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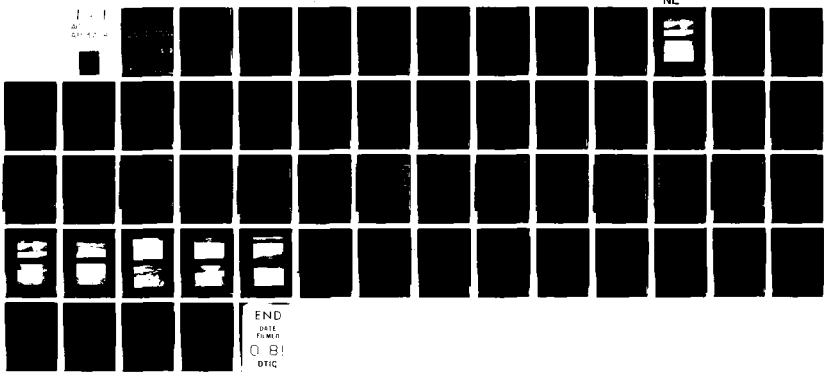

JAMES RIVER BASIN

LEVEL II

Name Of Dam: ELON WATER WORKS
Location: AMHERST COUNTY, VIRGINIA
Inventory Number: VA 00908

AD A103708

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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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 Inspection is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the gereral conditions of the dam is based upon available data and visual inspection. 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 idenify 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 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.

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JAMES RIVER BASIN

NAME OF DAM: ELON WATER WORKS DAM
LOCATION: AMHERST COUNTY
INVENTORY NUMBER: VA 00908

6 PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.

Elon Water Works (Inventory Number VA 00908),
James River Basin. Amherst County, Virginia.
Phase I Inspection Report.

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of 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

BRIEF ASSESSMENT OF DAM

Name of Dam:	Elon Water Works Dam
State:	Virginia
Location:	Amherst County
USGS Quad Sheet:	Lynchburg
Stream:	Graham Creek
Date of Inspection:	22 January 1981

The Elon Water Works Dam is a zoned earth fill dam approximately 52.1 feet high and 490 feet long. The dam is owned and maintained by the Madison Heights Sanitary District. The dam is classified as an intermediate size dam with a significant hazard classification. The emergency spillway is an earthen channel with a trapezoidal cross section at the left abutment. The principal spillway is a concrete drop-inlet with a fixed crest elevation of 663 feet. The reservoir is used for water supply.

Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) is the 1/2 PMF. The emergency spillway will pass 32 percent of the PMF or 64 percent of the SDF without overtopping the dam. The SDF will overtop the dam by a maximum of 1.2 feet, reach an average critical velocity of 5.1 feet per second and flow over the dam for 2.4 hours. The emergency spillway is adjudged inadequate, but not seriously inadequate.

The visual inspection revealed no apparent problems or remedial measures in need of immediate attention. There is no emergency operation and warning plan, and it is recommended that one be established. The maintenance items listed in Section 7.2 should be accomplished as a part of the regular maintenance program within the next 12 months.

Submitted By:

Original signed by
JAMES A. WALSH

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

Recommended By

Original signed by
JACK G. STARR

JACK G. STARR, P.E.
Chief, Engineering Division

Approved:

Original signed by:
Douglas L. Haller

DOUGLAS L. HALLER
Colonel Corps of Engineers
District Engineer

Date: MAY 12 1981

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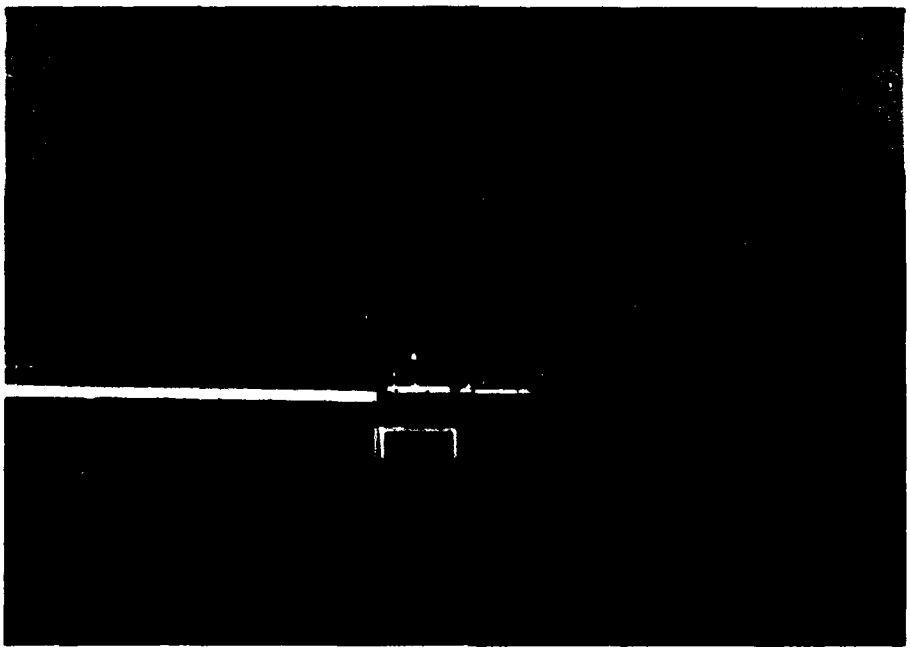


RESERVOIR AREA

OVERALL VIEWS-
ELON WATERWORKS DAM

22 JANUARY 1981

SECTION 1

PROJECT INFORMATION

1.1 GENERAL:

1.1.1 Authority: Public Law 92-367, 8 August 1972, 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 (Reference 1, Appendix V). 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: Elon Water Works Dam is a zoned earthfill embankment 52.1 feet high 1/ and 490 feet long with a crest width of 16 feet and elevation of 676.3 feet msl. The design drawings show that the embankment is keyed into rock via a cutoff trench and that there is upstream slope protection. The upstream slope is 3 horizontal to 1 vertical (3H:1V). The downstream slope is 2.5H:1V.

The principal spillway is a concrete drop-inlet riser with a fixed crest elevation of 663 feet above msl 2/ and 23 feet in length. There are trash racks in front of the weir intake to prevent floating debris from entering the intake.

The stilling basin, located approximately 150 feet downstream from the toe of the dam, is approximately 40 feet long and 30 feet wide, with riprapped banks. There is a blanket foundation drainage system.

The emergency spillway was cut through natural ground on the left abutment 3/. It has a trapezoidal cross section with a base width of 80 feet and side slopes of 1.5H:1V on the left side and 1.5H:1V on the right side. At the control section, the emergency spillway invert is at a elevation 666.0 feet msl. The emergency spillway discharges into the downstream channel approximately 350 feet downstream from the toe of the dam.

A 48-inch sluice gate, with invert elevation 638.0, is provided to drawdown the reservoir from normal pool.

1/ Measured from downstream embankment toe to the embankment crest
2/ All elevations are reference to Mean Sea Level (msl) datum
3/ Facing downstream

1.2.2 Location: Elon Water Works Dam is located on Graham Creek approximately 6 miles north of Lynchburg, Virginia, on State Route 130. A location plan is included in this report.

1.2.3 Size Classification: The maximum height of the dam is 52.1 feet; the reservoir storage capacity at the crest of the dam (elevation 676.33 feet above msl) is 1890 acre-feet. Therefore the dam is in the "Intermediate" size category as defined by the Recommended Guidelines for Safety Inspection of Dams (Reference 1, Appendix V).

1.2.4 Hazard Classification: The dam is located in a rural area; however, based upon the downstream proximity of State Route 130, a house at approximately 3000 feet and the Elon Water Works Filtration Plant, the dam is assigned a "Significant" hazard classification. Although loss of human life is not highly probable, severe economic losses due to the destruction of State Route 130, the house and filtration plant are likely in the event of failure of the dam. The hazard classification as defined by the Recommended Guidelines is a function of location only and has nothing to do with their stability or probability of failure.

1.2.5 Ownership: The dam is owned by Madison Heights Sanitary District, P. O. Box 100, Madison Heights, Virginia 24572, Mr. Henry L. Lanum, Superintendent.

1.2.6 Purpose: The dam is used for water supply.

1.2.7 Design and Construction History: The dam was designed by John McNair and Associates, L.B. & B. Building, Waynesboro, Virginia 22980. Construction was by English Construction Company with Mr. James T. Stinette supervising and inspecting for the Madison Heights Sanitary District. The project was completed in 1967.

1.2.8 Normal Operational Procedures: The principal spillway is ungated; therefore water rising above the crest of the weir is automatically piped through the dam and discharges downstream. Similarly, water is automatically passed through the emergency spillway in the event of an extreme flood which creates a pool elevation above that of the emergency spillway crest. Normal pool is maintained at elevation 663 msl.

1.3 Pertinent Data:

1.3.1 Drainage Area: The drainage area is 6.3 square miles.

1.3.2 Discharge at Dam Site:

Maximum flood: The maximum known flood at this dam occurred in June 1972, when an estimated pool elevation of 667 feet msl was observed.

Pool level at top of dam (elevation 676.3)

Principal Spillway . . . . . 400 cfs
Emergency Spillway . . . . . .8462 cfs

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in the following table:

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Elevation feet msl	Reservoir Capacity Area, (acres)	(Acre, feet)	(Watershed, inches)	Length (feet)
Top of Dam	676.3	97.0	1890	5.63	6900
Emergency Spillway Crest	666.0	65.0	1060	3.15	5200
Principal Spillway Crest	663.0	58.0	860	2.56	4700
Streambed beyond Toe of Dam	624.3	--	--	--	--

SECTION 2

ENGINEERING DATA

2.1 Design: Design plans (Appendix I) were obtained for use in preparing this report, along with the project specifications and soil boring information (Appendix I).

2.2 Construction: Construction records were kept during construction and were reviewed for this study. The dam was constructed by English Construction Company of Lynchburg, Virginia, and was completed in 1967. Full time construction inspection was performed by James T. Stinette, who represented the owner on the site. Comparison of all data including the design drawings with field inspection data indicates that the dam was constructed as planned.

2.3 Evaluation: John McNair and Associates, Consulting Engineers, designed the dam. The Sanitary District does not have in its files a stability analysis or detailed hydrologic and hydraulic data. The design assumptions are included in a preliminary report. All evaluations and assessments in the present inspection report are based upon data that was available, field observations, discussions with the owner's personnel, and office analyses. The available information is sufficient to evaluate the foundation condition. However, the available information pertaining to embankment stability is insufficient.

SECTION 3

VISUAL INSPECTION

3.1 Findings:

3.1.1 General: The field inspection was conducted on 22 January 1981. At the time of the inspection, the pool elevation was 663 feet msl; the tailwater elevation was 625.6 feet msl; the weather was clear and mild with a temperature of 58°F. The ground surface at the embankment and abutments was a normal dry condition. The dam and appurtenant structures at the time of inspection were found to be in good overall condition. Minor deficiencies found during the inspection are not believed to indicate any major stability problems. The following are brief summaries of deficiencies found during the inspection. The complete visual inspection check list is given in Appendix III.

3.1.2 Embankment: The embankment is in good condition. A cross section and plan view are provided on Plate 4 and 5, Appendix I, respectively. An overall view of the dam is provided at the beginning of the report.

There are no signs of surface cracks, unusual movement, sloughing, or riprap failures. However, there was some minor erosion from wave action in the left abutment below the emergency spillway. The alignment of the crest was good with no noticeable misalignment. The contacts between the abutments and embankment were in good condition with no signs of erosion. The dam was well vegetated and showed signs of regular mowing and care.

The design drawings show a blanket foundation drain placed under the downstream side of the embankment. A marshy area was noted at the toe of the embankment (Photo #4, Appendix II). This is probably due to normal seepage through the blanket drain. There is an indication of possible moisture on the downstream face of the dam above the toe, as evidenced by a difference in vegetation here from that higher on the slope. Local soils were used to construct the embankment and consist of red silty clays in the core and silty sands.

3.1.3 Principal Spillway: The principal spillway intake structure (Photo 5, Appendix II) was in excellent condition with no signs of cracking or spalling in the concrete. The outlet structure (Photo #6, Appendix II) was also in excellent condition. There is brush growing behind the wing walls and head walls of the outlet structure. The riprap protecting the plunge pool has failed in areas. The wheel controlling the 48-inch emergency gate appeared to be well maintained and in working order.

3.1.4 Emergency Spillway: (Photo 7 and 8, Appendix II) The control section is wide and well vegetated. The side slopes were well vegetated and showed no signs of erosion. The approach channel was well vegetated and clear of obstructions. The discharge channel was clear of obstructions and well vegetated with the exception of some erosion at the far end of the channel. Riprap had been placed in this area to help stop this erosion.

3.1.5 Instrumentation: There is no instrumentation on this dam.

3.1.6 Reservoir: The reservoir slopes (Photo 7, Appendix II) were steep and heavily wooded. There were no signs of instability along the reservoir shoreline. Sedimentation was not measured.

3.1.7 Downstream Channel: (Photo 10, Appendix II) The channel immediately below the dam is with mild side slopes. There are trees growing along the banks of the stream. Farther below the dam the channel narrows and the side slopes steepen and become wooded. State Route 130 crosses the channel about 2000 feet below the dam. There is an occupied structure and the water works filtration plant about 3000 feet below the dam. The natural streambed below the dam has moderate slopes.

