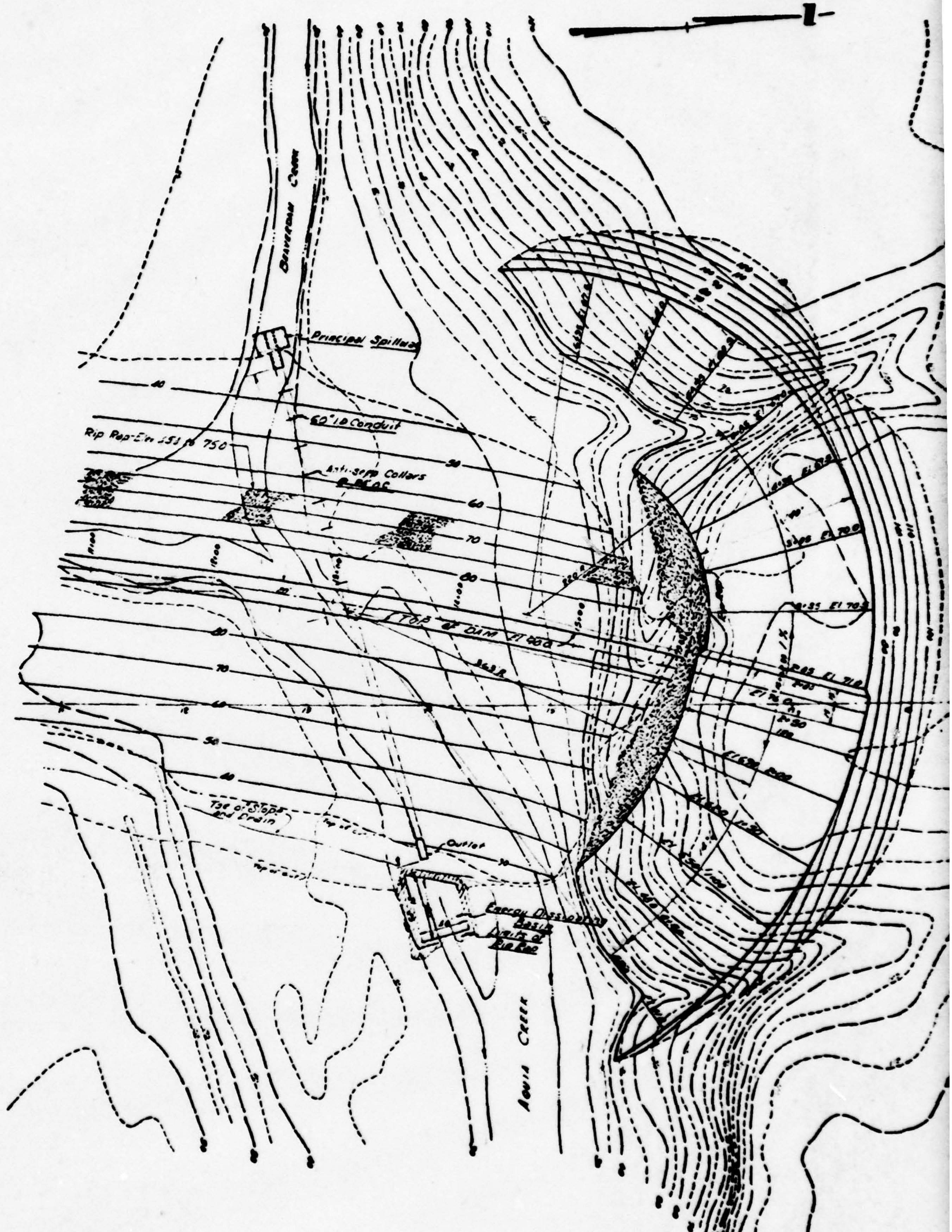
ACUIA SANITARY DISTRICT

WATER WORKS PROJECT

PLAN OF A 3 CREEK EARTH DAM & APPURTENANCES

STAFFORD COUNTY

Des. GDC	J. O. N. 6709-3-2
Drawn B.L.A.	Date MARCH 1968
Appr.	Scale 1" = 50'



Principal Spillway
60" I.D. Conduit
Anti-Seep Collars
Outlet
Toe of Slope and Drain
Energy Dissipating Basin
Limits of Rip Rap
Aquia Creek

