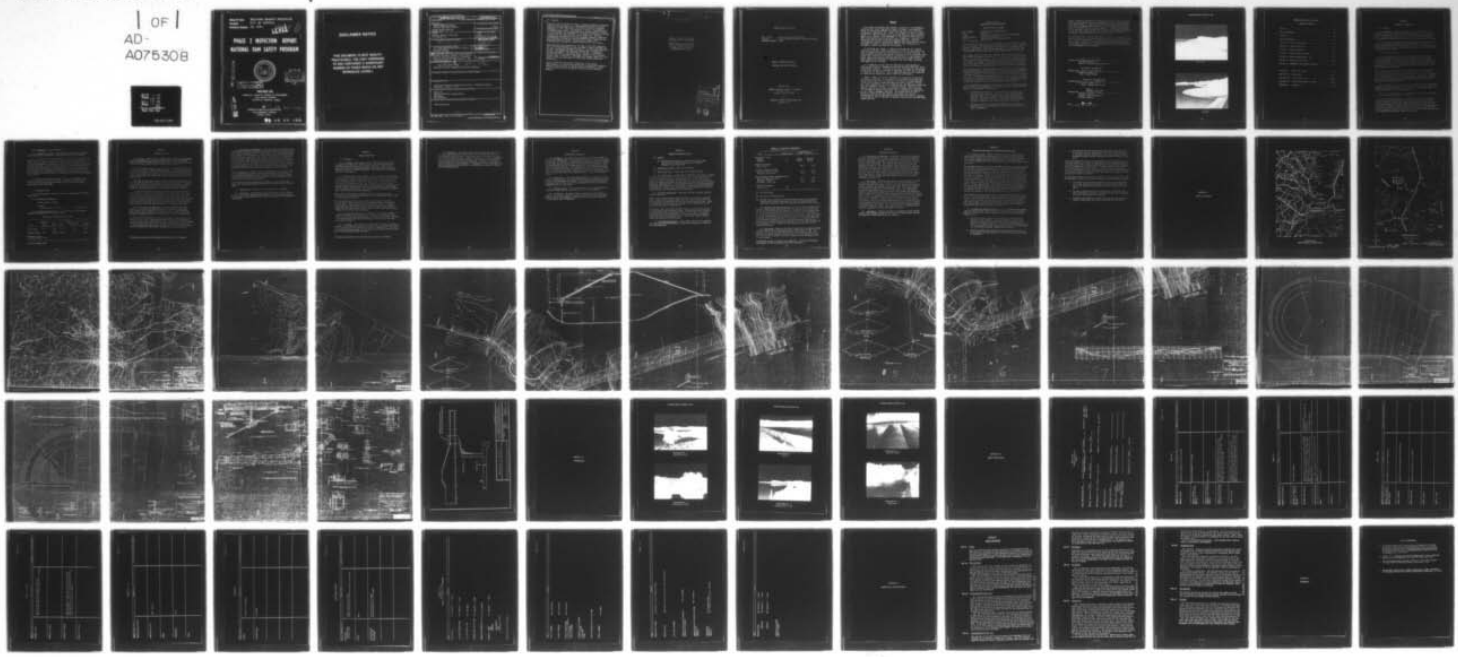
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Name Of Dam: WESTERN BRANCH RESERVOIR
Location: CITY OF SUFFOLK
Inventory Number: VA. 12311

LEVEL II

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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803 FRONT STREET
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BY

DEWARD M. MARTIN & ASSOCIATES
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20. Abstract

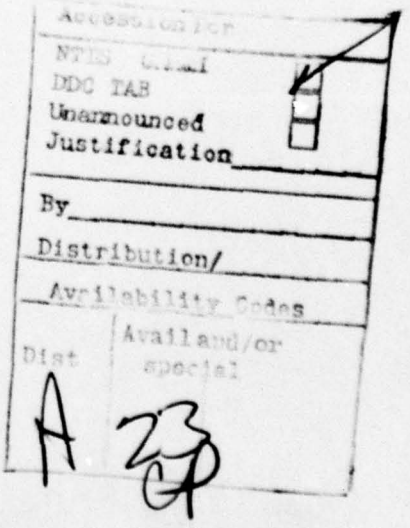
Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those 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.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

WESTERN BRANCH RESERVOIR DAM
CITY OF SUFFOLK, VIRGINIA
(Formerly Nansemond County)
INVENTORY NO. VA 12311



LOWER JAMES RIVER BASIN

Name of Dam : Western Branch Reservoir Dam
Location : City of Suffolk (formerly Nansemond County)
Inventory Number: 12311

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Prepared for

NORFOLK DISTRICT CORPS OF ENGINEERS
803 Front Street
Norfolk, Virginia 23510

by

Deward M. Martin & Associates, Inc.
August 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

BRIEF ASSESSMENT OF DAM

Name of Dam:	Western Branch Reservoir Dam
State:	Virginia
County:	City of Suffolk (formerly Nansemond County)
USGS Quad Sheet:	Chuckatuck, Virginia
Stream:	Western Branch of Nansemond River
Date of Inspection:	May 7, 1979

Western Branch Reservoir Dam is an earthfill structure 2,840 feet long and 30 feet high. The dam is owned and operated by the City of Norfolk, Virginia. The dam is classified an intermediate in size with a high hazard classification. The spillway consists of a semi-circular concrete approach 150 feet wide with a crest elevation of 19 feet m.s.l.

The spillway will pass 26% of the Spillway Design Flood (which is the PMF) without overtopping the dam. The SDF will overtop the dam by 2.8 feet. The water velocity of 9.5 feet per second and a 30 hour duration of flow over the dam, during the PMF, will cause the erosion and potential failure of the dam. Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway is rated as inadequate and the dam is assessed as unsafe-non-emergency.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

It is recommended that within 2 months from the date of notification to the Governor of the Commonwealth of Virginia, the owner engage the services of a professional consultant to:

a. Determine by more sophisticated methods and procedures the adequacy of the spillway. The study should include a more detailed study of the Spillway Design Flood appropriate to this dam. Remedial measures to be considered include modification to the dam, spillway, flood plain, and/or any other method of eliminating the danger imposed by the project.

b. Determine whether the stability conditions and the safety margins satisfy the requirements and guidelines given in Reference 4, Appendix V.

Within 6 months of the date of notification by the Governor, the professional consultant's report of appropriate remedial mitigating measures should have been completed and the Owner should have an agreement with the Commonwealth of Virginia to a reasonable time frame in which all remedial measures will be complete. In the interim, a detailed emergency operation plan and a warning system should be promptly developed. Also during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

The following items, although important, are not urgent and should be completed as part of the general maintenance of the dam: remove ponded water along the downstream toe of the dam, monitor settlements in the parapet wall on the crest of the dam and in the retaining wall panel. If settlement continues then remedial measures may be required to protect the integrity of the concrete.

Prepared By: Paul Seiler
PAUL SEILER, P.E.
Deward M. Martin & Associates, Inc.

ORIGINAL SIGNED BY:
Submitted By: JOHN E. KENNEDY
for JAMES A. WALSH, P.E.
Chief, Design Branch

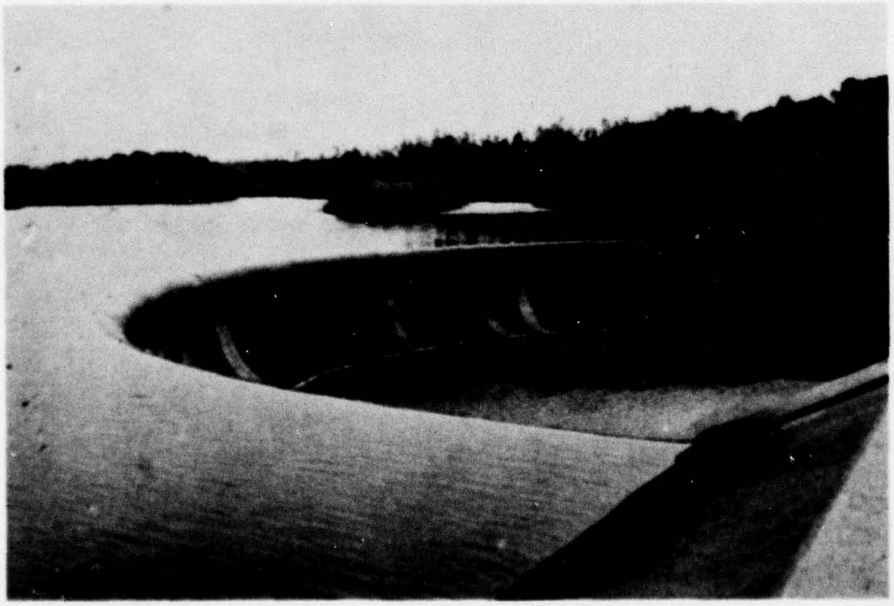
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Recommended By: CARL S. ANDERSON, JR.
for JACK G. STARR, P.E.
Chief, Engineering Division

Original signed by:
Approved By: Douglas L. Haller
DOUGLAS L. HALLER
Colonel, Corps of Engineers
District Engineer

Date SEP 17 1979



Top of Dam



Spillway

WESTERN BRANCH RESERVOIR DAM

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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 V, Reference 4). 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: Western Branch Reservoir Dam is an earthen embankment dam about 2,840 feet long and 30 feet high. The top of the dam is 14 feet wide at an elevation of 24.0 feet m.s.l. The upstream slope is 2(H):1(V) and the entire slope is covered with an 8-inch concrete slab. A 3 foot high parapet wall was built at the upstream edge of the dam along the entire length of the crest. The downstream slope is 3(H):1(V).