3.2 Evaluation: Overall the dam appears to be in excellent condition. It is apparent from its condition that it receives good maintenance and care. The wet spot at the toe of the dam and the moist area on the downstream face should be monitored periodically for seeps and boils. If seepage or boils should develop, they should be evaluated by a qualified geotechnical engineer as soon as possible. The riprap failure in the plunge pool should be repaired as soon as it is practical.

The inspection also revealed certain items which can be corrected as a part of the regular maintenance program for the dam. These are:

a. Remove the brush growing behind the wingwalls and headwall of the outlet structure.

b. Take measures to prevent further erosion of the shoreline in the left abutment below the emergency spillway by either placing riprap or dressing with compacted fill and reseeding.

c. Cut trees immediately below the plunge pool and remove the timber to prevent the possibility of damming.

d. Install a staff gage in the vicinity of the reservoir so that the pool level can be easily monitored.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedures: The operation of the dam is primarily an automatic function controlled by the principal and emergency spillways. Water entering the reservoir flows into the principal spillway at elevation 663 feet. When inflow is sufficient, the reservoir level rises above elevation 666 feet and discharges through the emergency spillway. A 48-inch sluice gate at a low level in the principal spillway riser is provided to draw-down the reservoir from normal pool.

4.2 Maintenance: Maintenance is the responsibility of the Madison Heights Sanitary District. Maintenance consists of inspection, debris removal, mowing of the vegetative cover, and repair. The operating appurtenances are reportedly in working order. A formal inspection and maintenance written schedule has not been instituted.

4.3 Warning System: At the present time, there is no warning system or evacuation plan for the dam.

4.4 Evaluation: The dam and appurtenances are in good operating condition. Maintenance of the dam appears to have been adequate but a formal check list should be compiled for use by the owner's personnel as a guide for the inspections. Records of such inspections should be maintained to provide a historical record. A warning system and emergency action plan should be developed and put into operation as soon as possible, which should include:

a. How to operate the dam during an emergency.

b. Who to notify, including public officials, in case evacuation from the downstream area becomes necessary.

The local Emergency Services Coordinator of the state office of Energy and Emergency Services can assist in the preparation of an Emergency Warning Plan.

SECTION 5

HYDRAULIC/HYDROLOGIC DATA

5.1 Design: None were available.

5.2 Hydrologic Records: None were available.

5.3 Flood Experience: In June of 1972, remnants of tropical storm Agnes caused the pool to rise to an elevation of approximately 667.0.

5.4 Flood Potential: The 1/2 PMF and PMF were developed by use of the HEC 1 computer model (Reference 2, Appendix V) and appropriate precipitation and storage-outflow data. Clarke's Tc and R coefficients for the local drainage area were estimated from basin characteristics. The rainfall applied to developed unit hydrograph was obtained from a National Weather Service Publication (Reference 4, Appendix V).

5.5 Reservoir Regulation: Pertinent dam and reservoir data are shown in Table 1.1.

Water passes automatically through the principal and emergency spillways as the reservoir rises above each.

The storage curve was developed based on areas obtained from a U. S. Geological Survey Quadrangle Map and original design plans. Rating curves for the non-overflow section, emergency spillway, principal spillway, and drawdown were developed internally by the DAMBREAK computer model. In routing hydrographs through the reservoir it was assumed that the initial pool level was at the principal spillway crest (elevation 663.0).

5.6 Overtopping Potential: The probable rise in the reservoir and other information on reservoir performance is shown in the following table:

TABLE 5.1

Item	Normal Flow	1/2 PMF	PMF 1/
Peak flow c.f.s			
Inflow	6	13405	26745
Outflow	6	13006	26540
Maximum elevation ft. msl	663.0	677.5	679.9
Non Overflow section (el. 676.3 ft. msl.)			
Depth of flow, ft.	--	1.2	3.6
Duration, hrs.	--	2.4	5.2
Velocity, fps. 2/	--	5.1	8.8
Tailwater elevation ft. msl.	625.6		

1/ The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

2/ Critical Velocity

5.7 Reservoir Emptying Potential: An 48-inch concrete pipe with a 48-inch square sluice gate is available for lowering the reservoir. The low level outlet will permit a withdrawal of about 406 cfs with the reservoir level at the crest of the principal spillway and essentially dewater the reservoir in approximately 1.5 days. This is equivalent to an approximate drawdown rate of 22 ft. per day. This is based on the hydraulic height measured from the maximum storage pool at elevation 663.0 to elevation 630.0 divided by the time to dewater the reservoir.

5.8 Evaluation: Based on the size (intermediate) and the hazard classification (significant) the recommended spillway design flood is the 1/2 PMF to the PMF. Because of the risk involved, the 1/2 PMF has been selected as the SDF. The emergency spillway will pass 32 percent of the PMF or 64 percent of the SDF without overtopping the dam. The SDF will overtop the dam by a maximum 1.2 feet, reach an average critical velocity of 5.1 feet per second and flow over the dam for 2.4 hours.

Conclusions pertain to present day conditions. The effect of future development on the hydrology has not been considered.

SECTION 6

DAM STABILITY

6.1 Foundation and Abutments: Elon Reservoir is located near the western edge of the Piedmont physiographic province. The bedrock underlying the area of the dam is Marshall gneiss of the Virginia Blue Ridge complex, of Precambrian Age. The Virginia Blue Ridge complex forms the core of the Catoctin-Blue anticlinorium, one of the major geologic structures of the region. Marshall gneiss is characterized in Geology and Mineral Resources of the Lynchburg Quadrangle, Virginia (Reference 6, Appendix V) as medium to dark gray, coarse grained biotite-quartz monzonite gneiss, with feldspar-mica augen in parts. Additionally, sill-like bodies of hornblende gneiss and amphibolite are found in the area.

The Marshall gneiss, a strong metamorphic rock which in its unweathered form provides a good foundation for heavy structures, was encountered in excavations for the spillway and keyway, and blasting was required for its removal. Weathered outcrops of this material can be observed in the eroded lower reaches of the channel below the emergency spillway. The riprap used on the upstream face of the dam consists in part of rock excavated from the emergency spillway.

Specifications call for the dam to be keyed into unweathered rock, and according to Mr. Stinette, the Madison Heights Sanitary District's on-site inspector, this was done. The base of the dam's core section is at the "rock line" or surface of unweathered rock. The top of the core is at elevation 668. The width is 16 feet at the base and 16 feet at the top. The specifications also provide for foundation drainage by means of a sand blanket filter and filter drains, to collect seepage through the embankment and conduct it away from the toe of the dam.

Hurt & Proffitt, Inc., conducted an inspection of the dam in 1977, ten years after its completion. Their evaluation, which concluded that the "dam is stable and there is no excess seepage", is included in Appendix V, Post Construction Inspection Report.

As the dam is keyed into unweathered bedrock, the predominate foundation material is the Marshall gneiss described above, which should provide a stable and impervious foundation for the embankment. The present inspection did not reveal any deficiencies related to the foundation and abutments.

6.2 Embankment:

6.2.1 Materials: The contract drawings show an earth embankment with a central cutoff core. According to documents on soil testing and the construction records, the dam key and core is composed of red silty clay from a borrow area about 2,000 feet downstream from the

damsite and on the northeast side of the stream. The upstream and downstream faces are composed variously of tan micaceous very silty fine sand, tan very silty sand, and red micaceous clayey silty sand, from the spillway and key excavations and other borrow areas in close proximity to the damsite. Specifications would indicate that the more pervious soils from these sources were to be placed on the upstream face. For the soils principally used to form the embankment, the pre-construction soil testing results are summarized as follows:

Borrow Area location	Description & Unified Sys. Classification	Liquid Limit	Plastic Limit	Plasticity Index	Optimum Dry Unit Weight (lb/ft3)	Optimum Moistur (%)
2,000' D/S from dam, N.E. side of stream	Red silty clay (CL)	47.2	23.3	23.9	94.8	26.0
Borrow area B12,13,14,15 3'-15' deep	tan micaceous very silty fine sand (SM)*	33.0	31.7	1.3	107.4	17.0
Spillway B1 & B2 below 3'	tan very silty (SM)*	25.6	28.4	2.8	106.0	15.0
Spillway B1 & B2 upper 3'	red micaceous clayey silty sand (SM)*	32.8	29.8	3.0	104.0	19.0

*The three soils given the Unified Soil Classification System symbol "SM" in this summary of testing data were labeled "SP" originally. The silty nature of these soils suggests that the "SM" designation is preferable.

The red silty clay is a fine grained residual soil of low to medium plasticity, and the various silty sands are coarse grained soils of residual or alluvial deposition, possessing slight plasticity.

Construction methods to be employed are detailed in the specifications, which cover such matters as avoidance of stockpiling of fill material before placement, removal of rock from the fill, moisture content, and type of compaction equipment to be employed. Fill in the embankment was to be compacted to at least 98% of maximum dry density, with moisture content to be between 95 and 110% of optimum. Field density tests were performed throughout the construction of the embankment to monitor compaction.

Daily on-site inspection was conducted by the owner during construction of the dam. The quality control program appears to have been very good, and by the use of daily progress reports and formal testing records, provided thorough documentation of the construction process.

6.2.2 Stability: There are no stability calculations included in the owner's document file. The dam is 52 feet high and 16 feet wide at the crest. The upstream slope is 3H:1V and the downstream slope is 2.5H:1V. The dam was designed for a normal pool elevation of 663. The maximum storage pool is 666 feet, the elevation of the crest of the emergency spillway. The upstream slope has never experienced a rapid drawdown, although it would be subjected to one if the low level drain was fully opened.

According to the guidelines presented in Design of Small Dams, (Reference 7 Appendix V), the slopes recommended for a small zoned dam of similar material are 2H:1V upstream and 2H:1V downstream, regardless of whether the dam is subjected to a rapid drawdown or not. The recommended crest width is 20 feet. Based on these guidelines, the Elon Water Works Dam has more than adequate slopes and a slightly inadequate crest width.

6.2.3 Seismic Stability: The dam is located in Seismic Zone 2. Therefore, according to the Recommended Guidelines for Safety Inspection of Dams, the dam is considered to have no hazard from earthquakes provided static stability conditions are satisfactory and conventional safety margins exist.

6.3 Evaluation: There is insufficient information to adequately evaluate the stability of the dam. The dam is engineered but there were no stability calculations in the owner's file of project documents. However, the visual inspection revealed no instability problems. Based on the Bureau of Reclamation guidelines, the upstream and downstream slopes are more than adequate and the crest width is slightly inadequate. However, the potential problem posed by the somewhat narrow crest width is offset by the flatter than required slopes. The embankment is considered stable during both normal pool and maximum storage pool operations. In addition, overtopping during the 1/2 PMF design storm should not be a problem because the flow is relatively shallow (1.2 feet) and of relatively brief duration (2.4 hours), and the velocity of 5.1 fps is less than 6 fps, the effective eroding velocity for a vegetated earth embankment. A stability check is not required.

SECTION 7

ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: The engineering data in the owner's file did not include a stability analysis or hydrologic/hydraulic analysis; therefore it was inadequate from the standpoint of completely assessing the design of the dam. There is a regular maintenance operations program; care should be taken to insure that all observations and work undertaken is recorded on the daily work record or otherwise documented. There is no emergency operation and warning plan. Overall, the dam is in good condition and there is no immediate need for remedial measures. Corps guidelines indicate that the appropriate Spillway Design Flood (SDF) for this dam (intermediate size and significant hazard) is the 1/2 PMF. The emergency spillway will pass 32 percent of the PMF or 64 percent of the SDF without overtopping the dam. The SDF will overtop the dam by a maximum 1.2 feet, reach an average critical velocity of 5.1 feet per second and flow over the dam for 2.4 hours. Flows overtopping the dam during the SDF are no considered detrimental to the embankment. The emergency spillway is adjudged inadequate, but not seriously inadequate.

A stability check of the dam is not required.

7.2 Recommended Remedial Measures: It is recommended that the regular maintenance operations program be formalized for future reference; care should be taken to insure that all observations and work undertaken is recorded on the daily work record or otherwise documented. The area of seepage at the toe of the dam and the moist area on the downstream face should be inspected regularly for any flow or turbidity which would indicate the potential for piping of embankment material. If any change is noted in flow or turbidity, a qualified geotechnical engineering firm should be consulted immediately. The riprap failure in the plunge pool should be repaired as soon as it is practical.

A formal emergency warning plan and operating procedure should be developed. This should include how to operate the dam during an emergency, and who to notify, including public officials, in case evacuation from the downstream area is necessary. Also a formal maintenance program with a system of keeping records should be developed.

Also, the inspection revealed the following maintenance items that should be scheduled by the owner during a regular maintenance period within the next 12 months.

a. Remove the brush growing behind the wingwalls and headwall of the outlet structure.