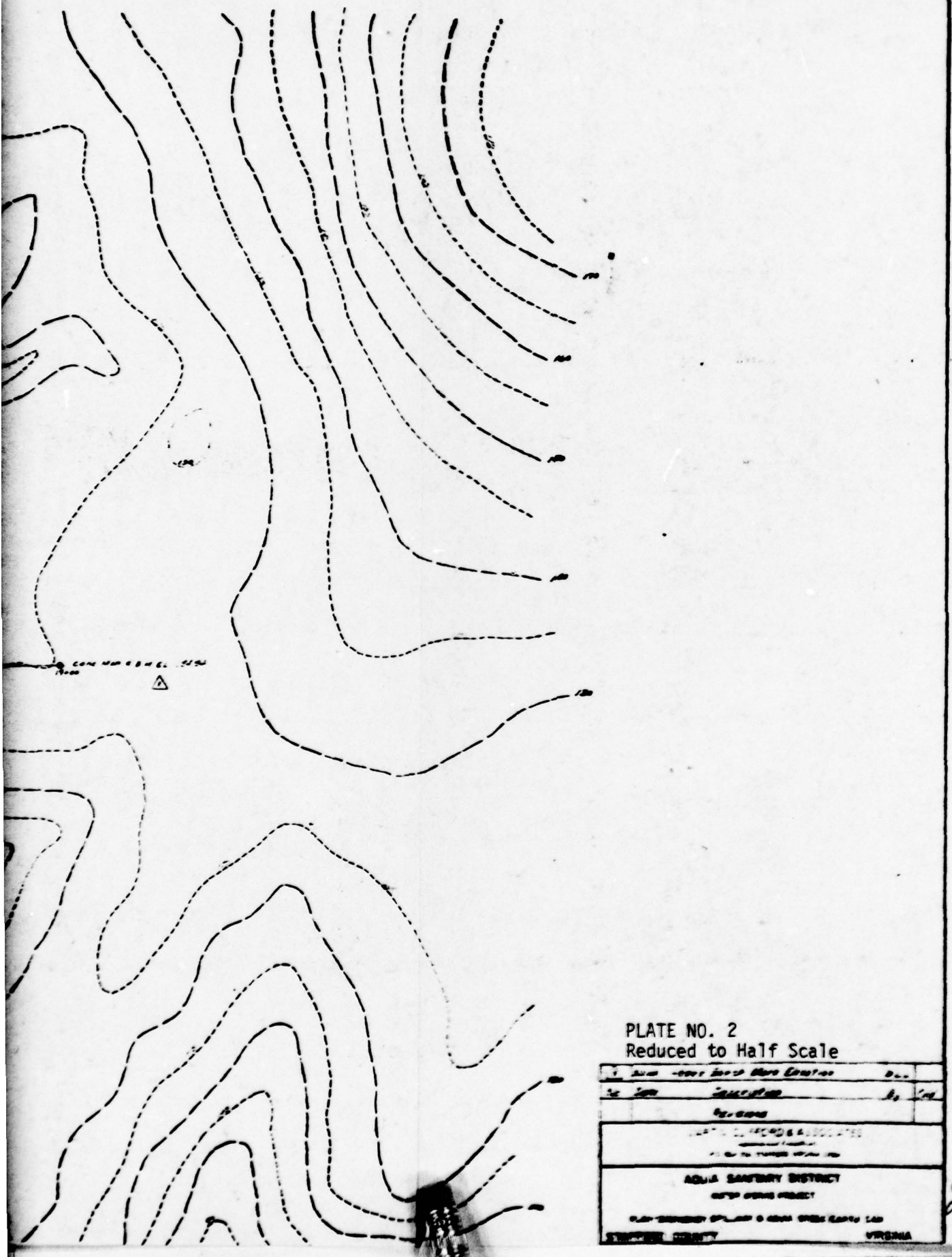
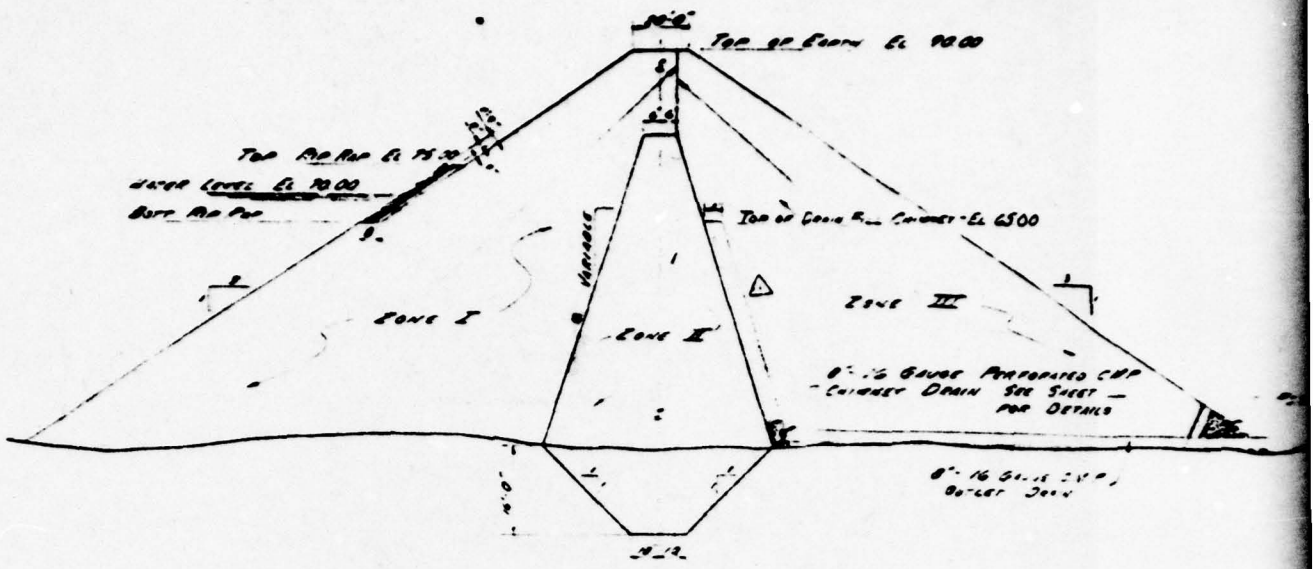