The spillway, located near the left abutment, is a semi-cirular ogee shaped spillway with the crest at elevation 19.0. A water intake structure in the reservoir near the right abutment is used to withdraw water for treatment and to empty the reservoir. Two 42-inch diameter pipes from the intake tower run through the dam and then are reduced to 30-inches to the treatment plant and then become two 30-inch Y branches to the downstream creek.

1.2.2 Location: The dam is located 4.7 miles south of Chuckatuck, Virginia, along State Route 10/32 and 2.4 miles north of U S Route 460 interchange with State Route 10/32 between Red Top and Reids Ferry on the Western Branch of the Nansemond River.

1.2.3 Size Classification: The dam is classified as intermediate by a storage capacity of 27,970 acre-feet.

1.2.4 Hazard Classification: The dam is located in a predominately rural area where failure of the dam would endanger the pump station at the dam and about 20 homes at Reids Ferry, (which are within the flood plain for the PMF) 3,000 feet downstream from the dam. The dam is classified as high hazard in accordance with the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of the location only and unrelated to the stability or probable failure of the dam.

1.2.5 Ownership: City of Norfolk.

1.2.6 Purpose of the Dam: The reservoir is used as a source of water for the City of Norfolk. Boating and fishing is permitted.

1.2.7 Design and Construction History: This dam was designed in 1960 under the guidance of Richard F. Wagner, Consulting Engineer. In 1963, a reverse filter of gravel and 2 feet thick riprap was added along the downstream toe between Sta. 4+15 and Sta. 11+50, in accordance to Change Order No. 3 by Justin and Courtney, Consulting Engineers of Philadelphia, Pennsylvania. Construction specifications for the dam are included with this report as Appendix IV. The name of the principal contractor for the dam is not known and no construction records were available to confirm that the construction of the dam was performed as specified.

1.2.8 Normal Operating Procedures: Water is withdrawn to the water treatment plant for water supply. Otherwise, regulation of flows is automatic with water rising above the crest of the spillway passing freely downstream.

1.3 Pertinent Data:

1.3.1 Drainage Area: The dam controls a drainage area of 65.18 square miles.

1.3.2 Discharge at Dam Site:

Maximum flood - Unknown.

Spillway
pool level at top of dam . . . . . 18,700 c.f.s.

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 m.s.l.	Reservoir Capacity Area, Acres	Acre, feet	Watershed, inches	Length, miles
Top of Dam *	27	1,651	27,970	8.1	4.0
Spillway Crest	19	1,282	14,620	4.2	4.0
Streambed at the toe of the dam	-3+				

* Top of parapet wall

SECTION 2

ENGINEERING DATA

2.1 Design: Plans entitled "Norfolk Water Development Construction Plans Contract No. 1, Western Branch Dam", dated April 1960, signed by Richard F. Wagner, Consulting Engineer, are available in the files of the Department of Public Works, City of Norfolk.

*2.1.1 Geologic Setting of the Dam Site: Physiographically, the dam is located in the Coastal Plain Province. The geologic formations at the site consist of the Sedley and Yorktown formations of pliocene to miocene geologic age. Downstream of the dam are Quarternary, alluvium, estuarine-beach sediments and fluvial-estuarine fills of recent geologic age.

The Sedley formation consists of marine and estuarine silt, clay and fine sand deposits which overlie the Yorktown formation. The contact between the Sedley and underlying Yorktown formation is normally irregular. Relief of up to 25 feet has been observed in exposures along the James and Pagan Rivers several miles north of the site.

The Yorktown formation consists of marine sand, clay and broken shell material. Soils of this formation tend to be more compact than those of the overlying Sedley formation. In general, the upper part of the Yorktown formation ranges from fossilferous clayey sand and clay to coquina (a limestone typically formed from broken shells, coral and organic debris) found in areas east of the site. The term "marl" is often used to describe the more compact mixtures of clay, sand and shells found at the site, which belong to the Yorktown formation.

*2.1.2 Geologic Investigations: Soil test borings have been drilled at the site in conjunction with its original construction. These borings were drilled by the City of Norfolk. The information obtained from these borings was compiled by the city in the form of a profile as shown on Plate No. 3 in Appendix I and dated April 1960.

As shown by the profile, marl exists at irregular depth varying from about 8 to -40 m.s.l. Overlying the marl were varying thicknesses of clay, sand, clayey sand and silty sand. This material was excavated prior to construction of the dam. A soil termed "mud", most likely an alluvial material, made up the majority of soil overlying the marl, between stations 3+00 and 11+00, just east of the Western Branch.

*Information provided By Law Engineering Associates of Virginia.

2.2 Foundation and Embankment: Original design calculations were not available. However, original construction plans and specifications are shown in Appendix I and IV, respectively. The plan and specifications called for excavation of existing mud in the proposed embankment area down to the underlying sand stratum. As shown by the subsurface profile along the axis of the dam (compiled by the City of Norfolk), the top of this sand stratum ranged from about 20 feet m.s.l. to about -28 feet m.s.l. The excavation was to have a maximum width of 100 feet and the angle of the slope of the exposed mud at the two sides of the prism formed, was to be the natural angle of slope assumed by the mud after the base of the prism was excavated to its full depth.

The construction specifications do not indicate the type of fill used for the embankment; however, shallow hand auger probes performed on the downstream embankment slopes revealed soils consisted of brown medium fine sand with little silt and clay. Specifications for fill placement are enclosed in Appendix IV.

Construction plans also showed the location of a steel sheet pile wall. The interlocking sheet piles were to be driven three feet into "marl."

2.3 Construction: Construction records were not available.

2.4 Operations: The operation record indicated that the riprap along the toe of the embankment was added in 1963 by change order No. 3, designed by Justin and Courtney, Consulting Engineers, Philadelphia, Pennsylvania.

SECTION 3

VISUAL INSPECTION

3.1 Findings:

3.1.1 General: The results of the 7 May 1979 inspection are included in Appendix III. At the time of the inspection the pool elevation was at 19.0 feet m.s.l. which is normal. There are no known past inspection reports available. The area around the dam is flat and forested. Trees are growing in the downstream flood plain but not in the channel.

3.1.2 Dam: There is no evidence of any horizontal misalignment of the crest of the dam. The dam has a concrete slab on the upstream side attached to a wall 3 feet high on the crest. This wall has a vertical settlement of 2 inches to 3 inches and appears to have been like this for a long time, since any shift of the wall at joints equally as weathered as other surfaces of the wall. The settlement in the wall may be related to the need for stabilization of the embankment just after construction. The embankment was stabilized by adding large rock to the toe of the embankment.

*There were several small undulations along the downstream slope, probably due to differential settlement of the underlying soils. None of these appeared serious.

*The downstream area of the dam, in the wooded section, had water puddled about 30 feet from the toe and several hundred feet east of the spillway. There is mud 15 inches below the surface. The topography was generally flat and water, probably runoff, was drained toward the toe, rather than a nearby ditch. There were no toe drains visible at the time of the inspection.

*3.1.3 Appurtenant Structures: Settlement of the wall (parapet) running along the crest of the dam was observed approximately 400 feet to the left of the intake tower. The area of settlement consists of two panels which have settled, forming a slight dip in the wall where they intersect.

3.1.4 Spillway: The concrete spillway shows evidence of surface spalling. Settlement and tilting was observed in a retaining wall panel on the north side of the spillway (see Plate 7, Appendix I). The top of the panel has tilted forward, and the front of the panel's base has settled. Both have moved about two inches.

*Information provided by Law Engineering Associates of Virginia.

3.2 Evaluation: The visual inspection revealed that there is a 2-3 inch sag in the wall on the crest of the dam and that there is water puddled below the dam. It appears there is no flow in an auger hole placed in the wet areas. Corrective measures are under consideration for the spalling of the spillway. The settlement and tilting in the retaining wall pond should be monitored regularly to determine whether or not it is still moving. If movement is still occurring, the owner should secure the services of a professional engineer to recommend corrective action.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure: The normal pool elevation is 19.0 feet which is the crest of the spillway. The reservoir is used as a source of water for the City of Norfolk. The Public Works Department maintains records of the lake level and water taken from the lake for treatment. Water is taken from the dam by the pump station 200 feet downstream of the dam at the right abutment. The pump station is manned during working hours. A water level guage is connected by direct wiring to the city office of the water treatment plant where records are maintained of the lake level and drawdown to the pumping station. Water is diverted as needed.