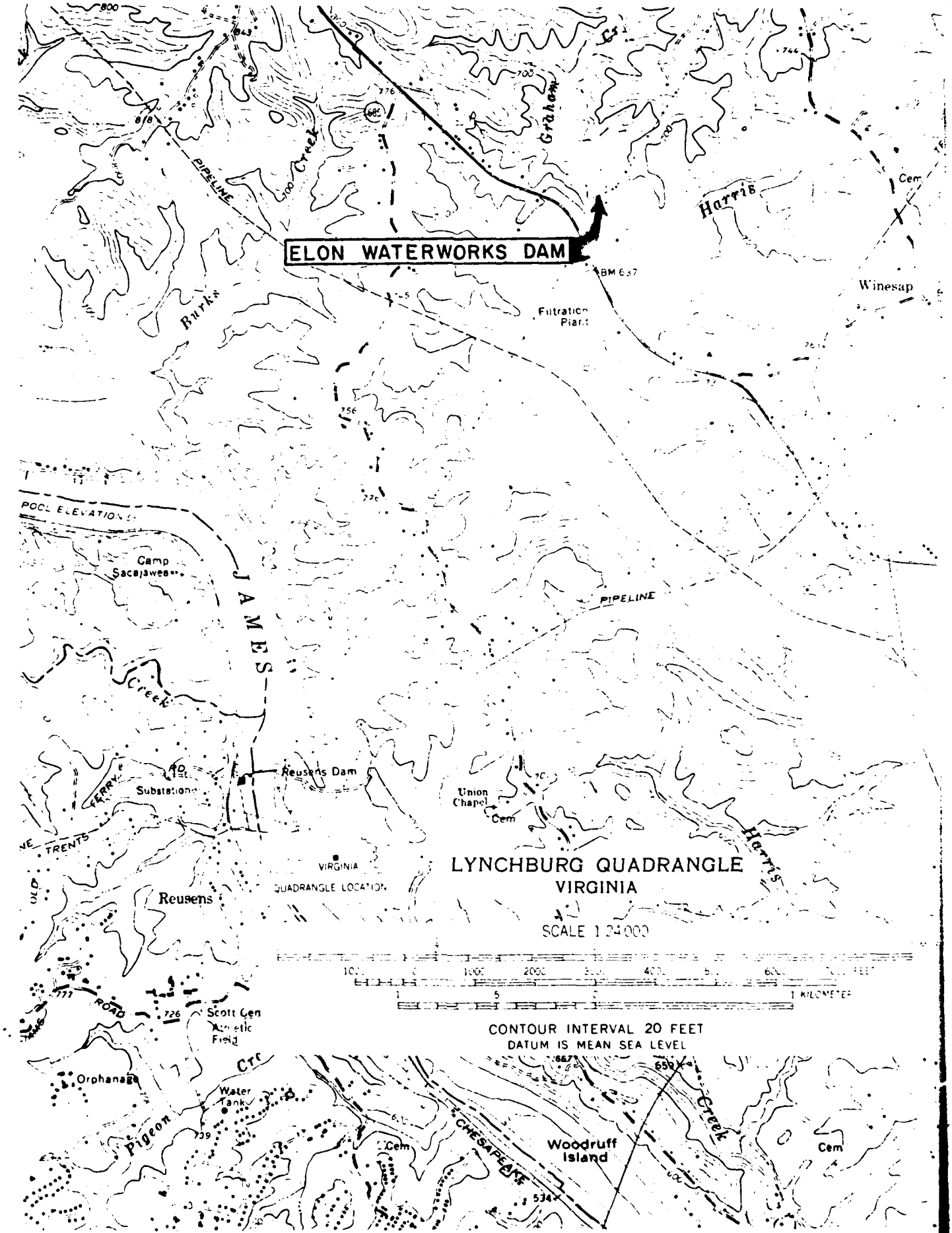
b. Take measures to prevent further erosion of the shoreline in the left abutment below the emergency spillway by either placing riprap or dressing with compacted fill and reseeding.

c. Cut trees immediately below the plunge pool and remove the timber to prevent the possibility of damming.

d. Install a staff gage in the vicinity of the reservoir so that the pool level can be easily monitored.

APPENDIX I

MAPS AND DRAWINGS


ELON WATERWORKS DAM
PIPELINE
Burks Creek
Graham
Harris
Cem
Winesap
BM 657
Filtration Plant
POOL ELEVATIONS
Camp Sacajawea
JAMES
Creek
PIPELINE
Reusens Dam
Substation
Union Chapel
Cem
TRENTS
VIRGINIA
QUADRANGLE LOCATION
LYNCHBURG QUADRANGLE
VIRGINIA
SCALE 1:24 000
Reusens
ROAD
Scott Gen
Athletic Field
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
Orphanage
Water Tank
Pigeon Ctr
Cem
CHESAPEAKE
Woodruff Island
Creek
Cem

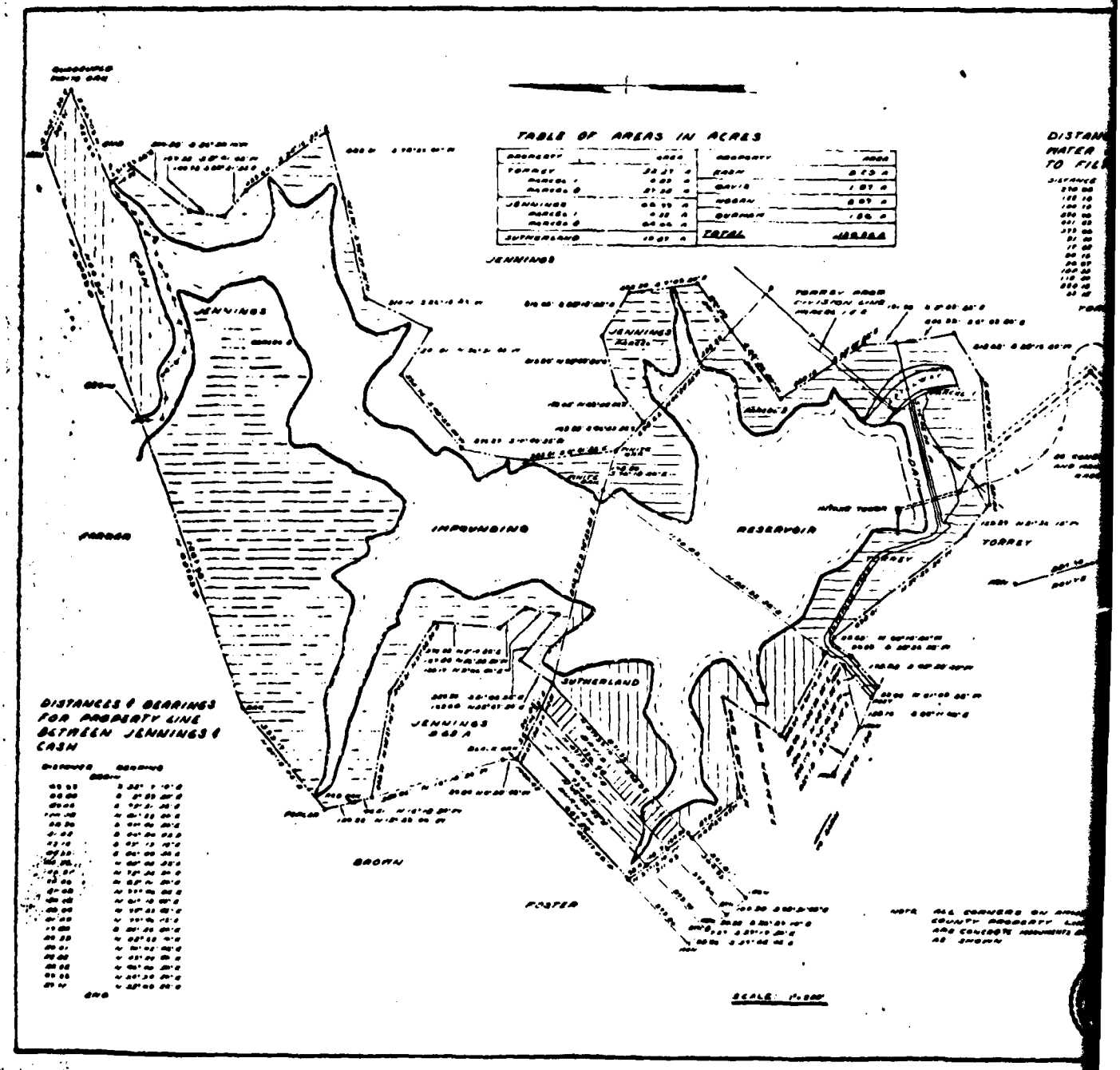


TABLE OF AREAS IN ACRES
JENNINGS
JENNINGS
JENNINGS EAST
IMPOUNDING
RESERVOIR
TORREY
SUTHERLAND
JENNINGS
BROWN
FOSTER
DISTANCES & BEARINGS FOR PROPERTY LINE BETWEEN JENNINGS & CASH

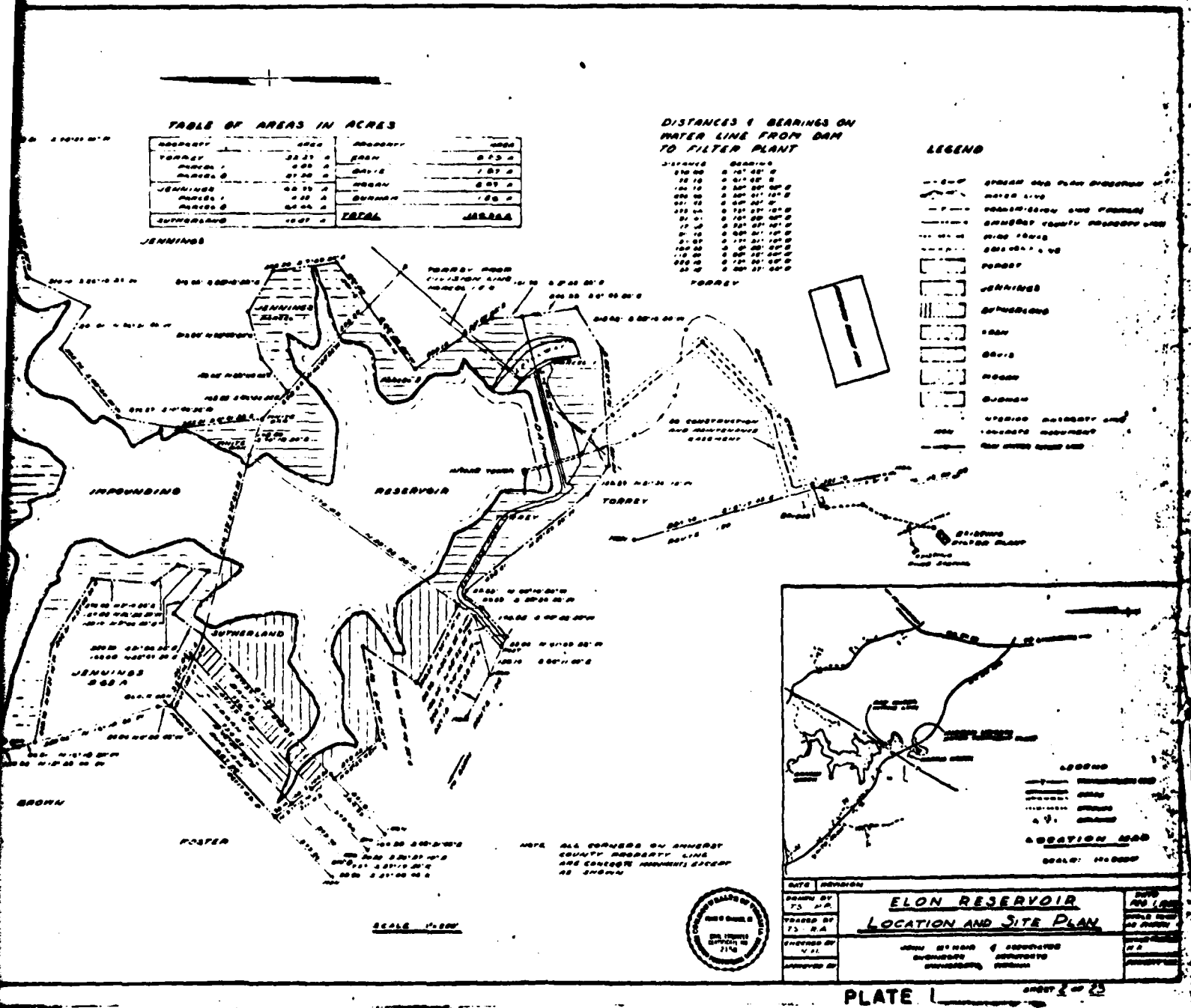
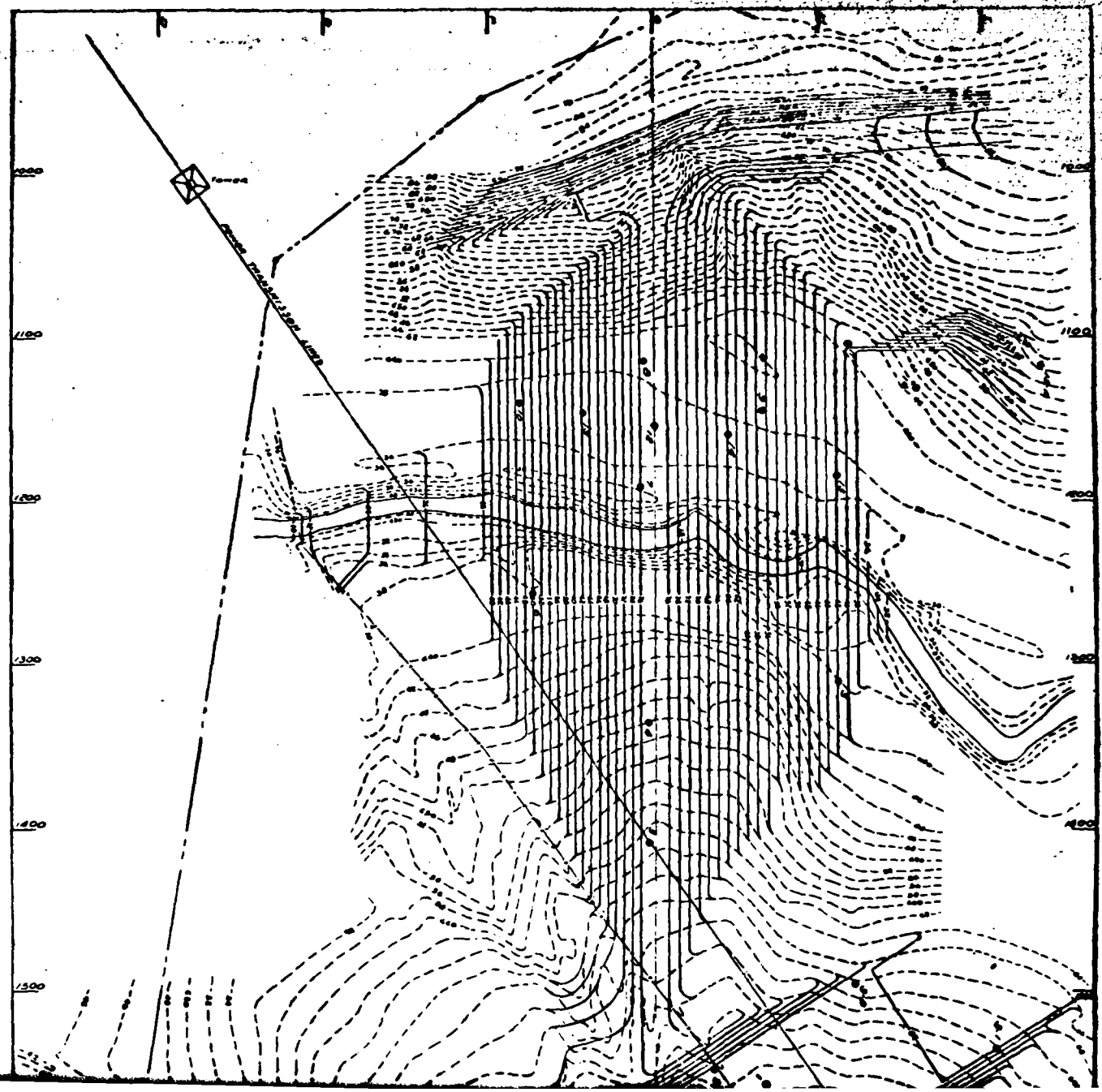