PLATE NO. 2
Reduced to Half Scale

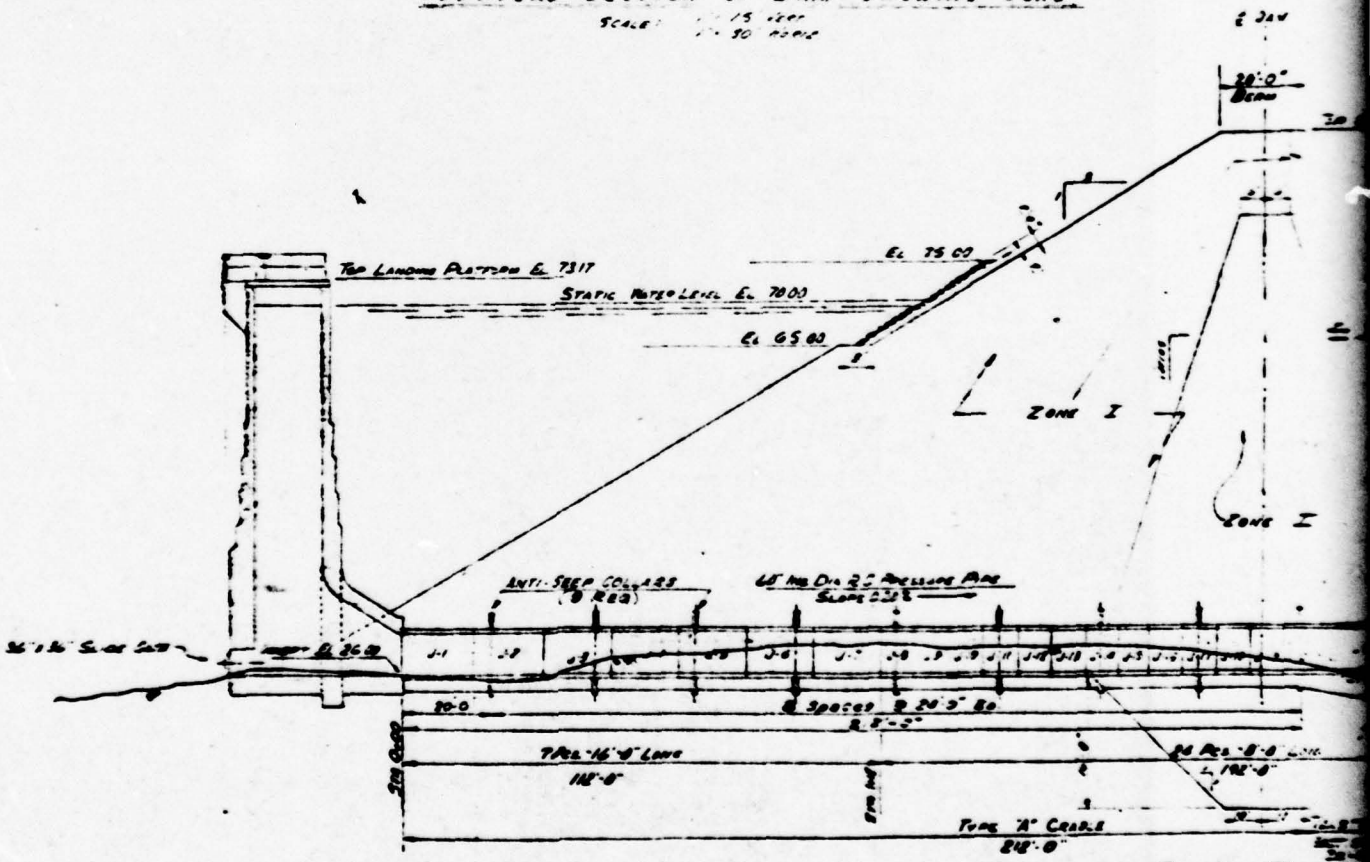
AQUIA SANITARY DISTRICT

VIRGINIA



TYPICAL SECTION OF DAM SHOWING CORE

SCALE: 1" = 150 FEET
1" = 30 FEET



SECTION THR.
AT
PRINCIPAL SP.

Gradation of Filter	
Sieve No.	% Passing
2"	100%
[illegible]"	100%-66%
[illegible]"	92%-54%
4	77%-42%
10	60%-26%
20	42%-12%
40	31%-6%
100	15%-0%
200	5%-0%

Note: 12" of cover will be provided around filter pipe. This material will be well graded between 2" and [illegible]". The pipe will be subsidiary to the Drain Fill

Pipe Joint Number	Station	Pipe Invert
Influent	0+00	26.00
J-1	0+16	25.97
J-2	0+32	25.94
J-3	0+48	25.90
J-4	0+64	25.87
J-5	0+80	25.84
J-6	0+96	25.81
J-7	1+12	25.78
J-8	1+20	25.76
J-9	1+28	25.74
J-10	1+36	25.73
J-11	1+44	25.71
J-12	1+52	25.70
J-13	1+60	25.68
J-14	1+68	25.66
J-15	1+76	25.65
J-16	1+84	25.63
J-17	1+92	25.62
J-18	2+00	25.60
J-19	2+08	25.58
J-20	2+16	25.57
J-21	2+24	25.55
J-22	2+32	25.54
J-23	2+40	25.52
J-24	2+48	25.50
J-25	2+56	25.49
J-26	2+64	25.47
J-27	2+72	25.46
J-28	2+80	25.44
J-29	2+88	25.42
J-30	2+96	25.41
J-31	3+04	25.39
J-32	3+20	25.36
J-33	3+36	25.33
J-34	3+52	25.30
J-35	3+68	25.26
J-36	3+84	25.23
J-37	4+00	25.20
J-38	4+16	25.17
J-39 (Discharge)	4+32	25.14

SECTION A-A

Scale:

COMPACTION REQUIREMENTS

Zone	Location of Borrow	Compaction
I	Borrow Area 9 & Emergency Spillway	95% of Standard Proctor ±2% of Optimum Moisture
II	Borrow Area A	Same as I
III	Borrow Area 8 & Emergency Spillway	To Be Determined by Test Fills

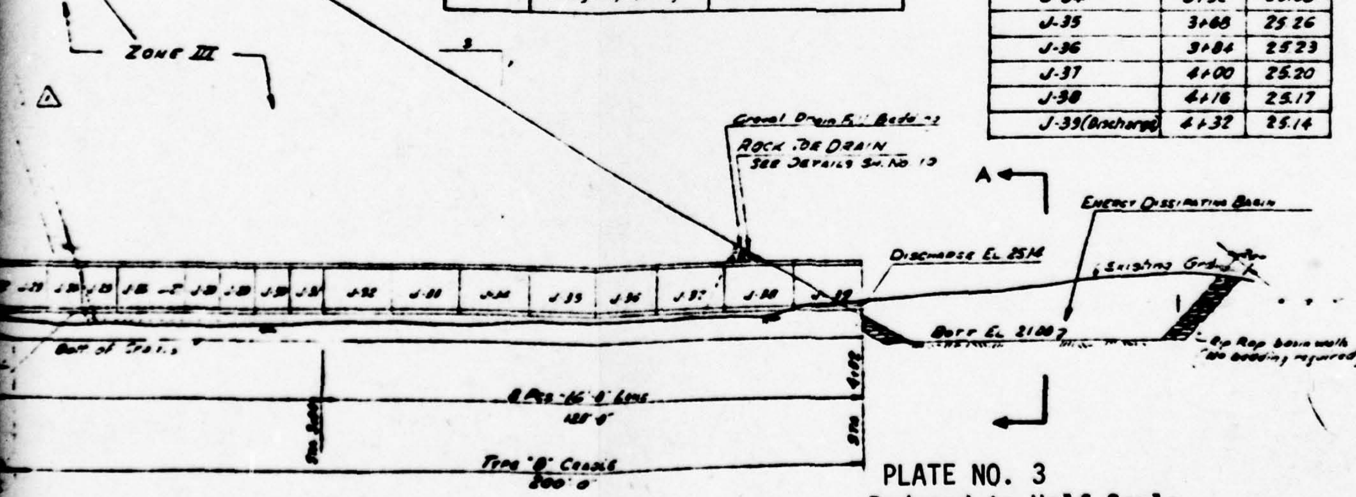


PLATE NO. 3
Reduced to Half Scale

No	Date	Description	By	Chk
3	[illegible]	Added Filter Gradation Tables	DLJ	
2	[illegible]	Added Compaction Requirements	DLJ	
1	[illegible]	Revised Chimney Drain	DLJ	
		Revisions		

MARTIN CLIFFORD & ASSOCIATES

Engineers and Consultants

P.O. BOX [illegible], STAFFORD, VIRGINIA [illegible]