4.2 Maintenance: The Public Works Department of the City of Norfolk has responsibility for maintaining the dam and pumping facilities as well as maintaining the grounds. Other maintenance or grounds improvements are by order of the City and would be on file at the city treatment plant or city office.

4.3 Warning System: There is no warning system established for this dam to warn persons in the area in case of an emergency.

4.4 Evaluation: The Public Works Department for the city of Norfolk has a well established system for operation and routine maintenance of the dam, however, a warning system should be established for the dam in case of emergency.

SECTION 5

HYDRAULIC/HYDROLOGIC DATA

5.1 Design:

a) Norfolk Water Development Construction Plans from the Director of Public Works, City of Norfolk, Virginia, dated April 1960.

5.2 Hydrologic Records: None were available.

5.3 Flood Experience: There were no records available.

5.4 Flood Potential: The PMF and 1/2 PMF were developed and routed through the Lake Burnt Mills, Lake Prince, and Western Branch Reservoir by use of the HEC-1 computer program (Reference 3, Appendix V) and appropriate unit hydrograph, precipitation, ans storage-outflow data. Clark's Tc and R coefficients for the local drainage area were estimated from basin characteristics. The rainfall applied to the developed unit hydrograph was obtained from a U S Weather Bureau Publication (Reference 1, Appendix V). Losses were estimated at an initial loss of 1.0 inch and a constant loss thereafter of 0.05 inch/hour.

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

Water is passed from Western Branch Reservoir to the water treatment plant. Two 42-inch diameter pipelines from a water intake tower in the reservoir run through the dam to the water treatment plant. Water also flows past the dam over the spillway in the event water in the reservoir rises above elevation 19.0.

The storage curve above the spillway crest was calculated by use of U S Geological Survey Quadrangle Maps. Rating curves were developed for the spillway and non-overflow section of the dam. In routing hydrographs through the reservoir, it was assumed that the initial pool level was at the spillway crest. Flow to the water treatment plant was neglected during routing.

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

Table 5.1 RESERVOIR PERFORMANCE

Item	Normal flow	Hydrograph 1/2 PMF	Hydrograph PMF (c)
Peak Flow, c.f.s.			
Inflow	3	44,671	104,525
Outflow	--	35,057	96,363
Maximum elevation feet, m.s.l.		28.4	31.4
Spillway (elevation 19.0)			
Depth of flow, feet (a)		6.6	8.6
Velocity, f.p.s. (b)		14.5	16.7
Non-overflow section (elevation 27.0)			
Depth of flow, feet (a)		0.9	2.8
Duration , hours		11	20
Velocity, f.p.s. (b)		5.4	9.5
Tailwater elevation, feet, m.s.l.	0±		

(a) Critical Depth.

(b) Velocity at Critical Depth.

(c) The PMF is an estimate of flood discharged that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

5.7 Reservoir Emptying Potential: The two 42-inch pipelines from the water intake tower can also be used for dewatering the reservoir. The two 42-inch pipelines are reduced to 30-inches near the downstream toe of the dam and then have two 30-inch laterals to the downstream creek and the main lines to the water treatment plant. Four gate valves on the 30-inch pipelines at elevation 0.0 are available for dewatering to within 3 feet of the bottom of the reservoir. The valves will permit withdrawal of about 350 c.f.s. with the reservoir level at the crest of the spillway and essentially dewater the reservoir in about 60 days assuming 3 c.f.s. inflow into the reservoir and no flow from upstream reservoirs.

5.8 Evaluation: Based on the size (intermediate) and hazard (high) classifications, the recommended Spillway Design Flood is PMF. The spillway will pass 26% of the PMF without overtopping the dam. The PMF will overtop the dam for 20 hours and reach a maximum of 2.8 feet over the top of the parapet, with an average critical velocity of 9.5 feet per second.

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

SECTION 6

STRUCTURAL STABILITY

6.1 Foundation and Abutments: A profile of the dam is shown on Plate No. 3, Appendix I. A soil termed "mud", probably an alluvial material, overlies a thin layer of sand which lies above a layer of "marl". The layer of mud above the marl was excavated prior to construction and backfilled. The construction specifications do not indicate the type of fill used, however, hand auger probes of the embankment revealed a soil consisting of brown medium fine sand with little silt or clay (see section 2.2.) Sheet piles were driven in the area of the spillway. The sheet piles were driven 3 feet into the marl layer and they provide a firm foundation for the toe wall. The piling appears to have been installed as a cutoff wall to aid in preventing seepage through the dam, however, there are no records available to verify this.

6.2 Embankment: The downstream slope of the embankment is 3(H):1(V) and the upstream slope is 2(H):1(V). The upstream slope is covered with an 8-inch thick concrete slab, over the entire length of the dam, probably for seepage control and slope protection although no records were available to substantiate this. The construction records do not indicate the type of fill used for the embankment, however, shallow auger probes performed on the downstream embankment slopes revealed soils consisting of brown medium fine sand with little silt or clay. In compliance with the Contract Specifications, (Appendix IV), the embankment was to be placed in layers with a compacted thickness of 6 inches. Compaction was by sheepsfoot and/or heavy duty rubber-tired rollers 95% maximum density in accordance with the specifications and the fill was to be placed so that proper drainage was maintained at all times. The above information indicates proper procedures, however, construction records were not available and no stability analyses have been performed on the dam.

6.3 Evaluation: Without information regarding the soil stratigraphy, soil strength parameters or lines of seepage within the dam, the stability conditions can not be assessed.

SECTION 7

ASSESSMENT AND REMEDIAL MEASURES/RECOMMENDATIONS

7.1 Dam Assessment: Design calculations, construction records and structural stability evaluations of the dam were not available. Ponded water exists along the downstream toe of the dam in a wooded area several hundred feet east of the spillway. The ponded water may soften the underlying soils with time, thus reducing their strength properties.

The spillway will pass 26% of the SDF (PMF) without overtopping the dam. The SDF will overtop the dam by 2.8 feet with a velocity of 9.5 feet per second for a duration of 30 hours. This flow will cause serious erosion and probable failure of the dam. Due to these facts, and based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway is rated as inadequate and the dam is assessed as "unsafe-non-emergency". The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

The ponded water located at the toe of the embankment could cause the soil to become soft and muddy unless the drainage conditions are corrected. The settlement in the parapet wall appears to have occurred some time ago and does not show signs of recent movements or major structural damage. Settlement and tilting detected in one section of the spillway wall may, if movement is still continueing, indicate potential failure of that section of the wall.

7.2 Recommended Remedial Measures: It is recommended that within 2 months from the date of notification to the Governor of the Commonwealth of Virginia, the owner engage the services of a professional consultant to :

a. Determine by more sophisticated methods and procedures the adequacy of the spillway. The study should include a more detailed study of the Spillway Design Flood appropriate to this dam. Remedial measures to be considered include modification to the dam, spillway, flood plain, and/or any other method of eliminating the danger imposed by the project.

b. Determine whether the stability conditions and the safety margins satisfy the requirements and guidelines given in Reference 4, Appendix V.

c. Determine if the settlement and tilting detected in one panel of the north side of the spillway channel is still occurring. If movement is still taking place, the owners engineer should recommend remedial measures designed to prevent failure of the wall.

Within six months of the date of notification by the Governor, the professional consultant's report of appropriate remedial mitigating measures should have been completed and the Owner should have an agreement with the Commonwealth of Virginia to a reasonable time frame in which all remedial measures will be complete. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

The following items do not require immediate action, however they should be corrected as part of the regular operation and maintenance program:

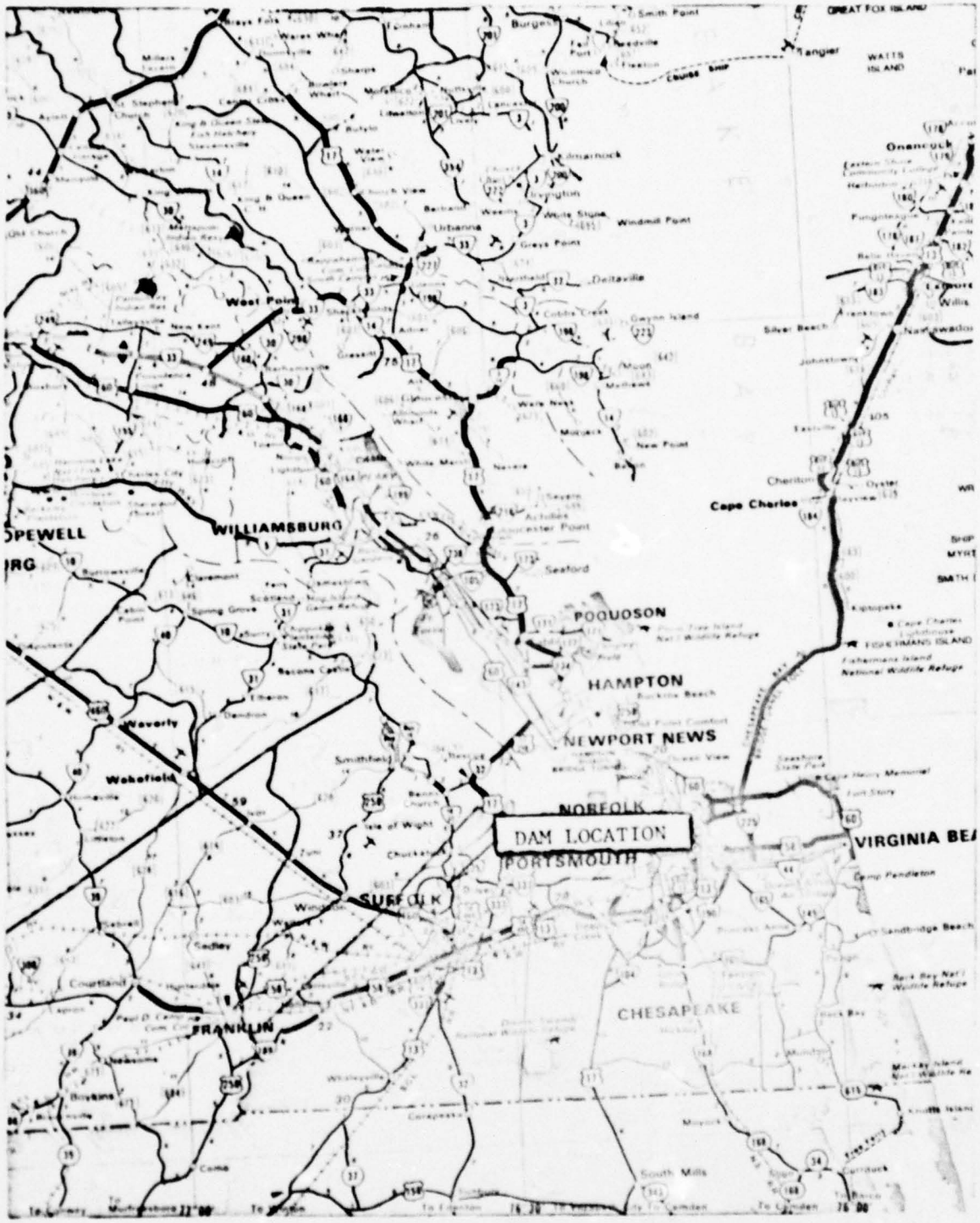
a. The ponded water should be removed from along the downstream toe of the dam and steps should be taken to insure that surface water drains away from the toe of the dam to the nearby ditch.

b. The owner should monitor the settlement of the parapet wall and if settlement continues, remedial measures may be required to protect the integrity of the dam.

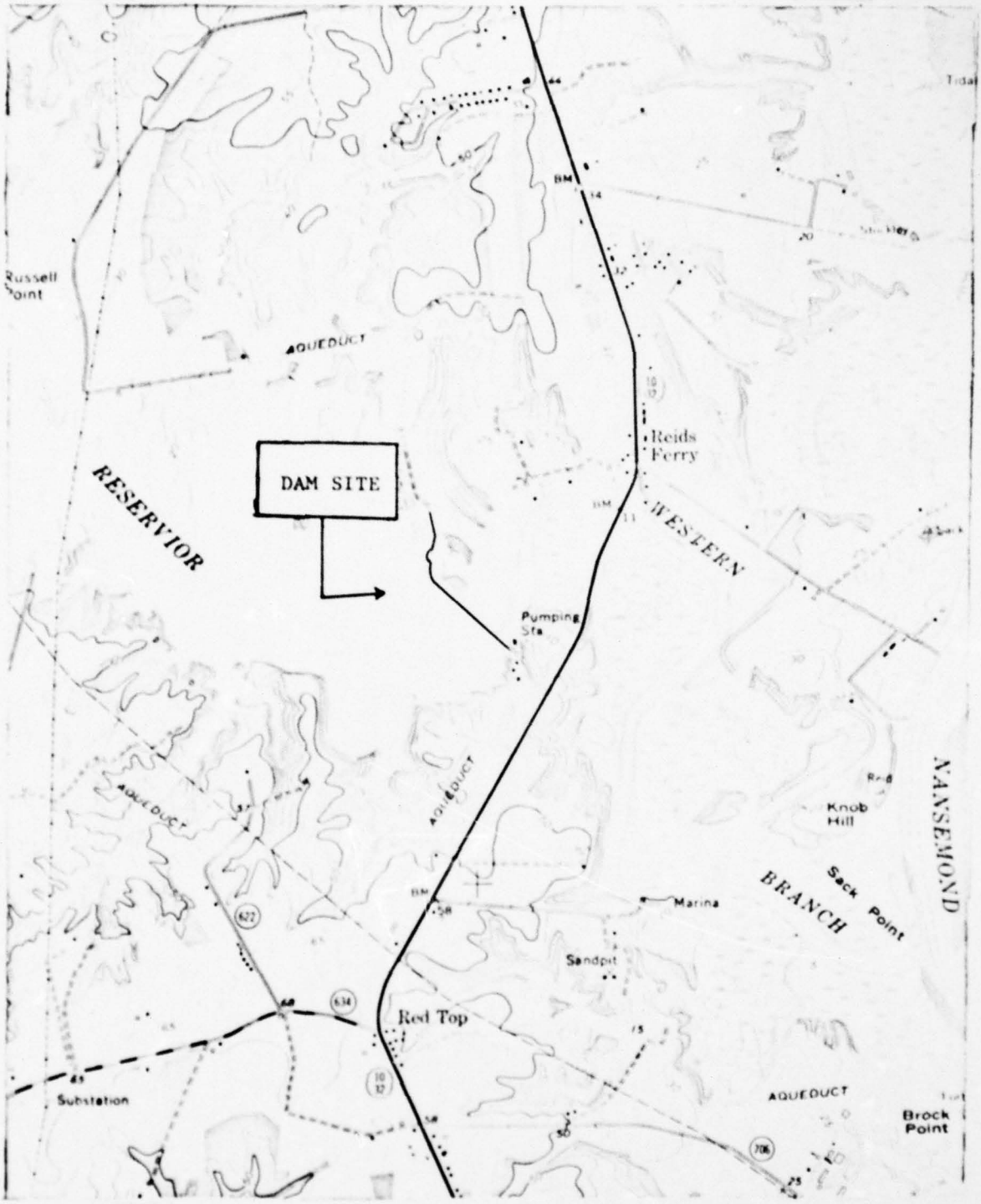
c. An annual maintenance and inspection program should be initiated to help detect and control problems that may occur.