TABLE OF AREAS IN ACRES
DISTANCES & BEARINGS ON WATER LINE FROM DAM TO FILTER PLANT
LEGEND
JENNINGS
TORREY
IMPOUNDING
RESERVOIR
SUTHERLAND
BROWN
FOSTER
LOCATION MAP
ELON RESERVOIR
LOCATION AND SITE PLAN

PLATE I


1000
1100
1200
1300
1400
1500

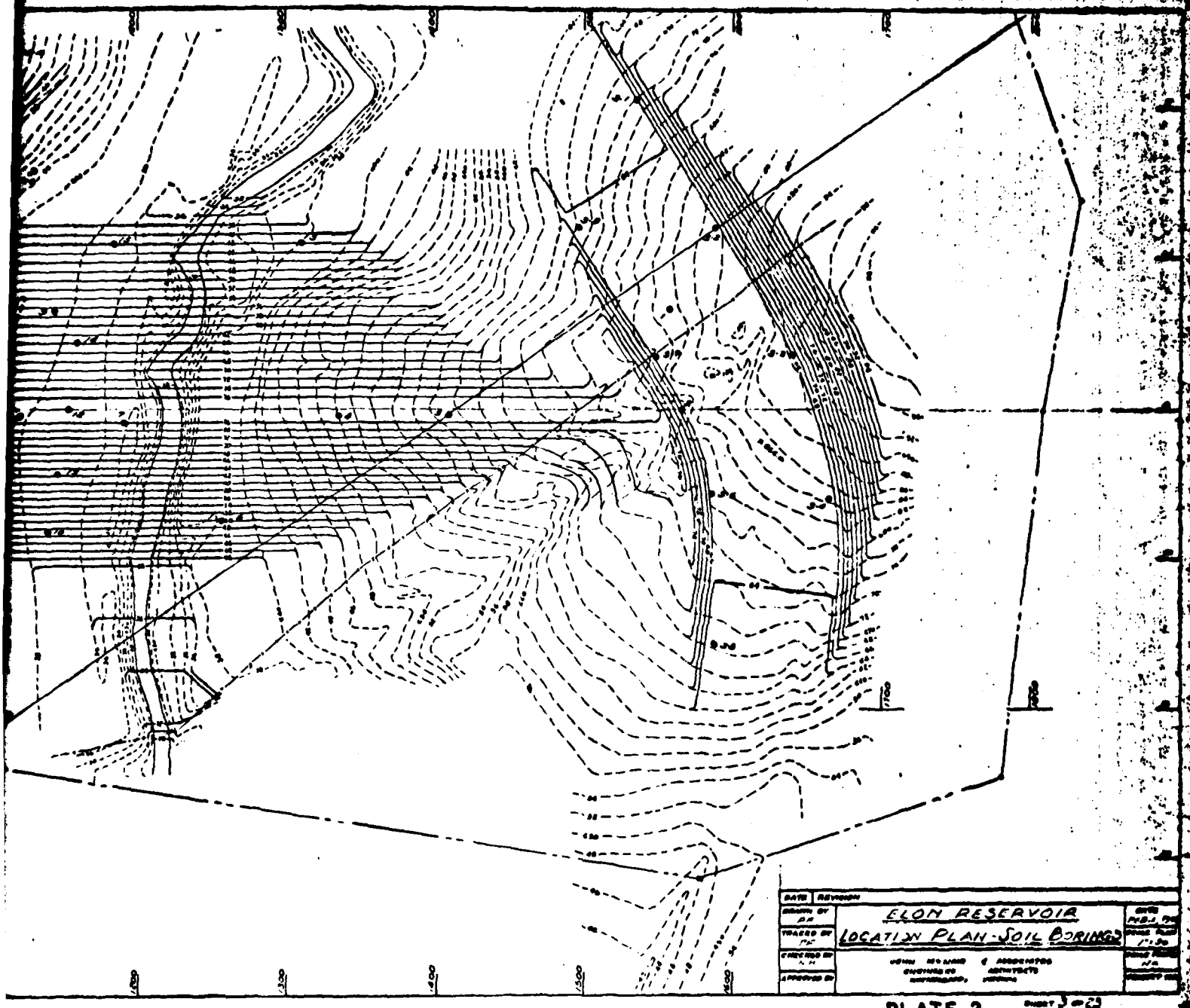
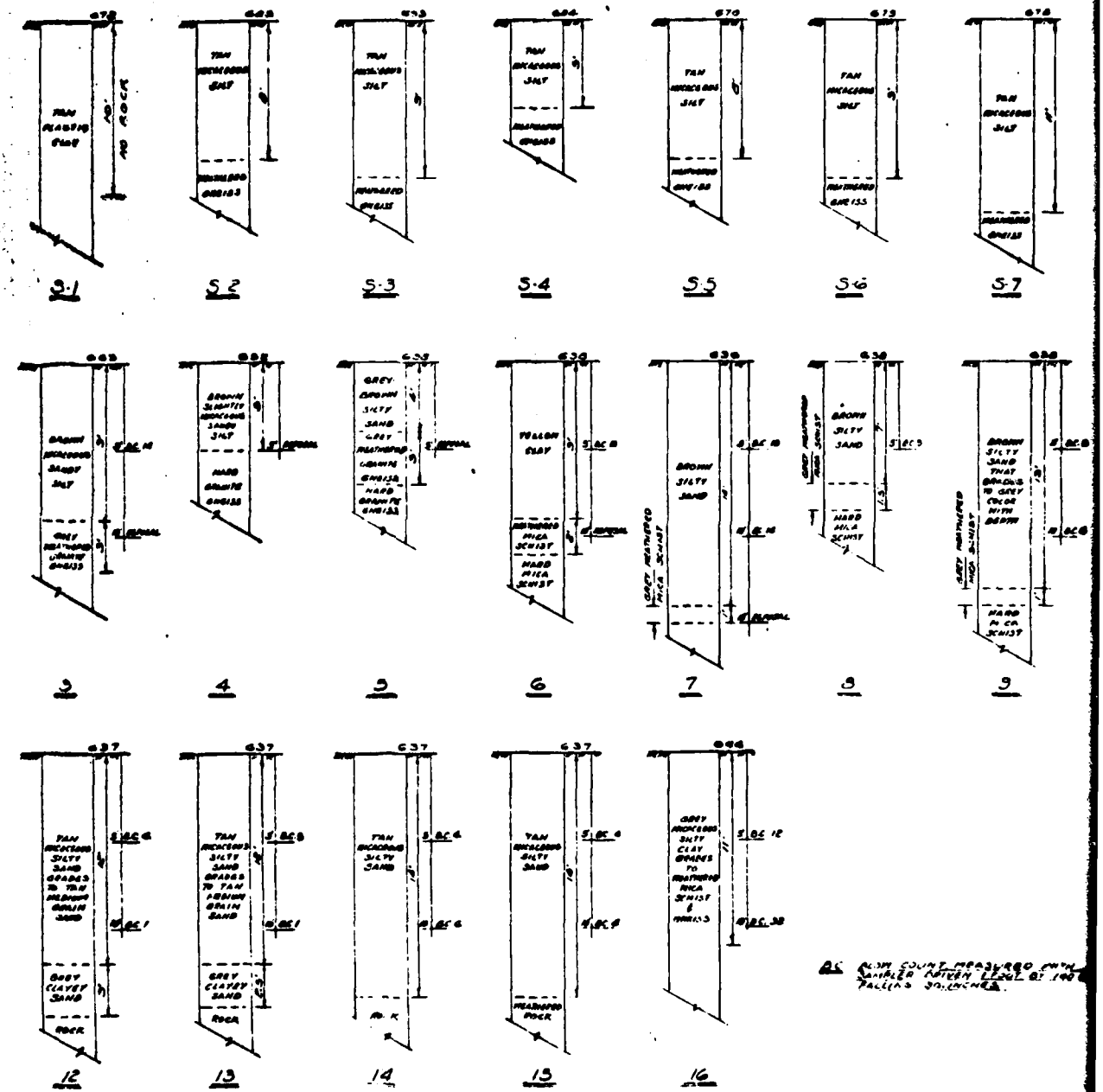
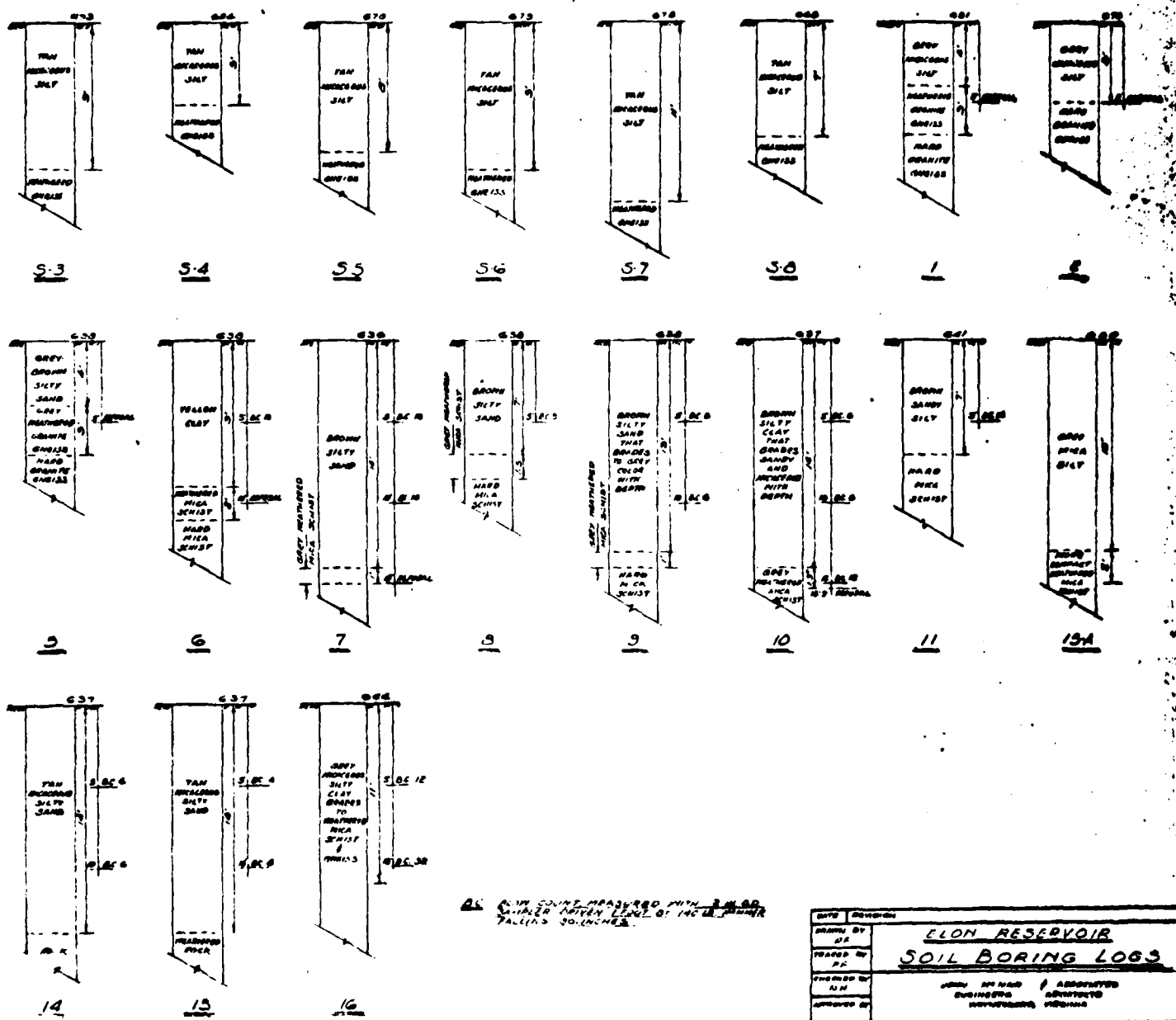