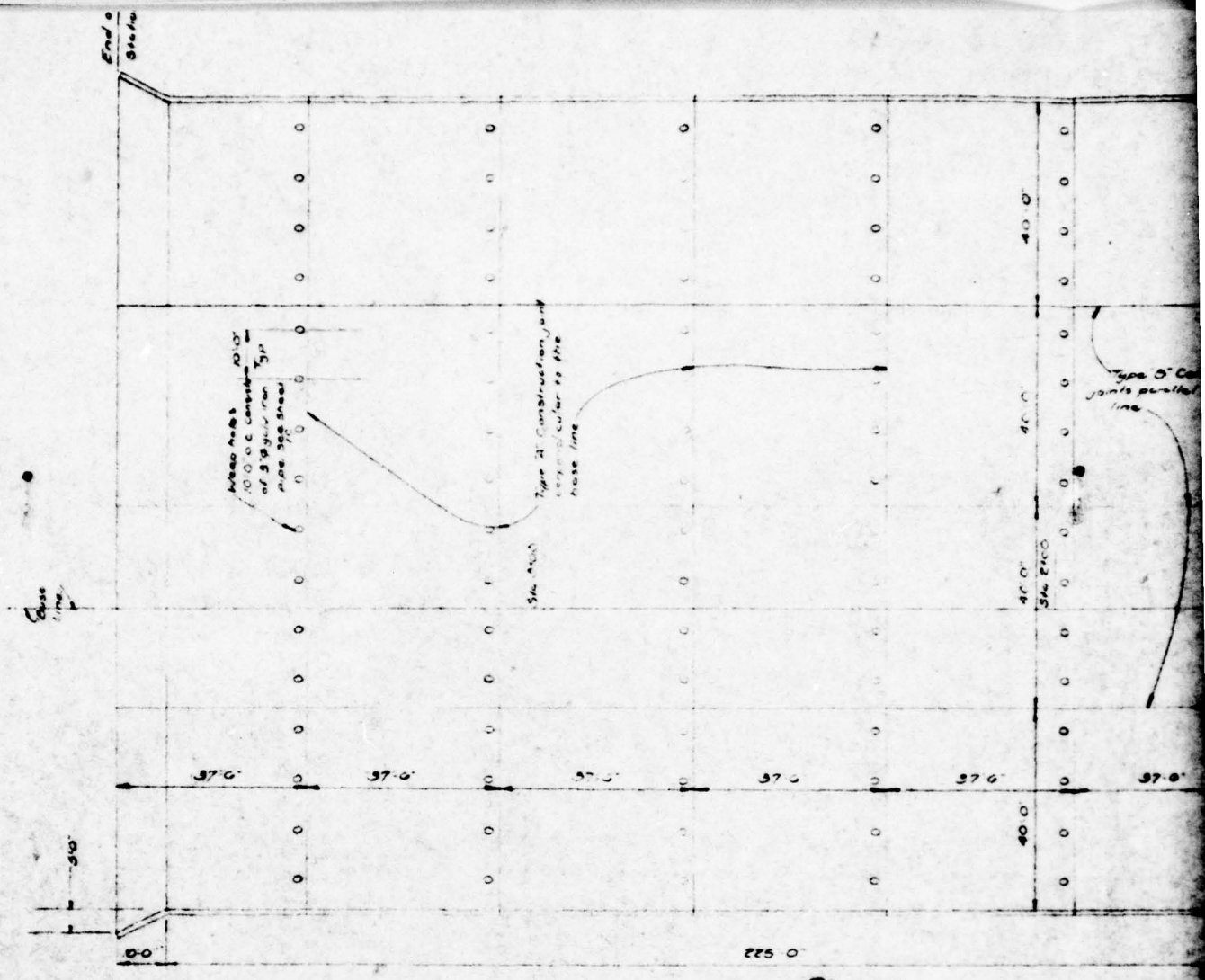
AQUIA SANITARY DISTRICT

WATER WORKS PROJECT

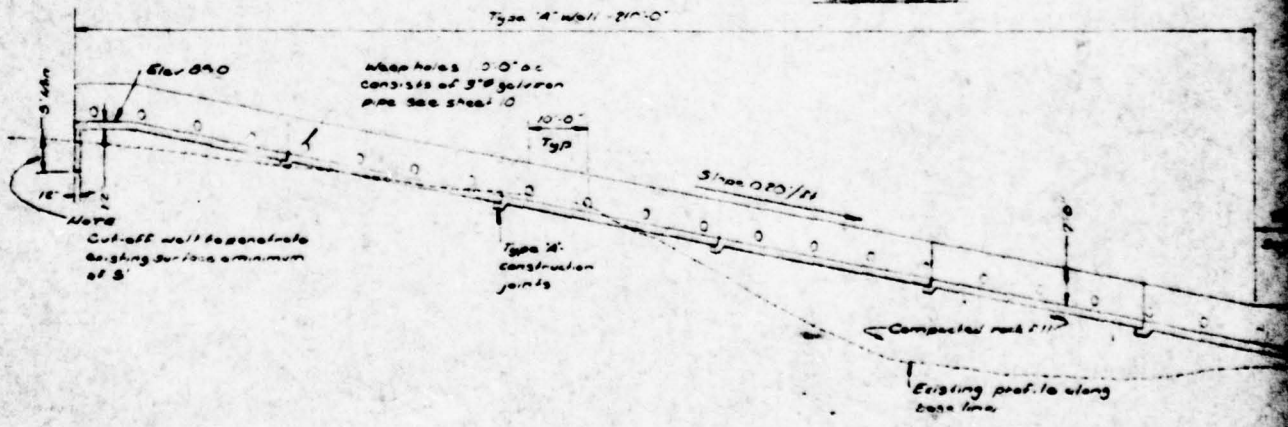
SECTION THRU DAM AT PRINCIPAL SPILLWAY

2

STAFFORD COUNTY VIRGINIA



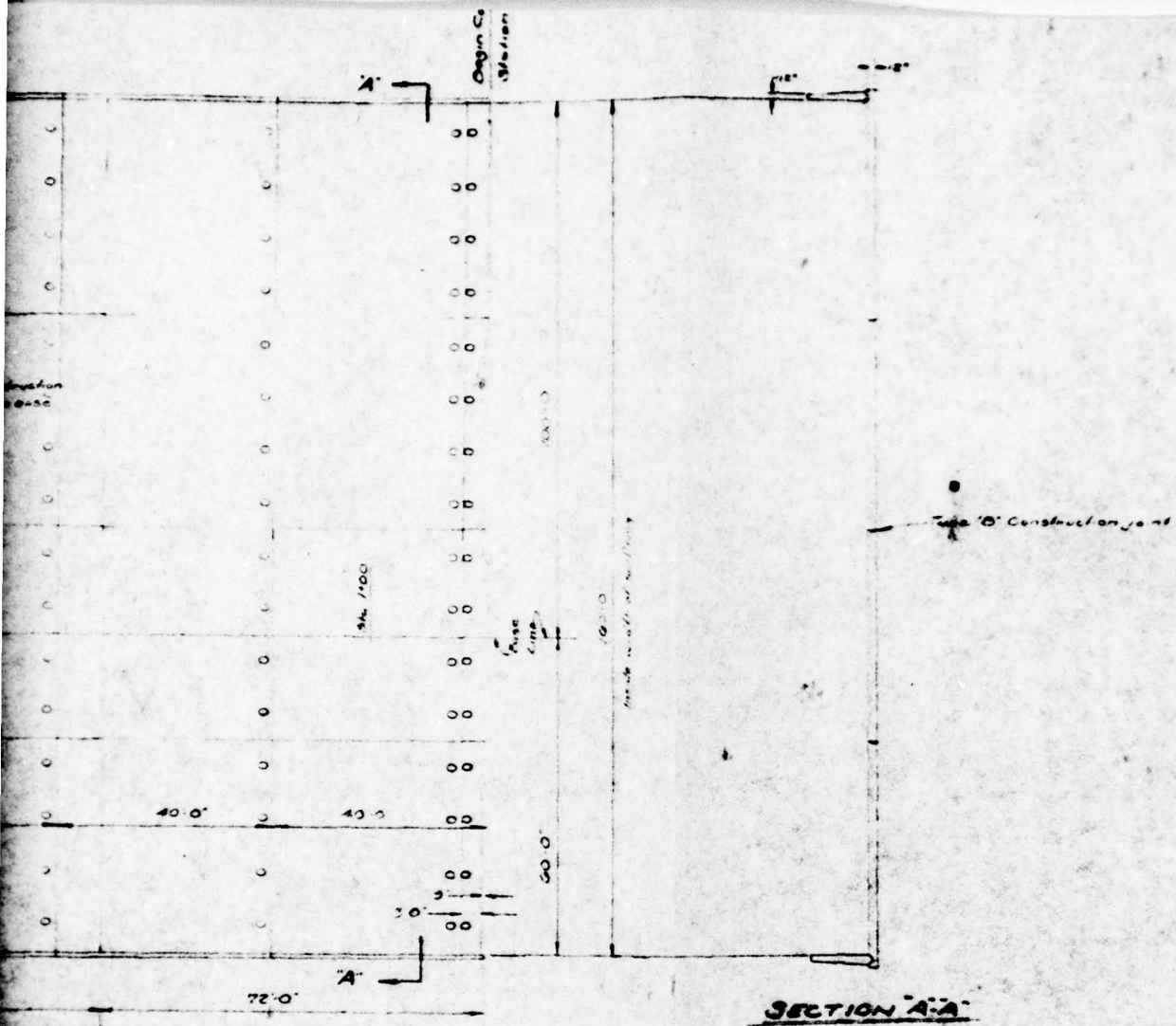
PLAN



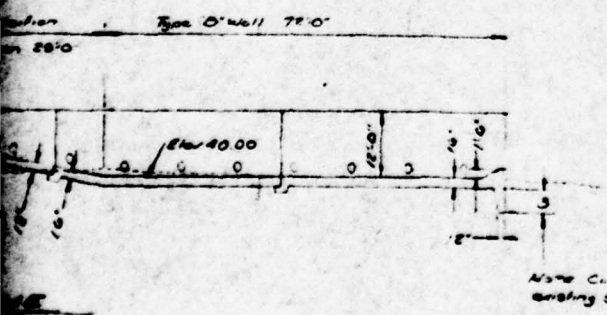
SECTION ALONG BASE

REVISIONS				
no.	date	description	by	chkd.

job number:	