APPENDIX I

MAPS AND DRAWINGS



REGIONAL MAP
WESTERN BRANCH RESERVIOR DAM



MN
GN
7°
12.4 MILS
0°56'
17 MILS

UTM GRID AND 1972 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

scale 1"=2000'
10' contours

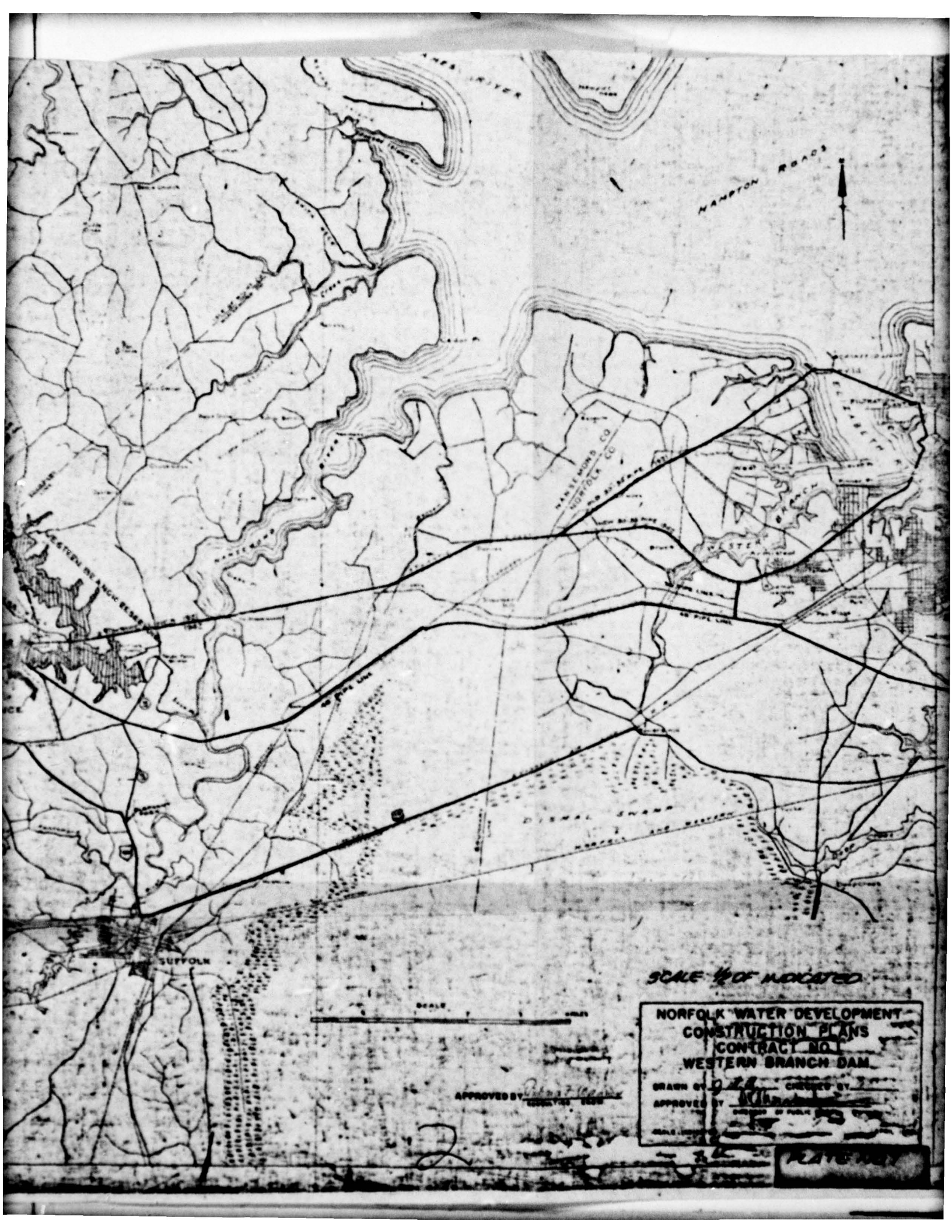
CHUCKATUCK, VA.

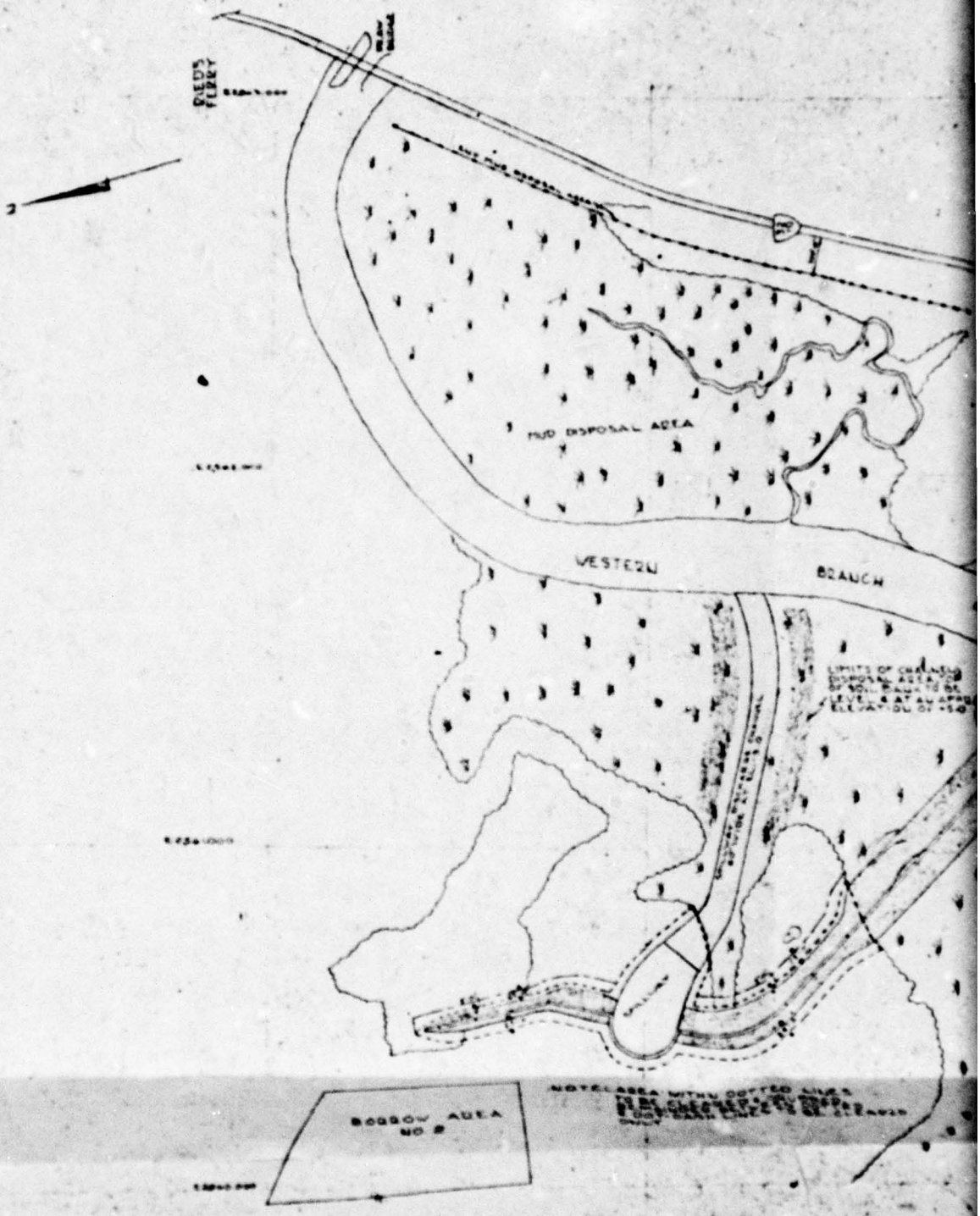
N3645—W7630/7.5

1965
PHOTOREVISED 1972
AMS 5657 I SE—SERIES V834

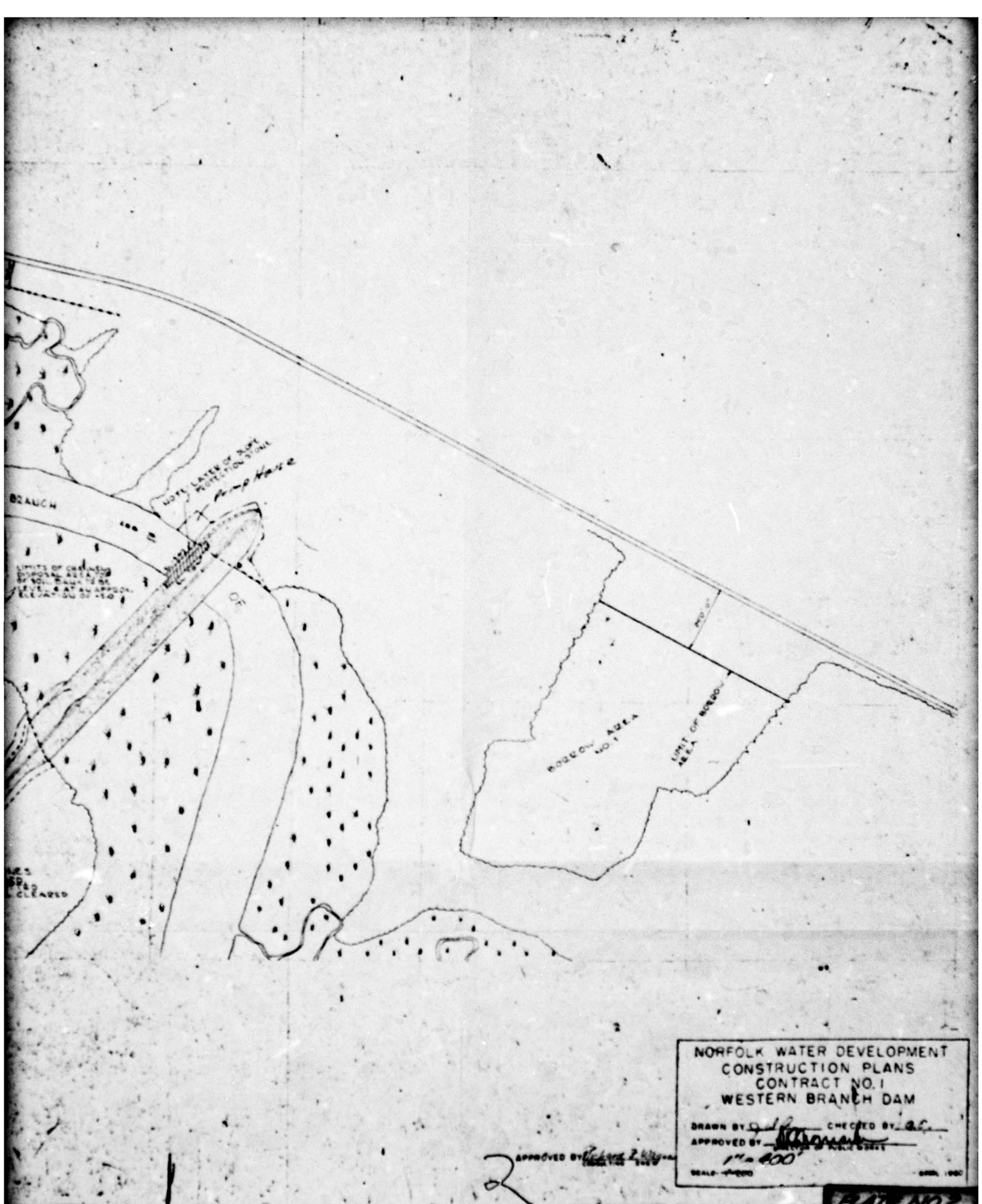
VICINITY MAP
WESTERN BRANCH RESERVOIR DAM
WESTERN BRANCH LAKE


Drainage Area
254.56 Miles
Drainage Area
80.2 56 Miles
Lake Prince


HAMPTON ROADS
SUFFOLK
SCALE ½ OF INDICATED
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
CONTRACT NO.
WESTERN BRANCH DAM
DRAWN BY
CHECKED BY
APPROVED BY
APPROVED BY
RETURNED