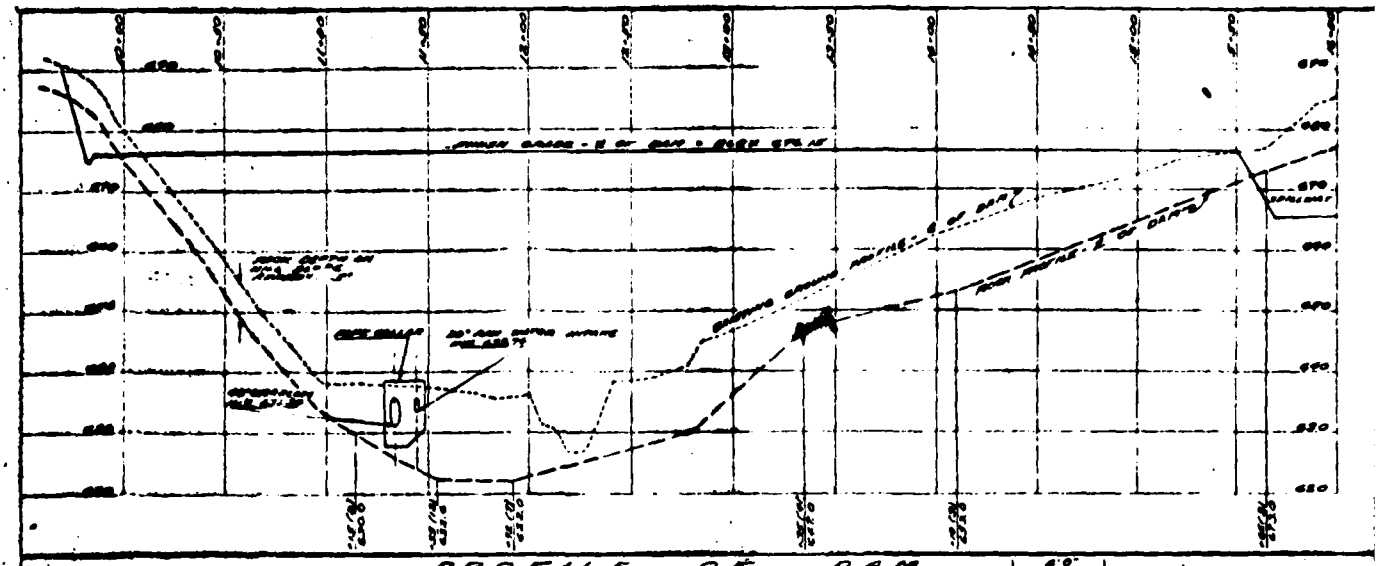
PLATE 2


S-1
S-2
S-3
S-4
S-5
S-6
S-7
3
4
5
6
7
8
9
12
13
14
15
16



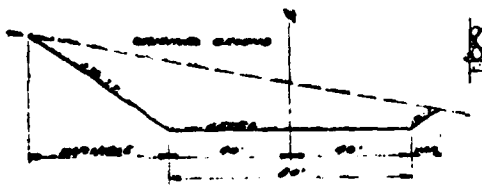
ELON RESERVOIR
SOIL BORING LOGS

PLATE 3



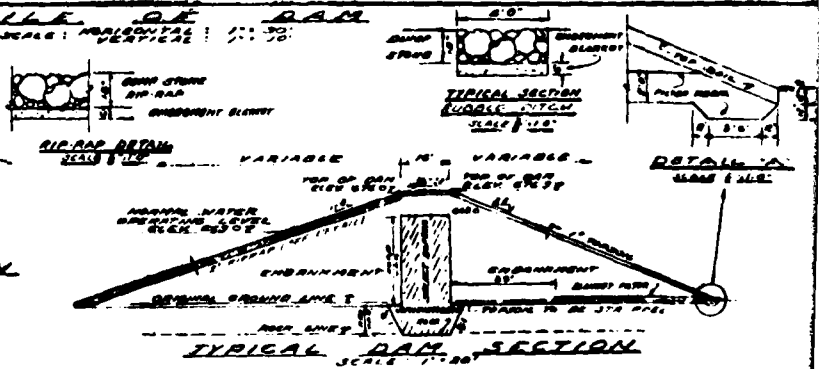
PROFILE OF DAM

SCALE: HORIZONTAL 1" = 20'
VERTICAL 1" = 10'



TYPICAL SPILLWAY SECTION

SCALE: 1" = 20'



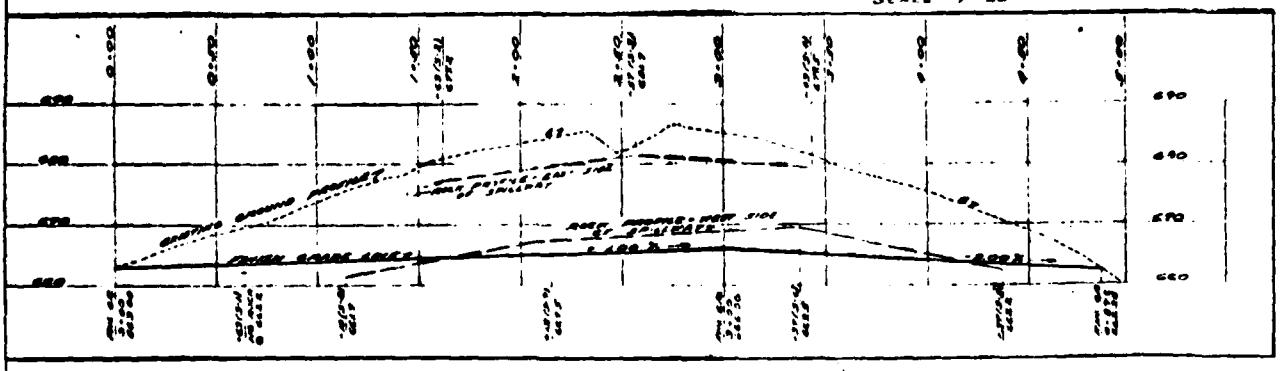
RIP-RAP DETAIL

TYPICAL SECTION

DETAIL "A"

TYPICAL DAM SECTION

SCALE 1" = 20'



PROFILE OF SPILLWAY

SCALE: HORIZONTAL 1" = 20'
VERTICAL 1" = 10'

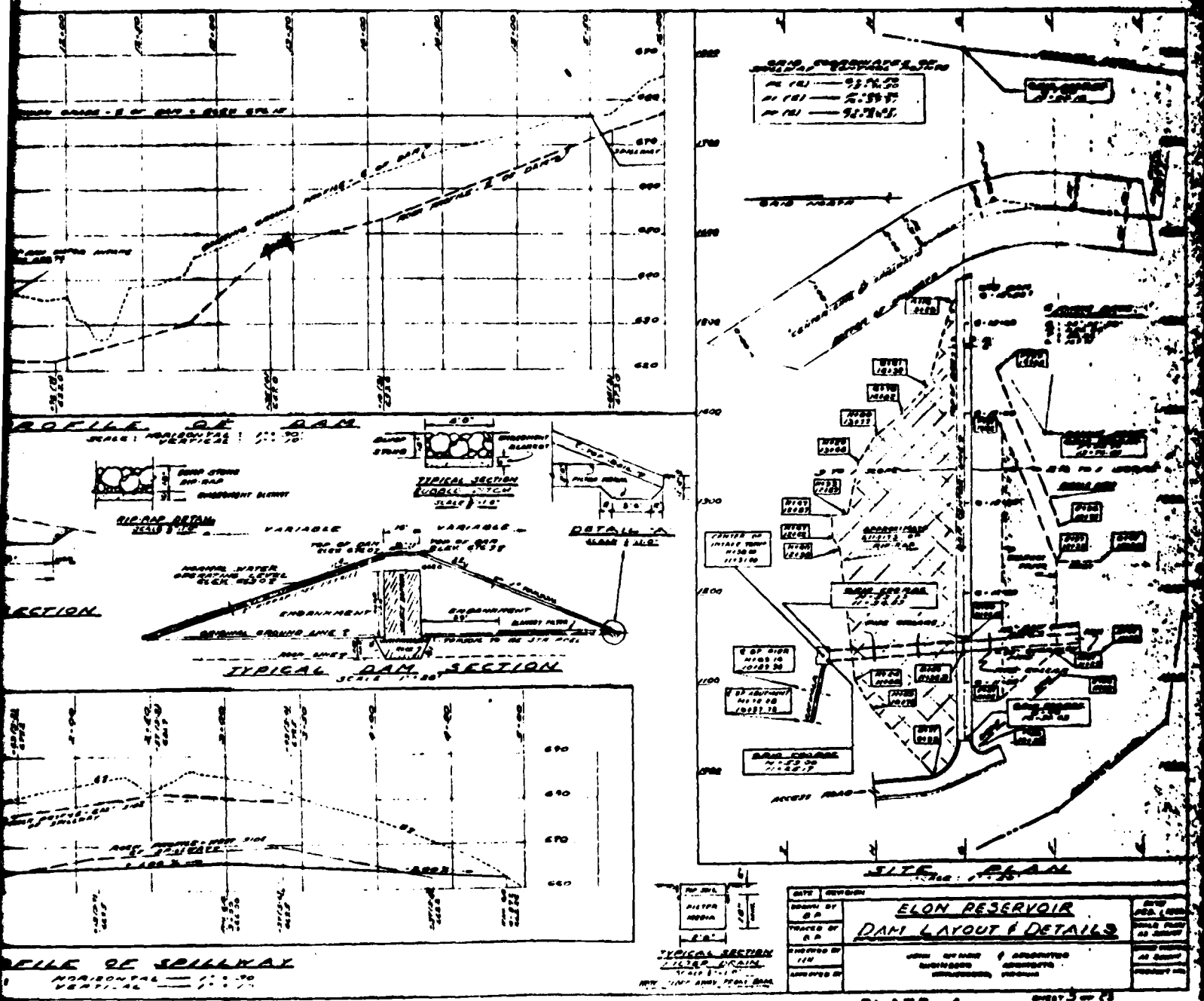
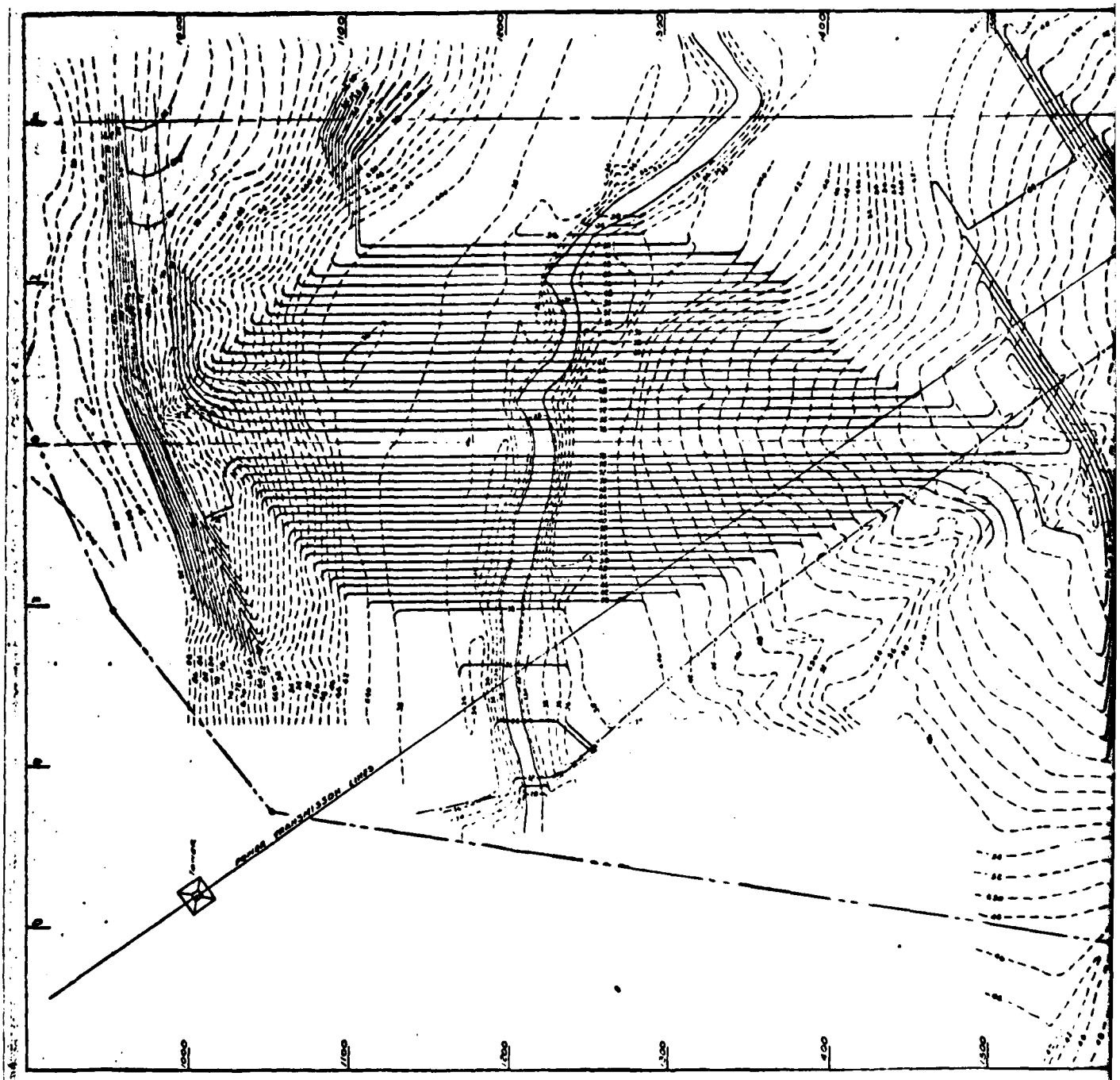