date:	
designed by:	GWC
drawn by:	GWC & R
approved by:	



SECTION "A-A"



Note Cut-off wall is constructed existing surface a maximum of 3'

PLATE NO. 4
Reduced to Half Scale

Herbert W. Clifford & Associates, Inc.

REPAIRS TO AQUIA DAM

SPILLWAY LAYOUT

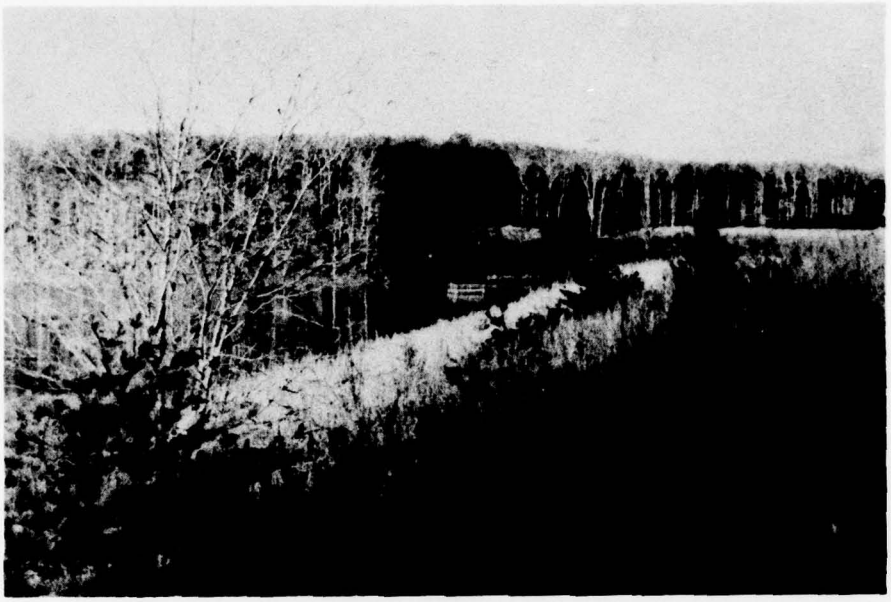
FOR
AQUIA SANITARY DISTRICT
STAFFORD COUNTY VIRGINIA

scale 1" = 10'-0"