REED'S FERRY
MUD DISPOSAL AREA
WESTERN BRANCH
BORROW AREA NO 2

1

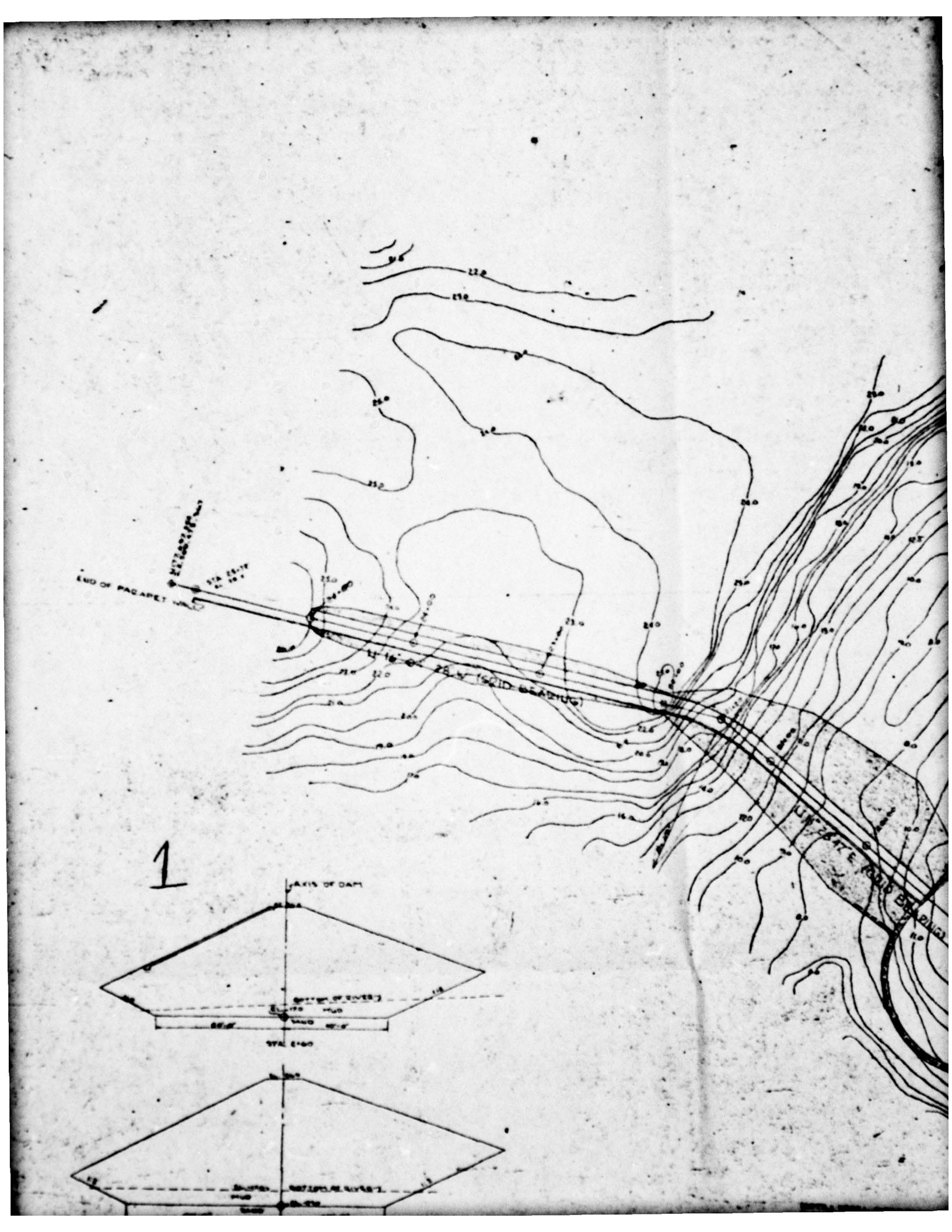


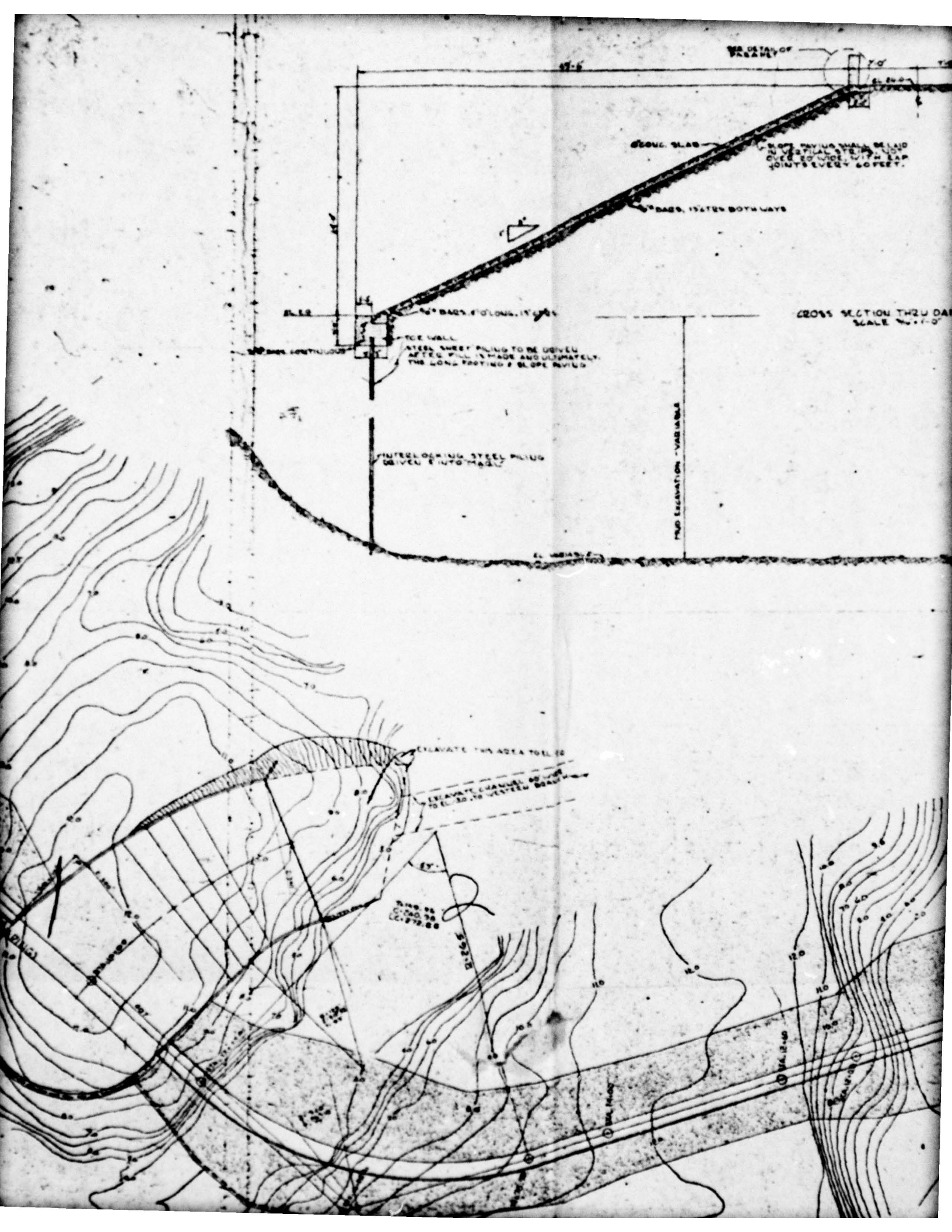
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
CONTRACT NO. 1
WESTERN BRANCH DAM