PROFILE OF DAM
TYPICAL SECTION
DETAIL A
TYPICAL DAM SECTION
SITE PLAN
PROFILE OF SPILLWAY
TYPICAL SECTION
ELON RESERVOIR
DAM LAYOUT & DETAILS

PLATE 4


POWER TRANSMISSION LINES
1000
1100
1200
1300
1400
1500

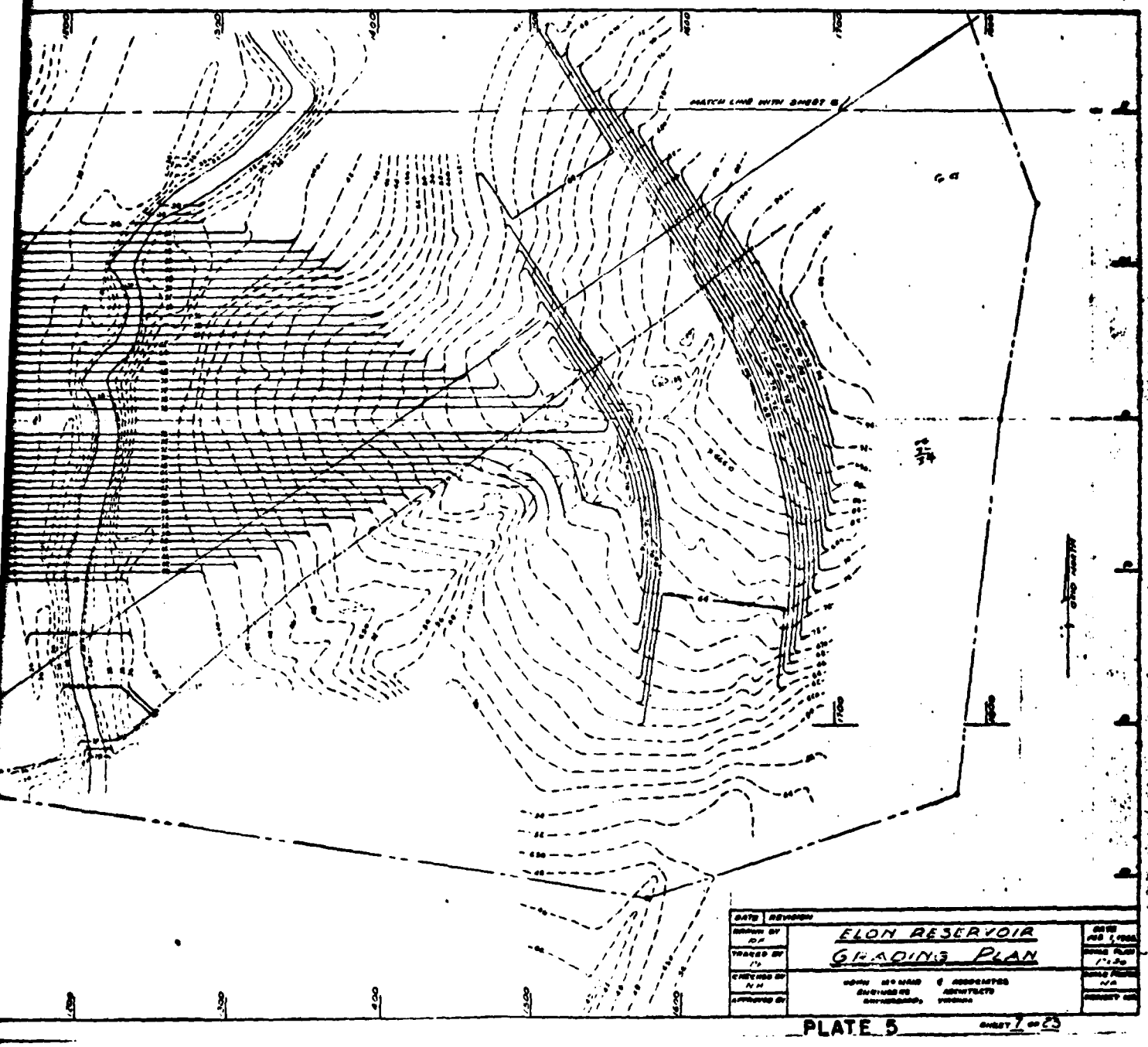
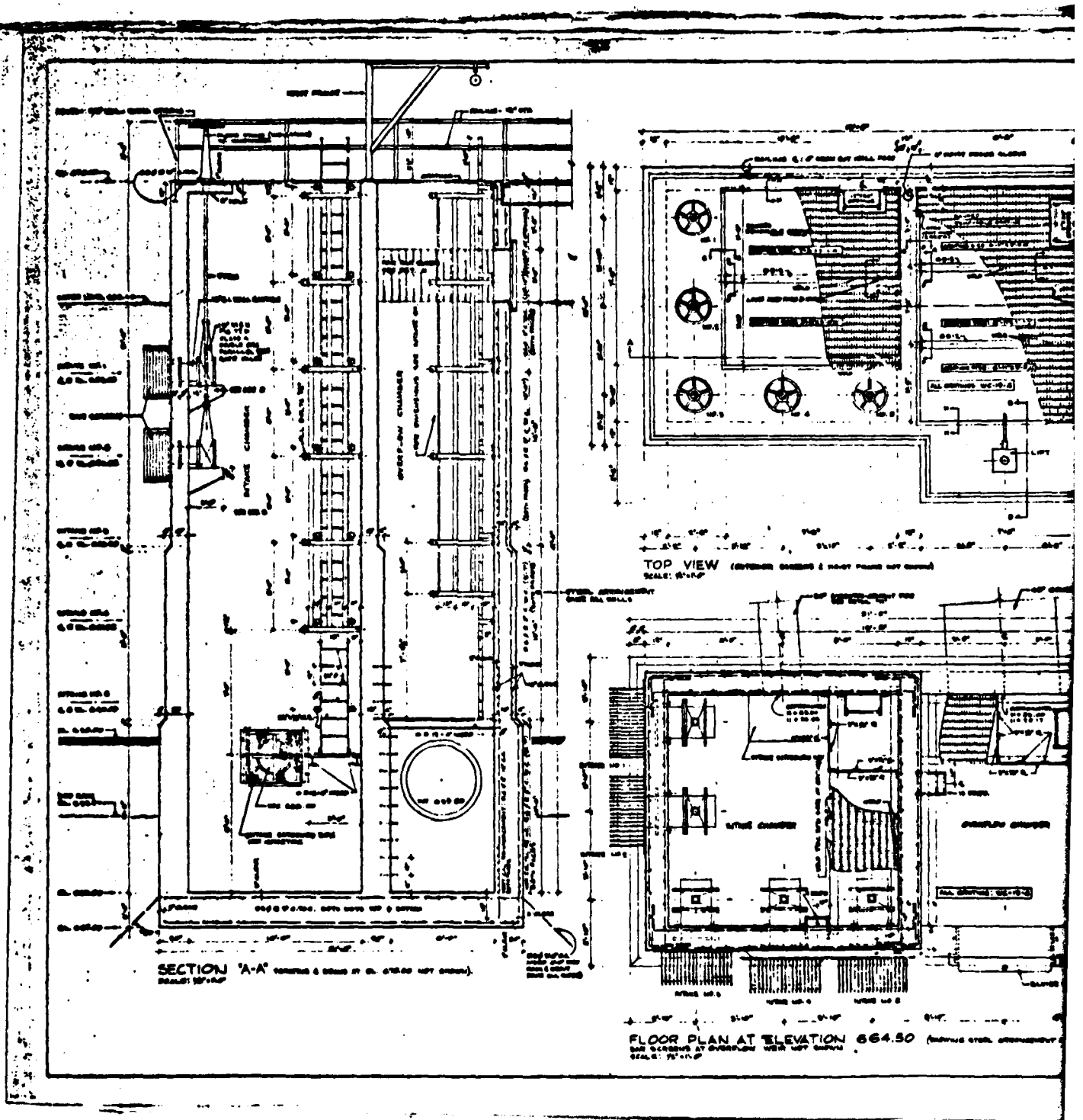