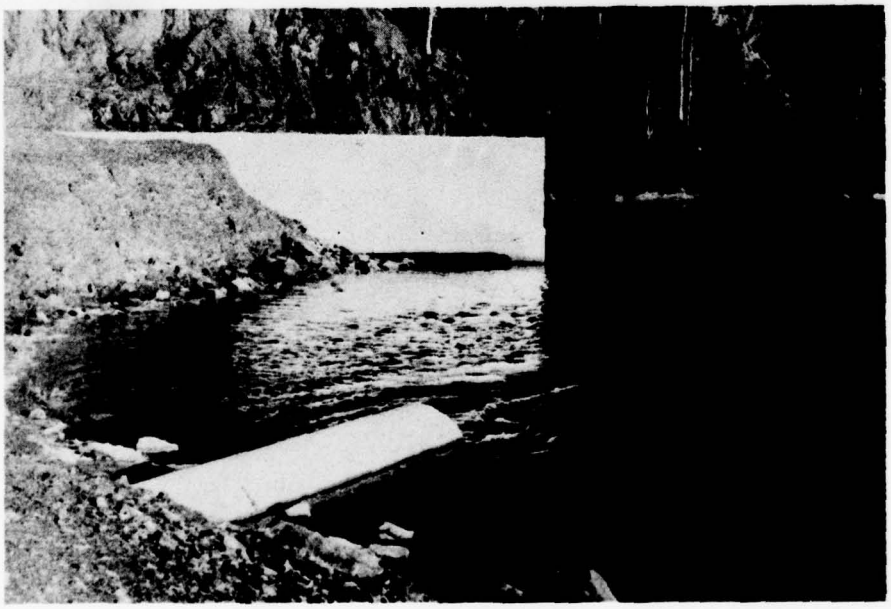
sheet 2 of 2

APPENDIX III

PHOTOGRAPHS

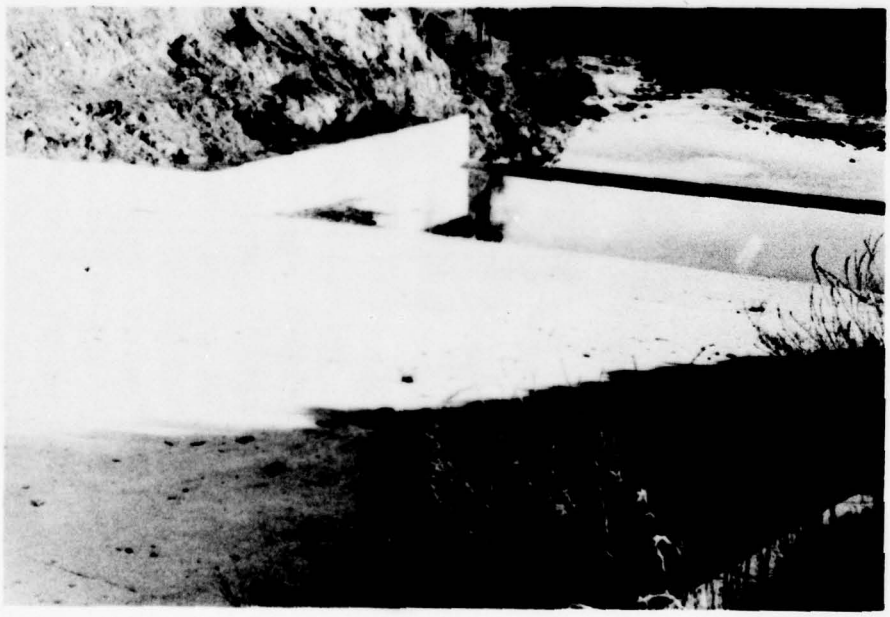


PHOTOGRAPH NO. 1
Upstream Face of Dam
Principal Spillway Intake Structure



PHOTOGRAPH NO. 2
Principal Spillway Outlet Pipe
& Erosion under Emergency Spillway

PHOTOGRAPH NO. 3
Lagoon Below Dam



PHOTOGRAPH NO. 4
Emergency Spillway
Downstream Channel

PHOTOGRAPH NO. 5
Surface Erosion

PHOTOGRAPH NO. 6
Silted Toe Drain

APPENDIX IV

FIELD OBSERVATIONS

Ref Inv. Dams Pg 790 Report 5/8/74 VA 17909 NAD 179-07
SMITH LAKE

Check List
Visual Inspection
Phase 1

STREAM: Aquia Creek, near Aquia, VA
H. CREST: 1600
DISCH: 8500
OWNER: Aquia Sanitary District, Stafford County

ENG. BY: M. C. & A.
CONSTRUCTED BY: Moore, Kelly & Reddish
QUAD: Stafford

Name Dam Aquia Creek Dam / Smith Lake County Stafford State Virginia Coordinates Lat. 3829.2 Long. 7723.9

Date(s) Inspection 12/4/78 Weather overcast occasional rain Temperature 65°

Pool Elevation at Time of Inspection 70 M.S.L. Tailwater at Time of Inspection 25 M.S.L.

Inspection Personnel:

Forest Fister , Hydrology
Neal Horst , P.E., Dam Design
John S. Jones , P.E., Law Eng. Soil & Geology
John W. Hyden , Ph.D., P.E.
(Water Resources Planning Engr.)

Paul Seiler , P.E., Project Engineer Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None visible.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None visible.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion under pipe cradle of outflow pipe, i.e. principal spillway - 60" dia. pipe. Dam slopes are 3:1 upstream and 3:1 downstream. Erosion gullies from rain fall 2' deep right of emergency spillway. Erosion at back of right abutment of spillway and dam embankment about 3 or 4 cu. ft. of earth eroded.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No evidence of settlement or misalignment of the top of the dam.	
RIPRAP FAILURES	Riprap at principal spillway pipe submerged.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATION
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Looking downstream - right abutment of emergency spillway has some embankment erosion on upstream side, 2-3 cu. ft. Left abutment back of emergency spillway has natural vertical foliation, weathered Quantico Slate.	
ANY NOTICEABLE SEEPAGE	Toe of dam - drains silted shut - 8" CMP drain rusted out. Seepage started at drain by prod with stick. 8" CMP Drain 600' from L. Abutment showed 3 gal./min. after stick prod. Junction right abutment to exist ground seepage est. ½ gal./min.	
STAFF GAGE AND RECORDER	None.	
DRAINS	Toe drains, 8" CMP silted closed (3 visible.)	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None visible.	
INTAKE STRUCTURE	Ungated type concrete platform with weir.	
OUTLET STRUCTURE	60" Diameter concrete pipe on poured concrete cradle. Erosion under cradle.	
OUTLET CHANNEL	No energy dissipater below pipe. Outlet structure has caused erosion under emergency spillway stilling basin. (Lower end of concrete spillway) Outlet pipe about 3/4 under water. Imported riprap used on Dam not visible around outlet pipe.	
EMERGENCY GATE		