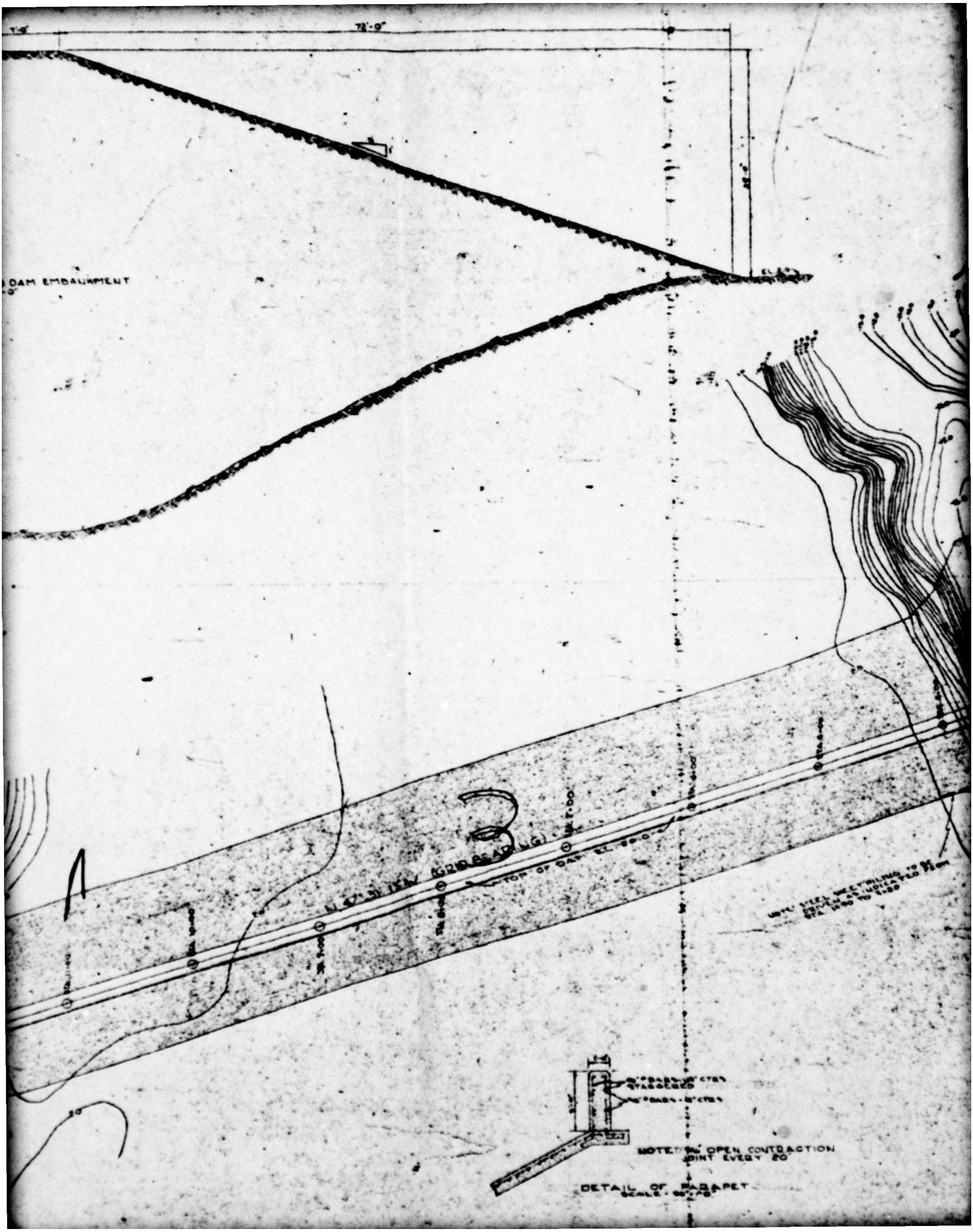
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APPROVED BY [illegible]
1" = 400'
SCALE [illegible] DATE [illegible]

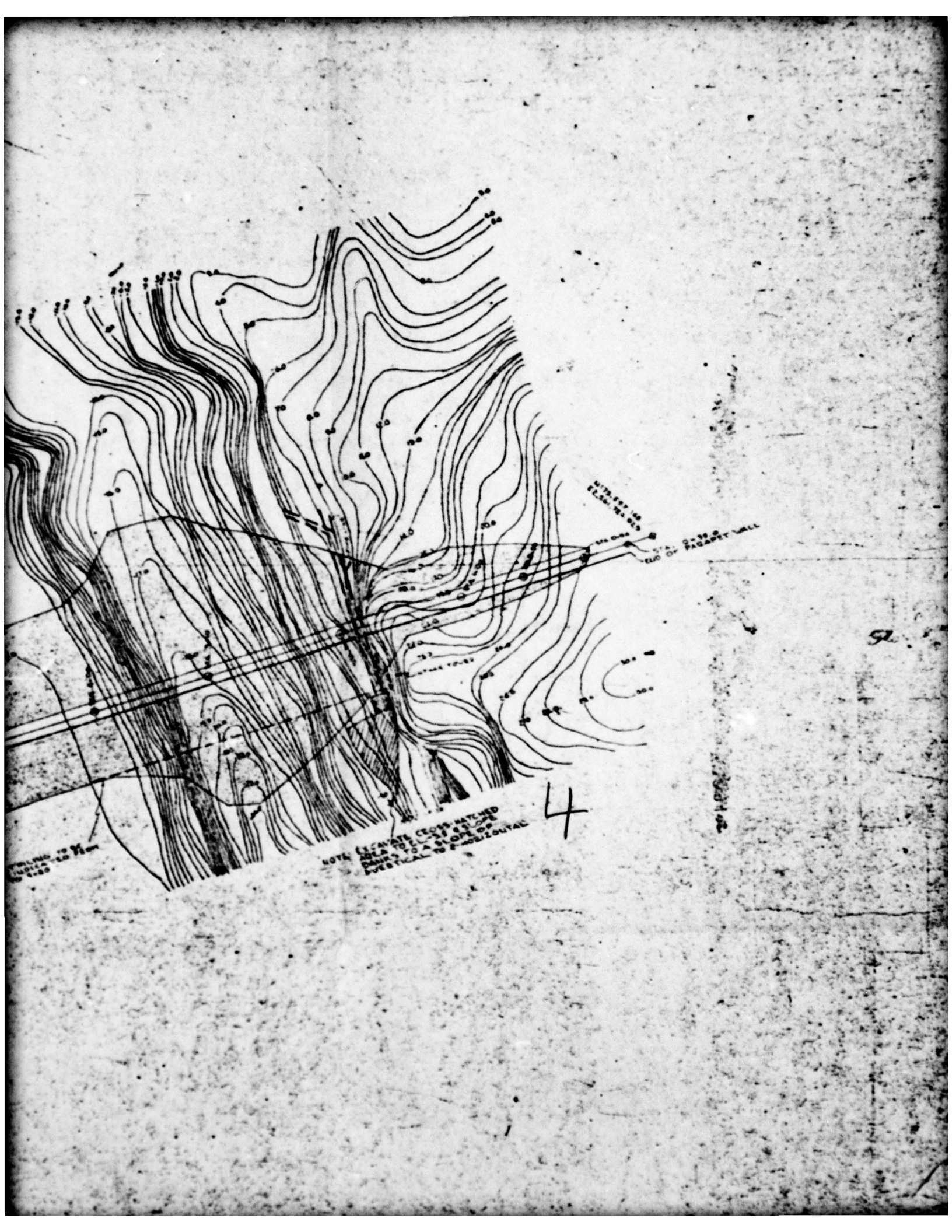
APPROVED BY [illegible]

PLATE NO. 2


END OF PARAPET WALL
AXIS OF DAM


SEE DETAIL OF PARAPET
SLOPE PAVING SHALL BE LAID IN VERTICAL STRIPS 1.00 FEET WIDE SEPARATED WITH EXPANSION JOINTS EVERY 60 FEET.
CONC. SLAB
BAGS, LAYERS BOTH WAYS
CROSS SECTION THRU DAM
SCALE
TOE WALL
STEEL SHEET PILING TO BE DRIVEN AFTER FILL IS MADE AND ULTIMATELY THE CONC. FOOTING & SLOPE PAVING
FINISHED SLOPING STEEL PILING DRIVEN INTO PLACE
MUD EXCAVATION - VARIABLE
EXCAVATE THIS AREA TO EL.
EXCAVATE CHANNEL OF DEPTH AS SHOWN
EL.
BENCH MARK