PLATE 5

SHEET 7 OF 23


SECTION 'A-A'
TOP VIEW
FLOOR PLAN AT ELEVATION 664.50

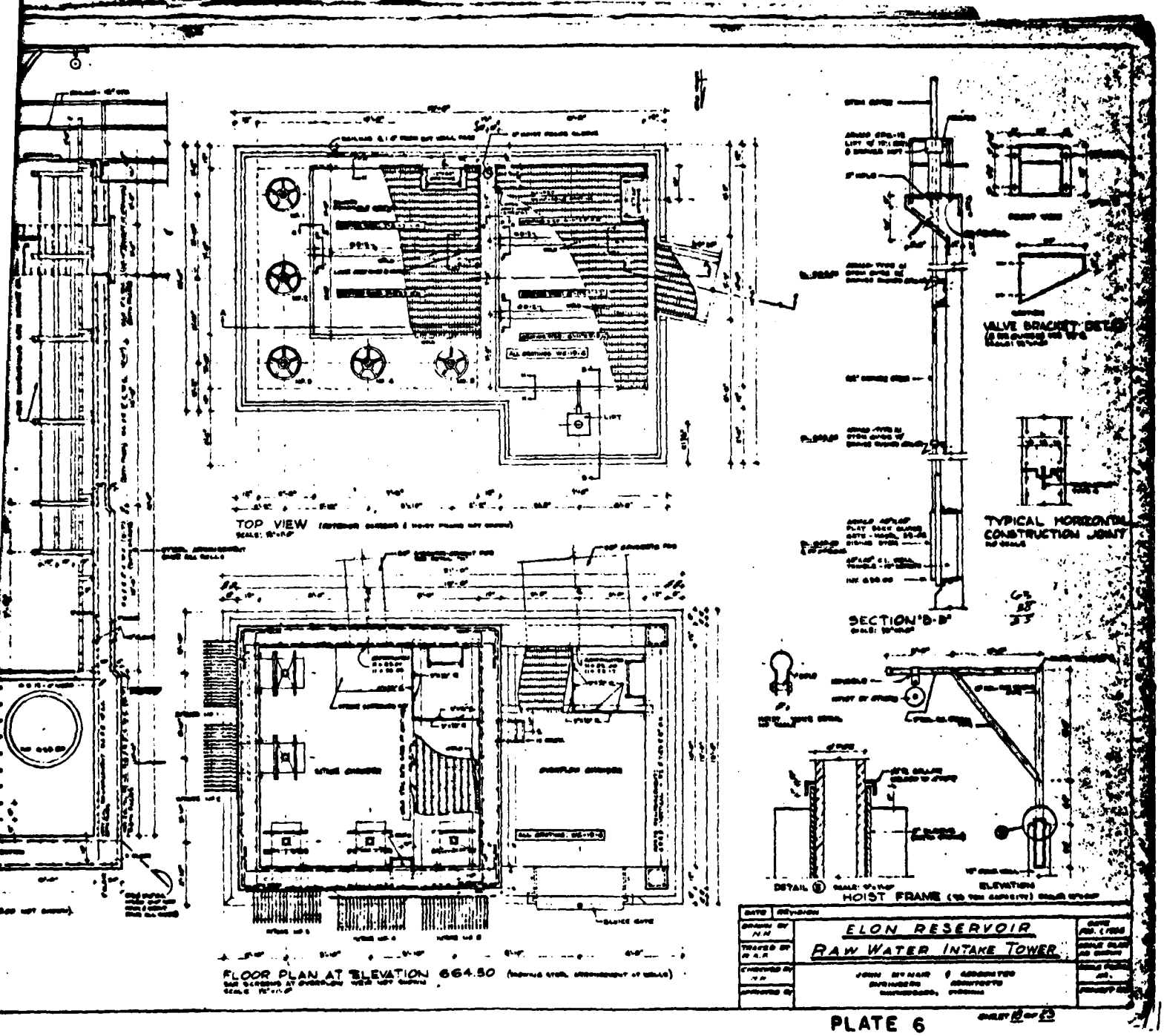
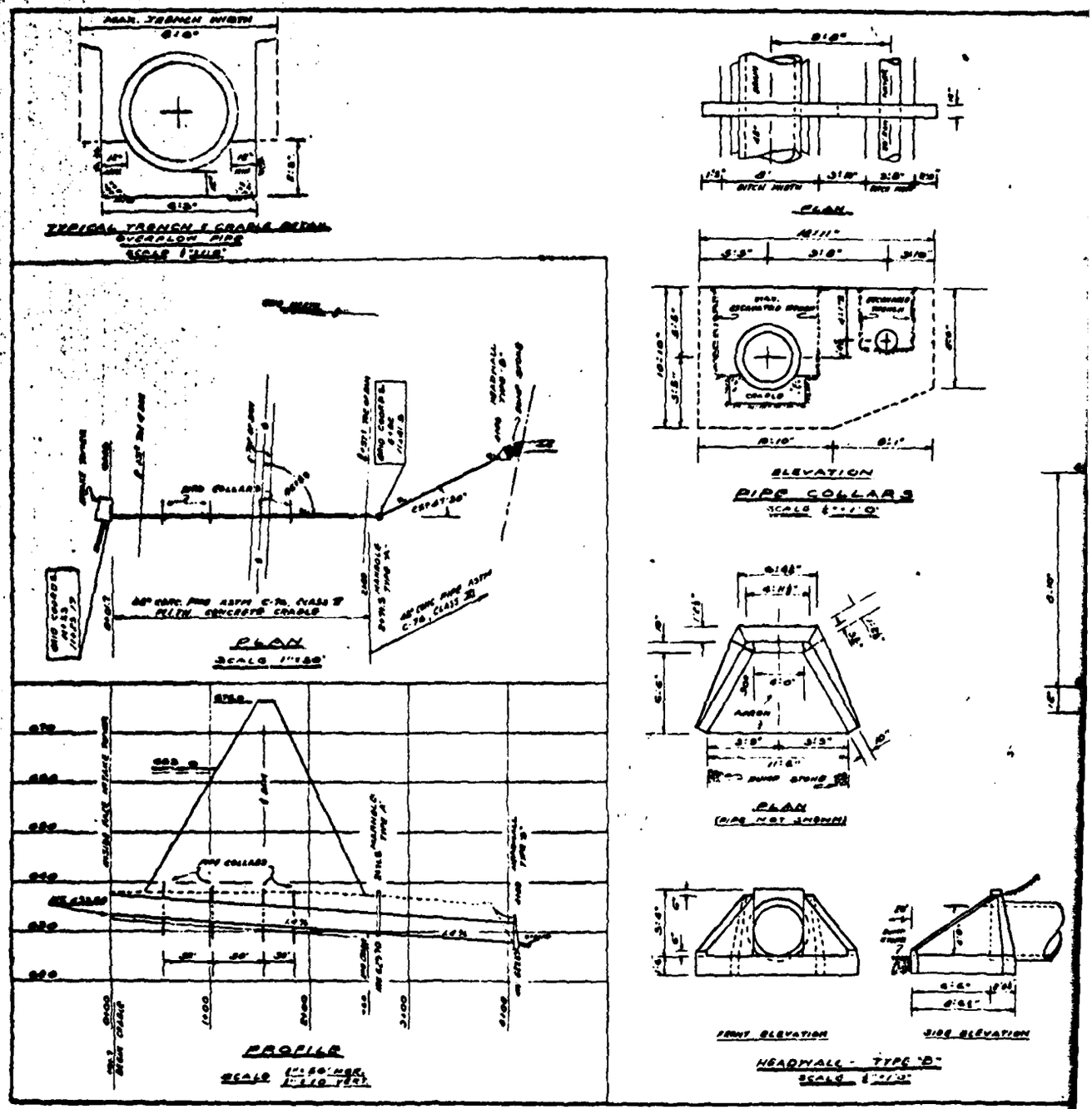

TOP VIEW
VALVE BRACKET DETAIL
TYPICAL HORIZONTAL CONSTRUCTION JOINT
SECTION "D-D"
DETAIL
ELEVATION
HOIST FRAME
FLOOR PLAN AT ELEVATION 664.50
ELON RESERVOIR
RAW WATER INTAKE TOWER

PLATE 6


MAX. TRENCH WIDTH
TYPICAL TRENCH & CRADLE DETAIL
OVERFLOW PIPE
PLAN
ELEVATION
PIPE COLLARS
PLAN
(PIPE NOT SHOWN)
PROFILE
FRONT ELEVATION
SIDE ELEVATION
HEADWALL - TYPE "D"

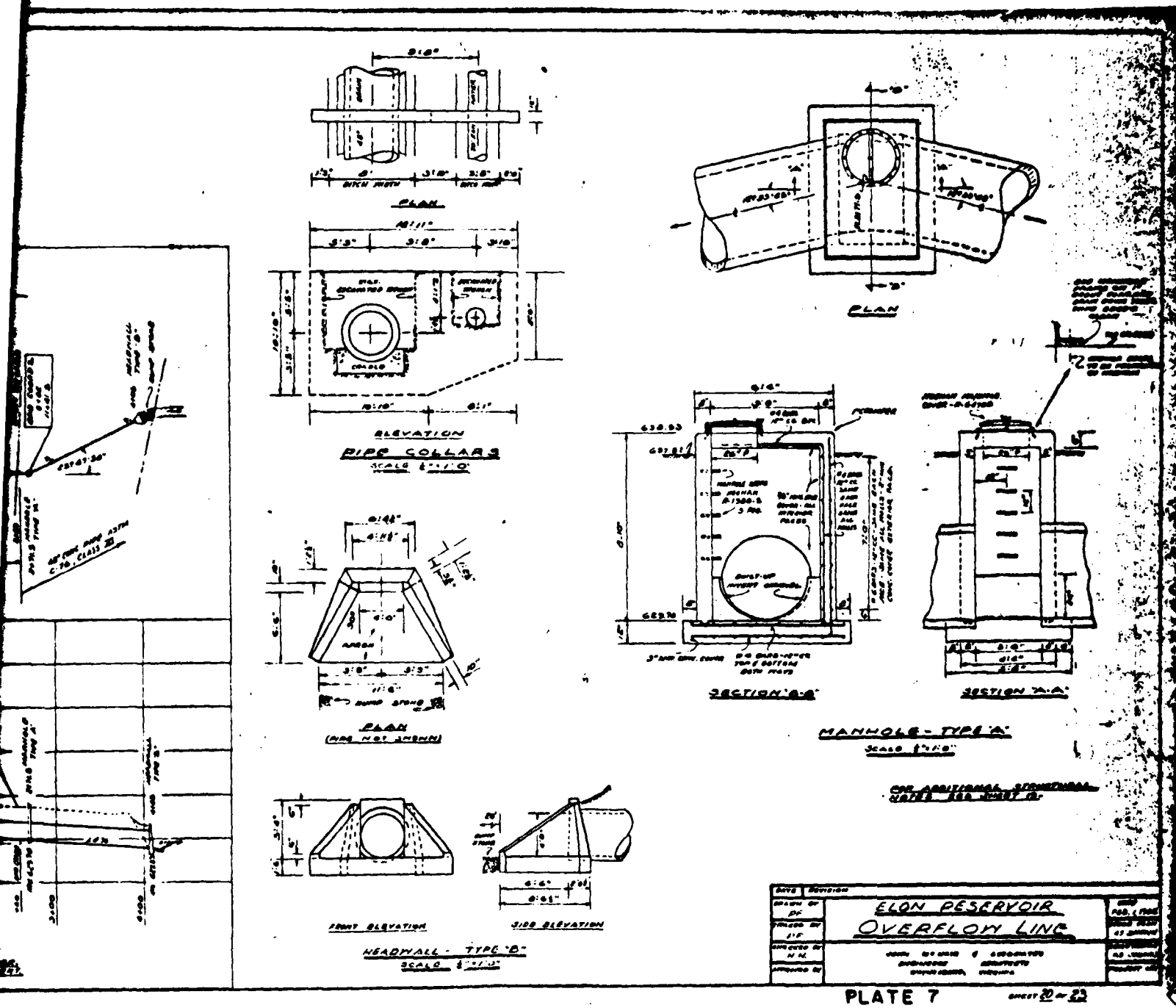


PLATE 7

SHEET 20 of 23

APPENDIX II

PHOTOGRAPHS

PHOTO #1 CREST OF DAM

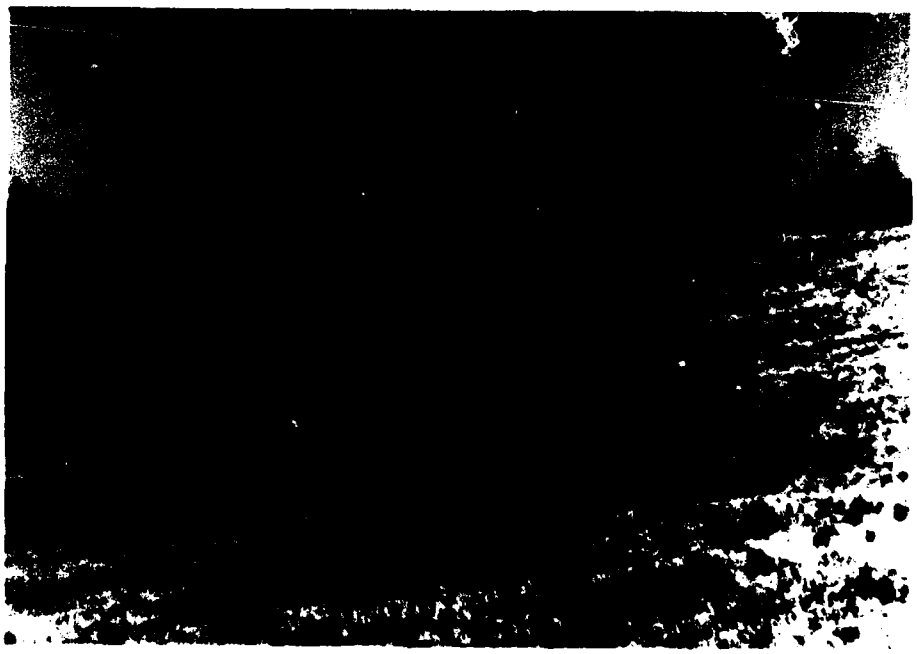


PHOTO #2 DOWNSTREAM FACE

PHOTO #3 UPSTREAM FACE

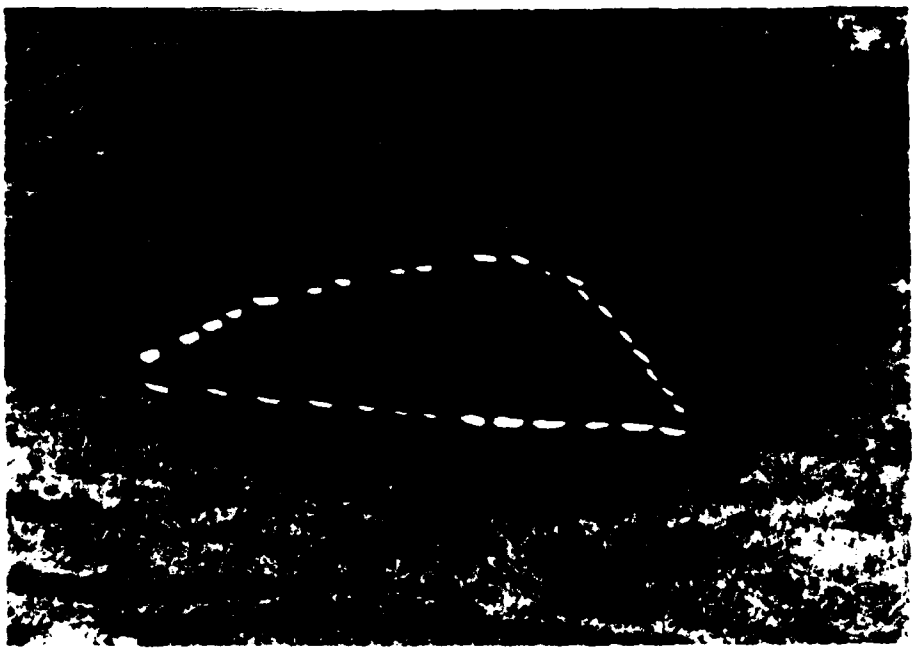


PHOTO #4 AREA BEYOND D/S TOE
(CATAILS, MARSH GRASS.
REEDS)