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Principal Spillway is a weir on a riser structure.	
APPROACH CHANNEL	Shale bank on left side 25' high. Right side channel shale, bottom shale, partly covered with soil.	
DISCHARGE CHANNEL	Debris in channel 2' higher than princip spillway pipe about 100' below outlet. Channel below the debris area is clean.	
BRIDGE AND PIERS	None.	

LAKE DRAIN

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not visible.	
APPROACH CHANNEL	Not visible, intake pipe on lake bottom.	
DISCHARGE CHANNEL	36-inch diameter pipe to drain lake. Manual control; did not operate for inspection since it was not used for 8 years.	
BRIDGE AND PIERS	None.	
GATES AND OPERATION EQUIPMENT		

INSTRUMENTATION

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

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Wooded.	
SEDIMENTATION	Unknown.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Rocks in channel about 100' below principal spillway pipe.	
SLOPES	Left side in rock, Forested. Right side has Lagoon embankment for sewage sludge. This is to be discontinued in several years.	
APPROXIMATE NO. OF HOMES AND POPULATION	Community of Aquia is 3000' downstream. Approximately 70 homes, population approximately 250.	I-95 bridges.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	No plan of Dam available at time of inspection. Plans of new emergency spillway and dam in Appendix.
REGIONAL VICINITY MAP	Yes. See index.
CONSTRUCTION HISTORY	None available at time of inspection.
TYPICAL SECTIONS OF DAM	See Appendix.
HYDROLOGIC/HYDRAULIC DATA	None available.
OUTLETS - PLAN - DETAILS -CONSTRAINTS -DISCHARGE RATINGS	See appendix. Section thru dam.
RAINFALL/RESERVOIR RECORDS	None available from owners.

ITEM	REMARKS
ESIGN REPORTS	None available.
EOLOGY REPORTS	Not available.
ESIGN COMPUTATIONS YDROLOGY & HYDRAULICS AM STABILITY EEPAGE STUDIES	None available.
ATERIALS INVESTIGATIONS ORING RECORDS ABORATORY IELD	None available.
OST-CONSTRUCTION SURVEYS OF DAM	None available.
ORROW SOURCES.	Core material from downstream site of present lagoons.

ITEM	REMARKS
MONITORING SYSTEMS	None visible.
MODIFICATIONS	Earth emergency spillway washed out in 1972, Reconstructed using concrete .
HIGH POOL RECORDS	None available.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Original emergency spillway lost in 1972, replaced with present concrete structure , see plans, Appendix.
MAINTENANCE OPERATION RECORDS	Following heavy rains, the water treatment operator indicated the owners open value to lower water level to normal pool elevation.

ITEM	REMARKS
SPILLWAY PLAN	See plans
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	OUTLET STRUCTURES - Hand operated value. Not opened in 8 yrs. Did not operate for inspectors. 2-4" pipes with submersible pumps take water from lake for water treatment plant. Provision for 3rd,4" Diameter pipe - not extended into lake at inspection date.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

Aquia Dam:

DRAINAGE AREA CHARACTERISTICS: Forested Slope 1/10

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 70.00 m.s.l. 2938 Ac. ft.

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Same as above

ELEVATION MAXIMUM DESIGN POOL: 70

ELEVATION TOP DAM: 90

CREST: Emergency Spillway

a. Elevation 85 plans (76.5 msl)
b. Type Concrete Ilum
c. Width 160' Spillway
d. Length 225' ogee shape
e. Location Spillover Left side looking downstream
f. Number and Type of Gates None - ungated concrete spillway.

OUTLET WORKS:

a. Type 60" diameter pipe. (Principal Spillway)
b. Location Left end of embankment just right of concrete spillway.
c. Entrance inverts 70
d. Exit inverts 25
e. Emergency drawdown facilities 36" x 36" Knife gate

HYDROMETEOROLOGICAL GAGES: None at dam.

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 10,000 cfs.

APPENDIX V

REFERENCES

REFERENCES

Reference No. 1: Riedel, J.T.; Appleby, J.F.; and Schloemer, R.W.; Hydrometeorological Report No. 33, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 200 to 100 Square Miles and Durations of 6, 12, 24, and 48 hours"; U.S. Department of Commerce, Weather Bureau, Hydrologic Services Division, 1956.

Reference No. 2: Synder, "F.F. Synthetic Unit-graphs", Transactions of the American Geophys. Union, Vol. 19, pp 497-545, 1938.

AQUIA DAM

List of Data Available

Furnished by:

Aquia Sanitary District, Stafford County, Virginia

1. Plans - Water Works Project Phase III,
   Earth Dam Section 1 - March 1968

2. Plans - Repairs to Aquia Creek Dam Project No. 6705-3
   Prepared by G. W. Clifford & Associates, Inc.,
   Fredericksburg, Virginia