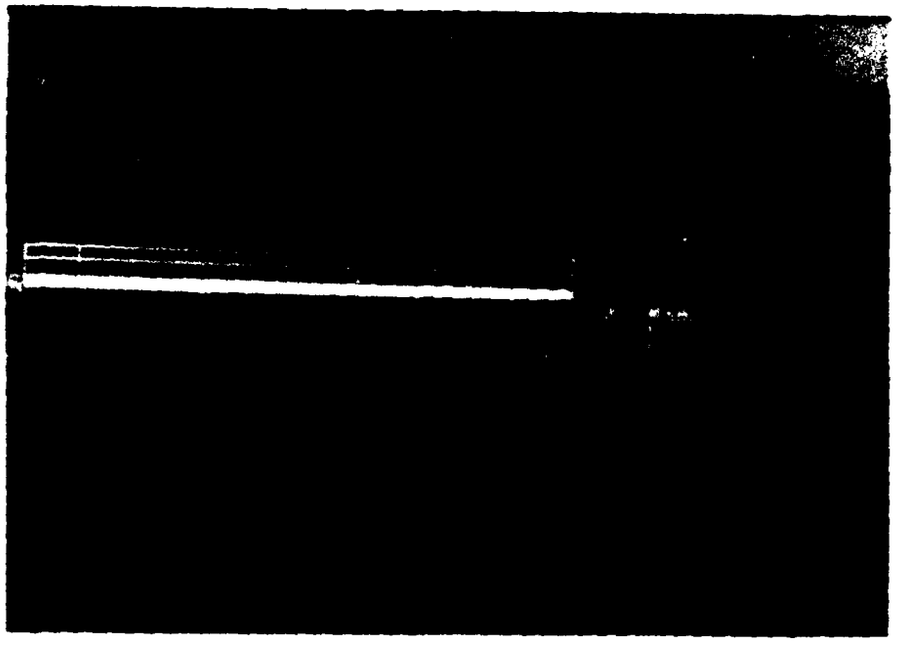


PHOTO #5 INTAKE STRUCTURE

PHOTO #6 PRINCIPAL SPILLWAY OUTLET

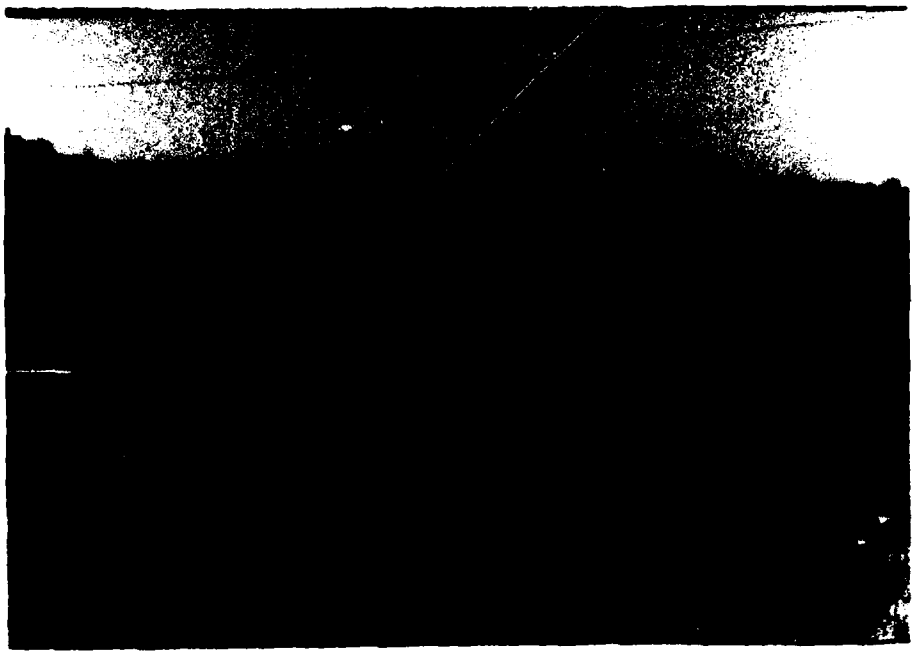


PHOTO #7 EMERGENCY SPILLWAY
APPROACH CHANNEL

PHOTO #8 EMERGENCY SPILLWAY

PHOTO #9 PLUNGE POOL

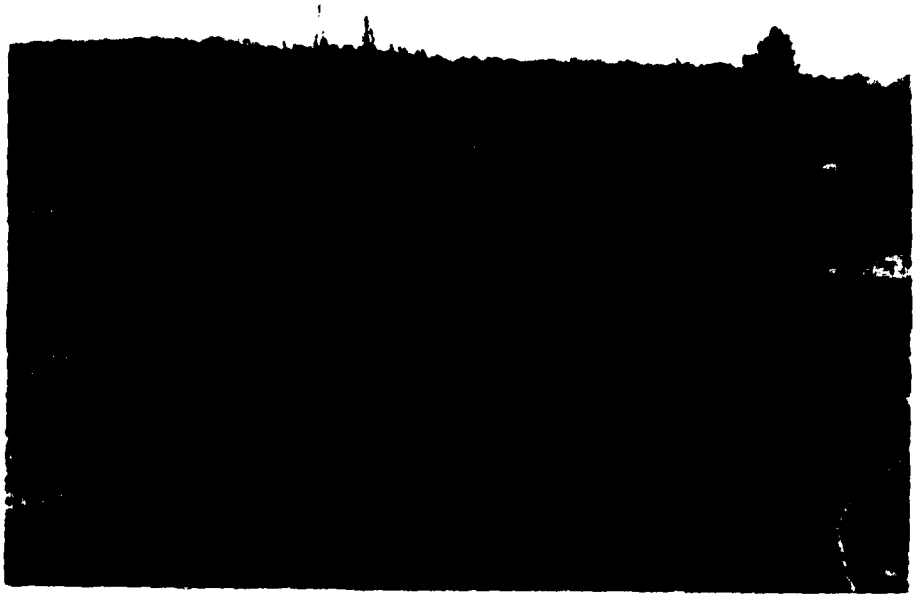


PHOTO #10 DISCHARGE CHANNEL

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam: Elon Water Works County: Amherst State: Virginia Coordinates: Lat. 37°- 29.4'
Long. 79° 10.0'

Date Inspection: 22 Jan 1981 Weather: Clear & Mild Temperature: 58°

Pool Elevation at Time of Inspection: 663.0 msl* Tailwater at Time of Inspection: 625.6 msl*

Inspection Personnel:

B. Taran, COE
J. Robinson, COE
D. Davis, COE

L. Jones, COE
R. Gay, SWCB
E. Constantine, SWCB

L. Musselwhite, SWCB
H. Gildea, SWCB

Constantine & Gildea Recorders

Heights
Madison Sanitary District (owner):

Mr. Henry L. Lanum
Mr. Dan E. French
Mr. James T. Stinette

*Mean sea level

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No surface cracks were observed. The general ground conditions were normal.	None.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	None.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	There is minor erosion from wave action in the left abutment below the emergency spillway.	Take measures to prevent further erosion.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	There is no appreciable settlement or horizontal movement of the crest.	None.
RIPRAP FAILURES	None observed.	None.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FOUNDATION	There is no evidence to suggest that the foundation is unstable.	None.
ANY NOTICEABLE SEEPAGE	Moist soil with marsh grass was noted at the toe of the dam, and there was some indication of possible moisture on the face of the dam above the toe, as evidenced by a difference in the vegetation here from that higher on the slope.	The moisture at the toe is probably normal seepage through the blanket drain. Monitor the areas for any flow or turbidity.
DRAINS	The dam was constructed with a blanket drain under a substantial portion of the downstream embankment. The moist area at the toe noted above may be an indication that it is working.	None.
MATERIALS	Local soils used in the construction of the dam are red silty clay (core) and silty sand.	None.
VEGETATION	The dam has a good grass cover.	Continue to maintain grass cover by periodic mowing.

PRINCIPAL SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONTROL SECTIONS		
INTAKE	The principal spillway intake for the dam is a square shaped concrete tower with three rectangular openings with the crests at elevation 663 feet MSL, in good condition.	None.
OUTLET	The principal spillway outlet is a 48" concrete pipe which discharges into a plunge pool or stilling basin. Concrete in good condition. The riprap protecting the plunge pool has failed in places. There is brush growing behind the wingwalls and headwalls of the outlet.	Repair riprap in plunge pool. Remove brush behind headwall and wingwalls.
BRIDGE AND PIERS	The bridge consists of a metal grating, supported by a concrete pier system, in good condition.	None.
EMERGENCY GATE	Operated from a stem on the intake structure, the emergency gate consists of an Armco 48" X 48" flat back sluice gate with the center of the opening at elevation 640.00.	None.
GATES AND OPERATION EQUIPMENT	None.	None.

EMERGENCY SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONTROL SECTIONS	The emergency spillway is an earthen side channel with a trapezoidal cross section. The control section has a base width of 80 feet, and side slopes of 1.5H:1.0V.	None.
APPROACH CHANNEL	The approach channel is clear of debris with no obstructions. There is minor erosion from wave action at the waterline in this area.	Take measures to prevent further erosion.
DISCHARGE CHANNEL	The discharge channel is somewhat eroded in its lower reaches where no danger is posed to the dam, and large riprap has been placed to dissipate the energy of flow in this area.	None.
BRIDGE AND PIERS	None.	None.
MISCELLANEOUS	None.	None.

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATION
MONUMENTATION/SURVEYS	None.	None.
OBSERVATION WELLS	None.	None.
WEIRS	None.	None.
PIEZOMETERS	None.	None.
STAFGAGES	None.	Install a staff gage, which is a staff, rod, or post with elevations indicated on it permanently mounted in a lake to show the depth of the water. It should be of sufficient height to indicate the depth of flow through the emergency spillway.
OTHER	None.	None.

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The slopes surrounding the reservoir are generally steep and heavily wooded, with open areas toward the dam. No slope stability problems or significant shoreline erosion was noted.	None.
SEDIMENTATION	Not measured.	None.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The channel immediately below the dam was wide with mild side slopes. Further below this the channel narrows and the side slopes steepen. There are trees growing along the banks of the stream..	Remove trees immediately below the plunge pool to eliminate the possibility of daming
SLOPES	The channel follows a natural streambed with a moderate slope.	None.
APPROXIMATE NO. OF HOMES AND POPULATION	There is one residence in the downstream flood plain approximately 3000 feet below the dam and then the Sanitary District's filtration plant, as well as State Route 130.	Develop an Emergency Warning Plan for the protection of downstream area.

APPENDIX IV

POST CONSTRUCTION INSPECTION REPORT

HURT & PROFFITT, INC. A Professional Corporation
ENGINEERS • SURVEYORS
1933 Fort Ave. • P. O. Box 1054 • Lynchburg, Virginia 24505 • 804 - 847-7796

February 24, 1977

Mr. Henry L. Lanum, Jr.
Madison Heights Sanitary District
P. O. Box 100
Madison Heights, Va. 24572

Re: Graham Creek Reservoir and Dam

Dear Mr. Lanum:

Upon your request, I made an inspection of the dam on Graham Creek, it's emergency overflow, the toe of the dam and the toe filter drains, and found the dam to be in excellent condition. All slopes were stable and with a good stand of grass. The toe filter drains and drainage ditches showed no excess amounts of seepage. Down stream rip-rap, below the overflow tower's outlet, was stable.

Seepage of this dam in relationship to other earth dams of similar size and height was relatively low.

At this time, we feel the dam is stable and there is no excess seepage.

Yours very truly,

HURT & PROFFITT, INC.

Charles F. Hurt, P. E.
CFH/bht

APPENDIX V

REFERENCES

APPENDIX V

REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Office of the Chief of Engineers, Department of the Army, Washington, D. C.

2. HEC-1 Flood Hydrograph Package, (Hydrologic Engineering Center, U. S. Army Corps of Engineers, January 1973).

3. NWS-Dambreak Computer Model, (Office of Hydrology, National Weather Service (NWS), Silver Spring, Maryland, September 1980).

4. "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Hydrometeorological Report No. 51, (National Weather Service, June 1978).

5. "Rainfall Frequency Atlas of the Unites States", Technical Paper No. 40, (National Weather Service, May 1961).

6. Bulletin 74: Geology and Mineral Resources of Lynchburg Quadrangle, Virginia, William Randall Brown, (Virginia Division of Mineral Resources, 1958).

7. Design of Small Dams, U. S. Department of the Interior, Bureau of Reclamation.