DAM EMBANKMENT
NOTE: 1/2" OPEN CONTRACTION JOINT EVERY 20'
DETAIL OF PARAPET

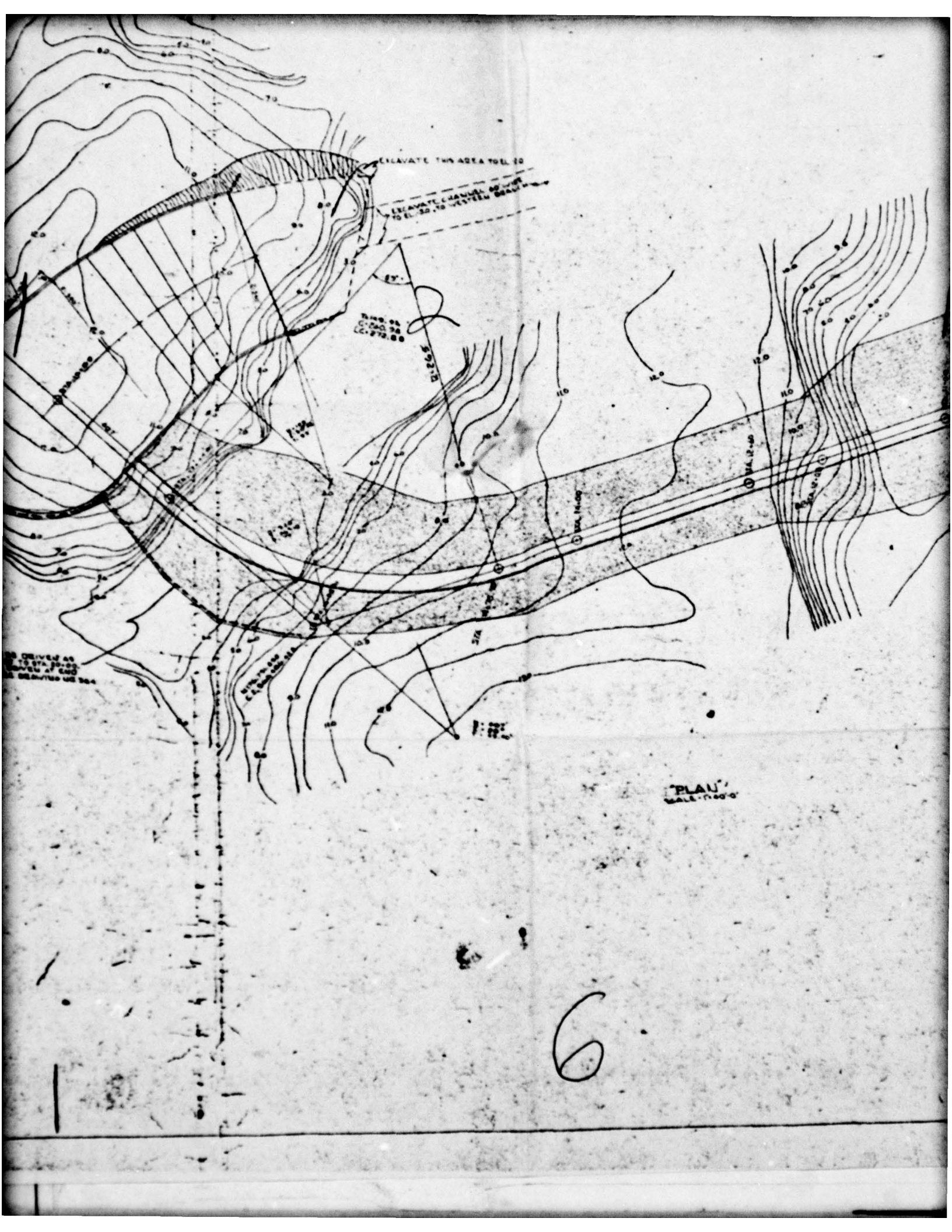

4

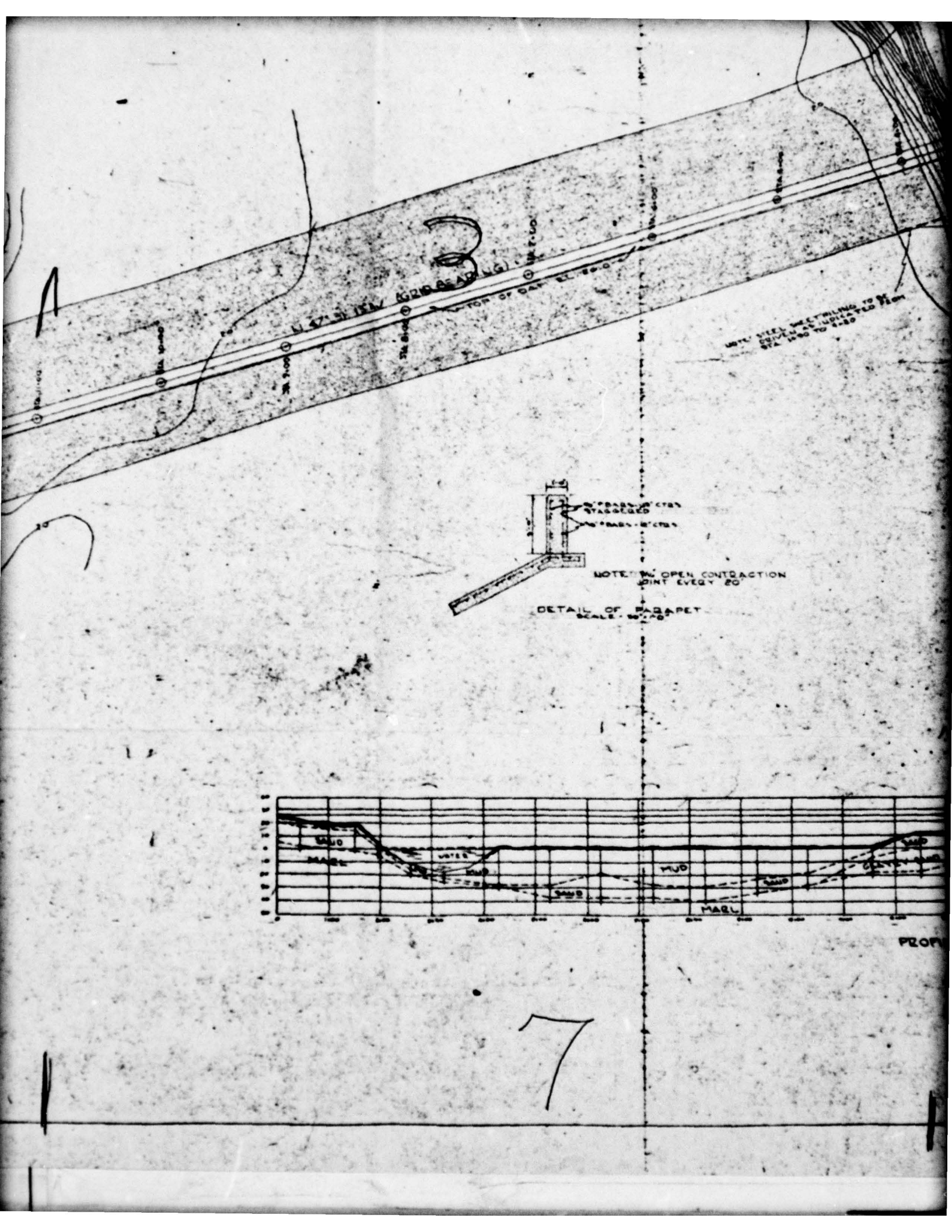
1

NOTE: STEEL SHEET PILING TO BE
INDICATED FROM STA
FOR SHEET PILING TO BE
OF SPILLWAY CHUTE

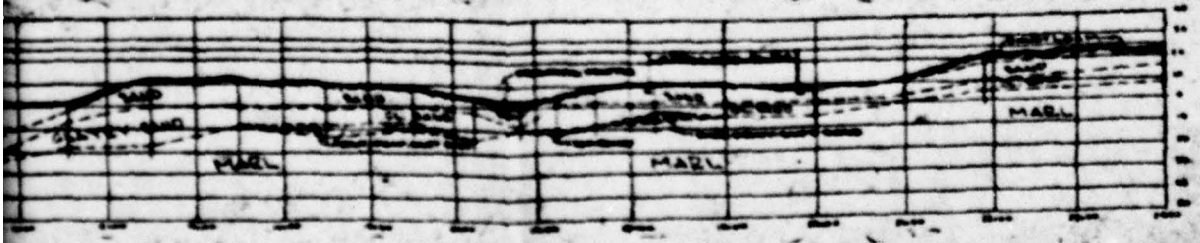
SECTIONS THRU STA AS SHOWN
SCALE 1"=10'

2 5


ELEVATE THIS AREA TO EL. 20
PLAN
6


NOTE: 3/4" OPEN CONTRACTION JOINT EVERY 20'
DETAIL OF PARAPET
MUD
MARL
SAND
MARL





PROFILE

"M.S.L. ELEV. PLANE"

NORFOLK WATER DEVELOPM
CONSTRUCTION PLANS
CONTRACT NO.1
WESTERN BRANCH DAM

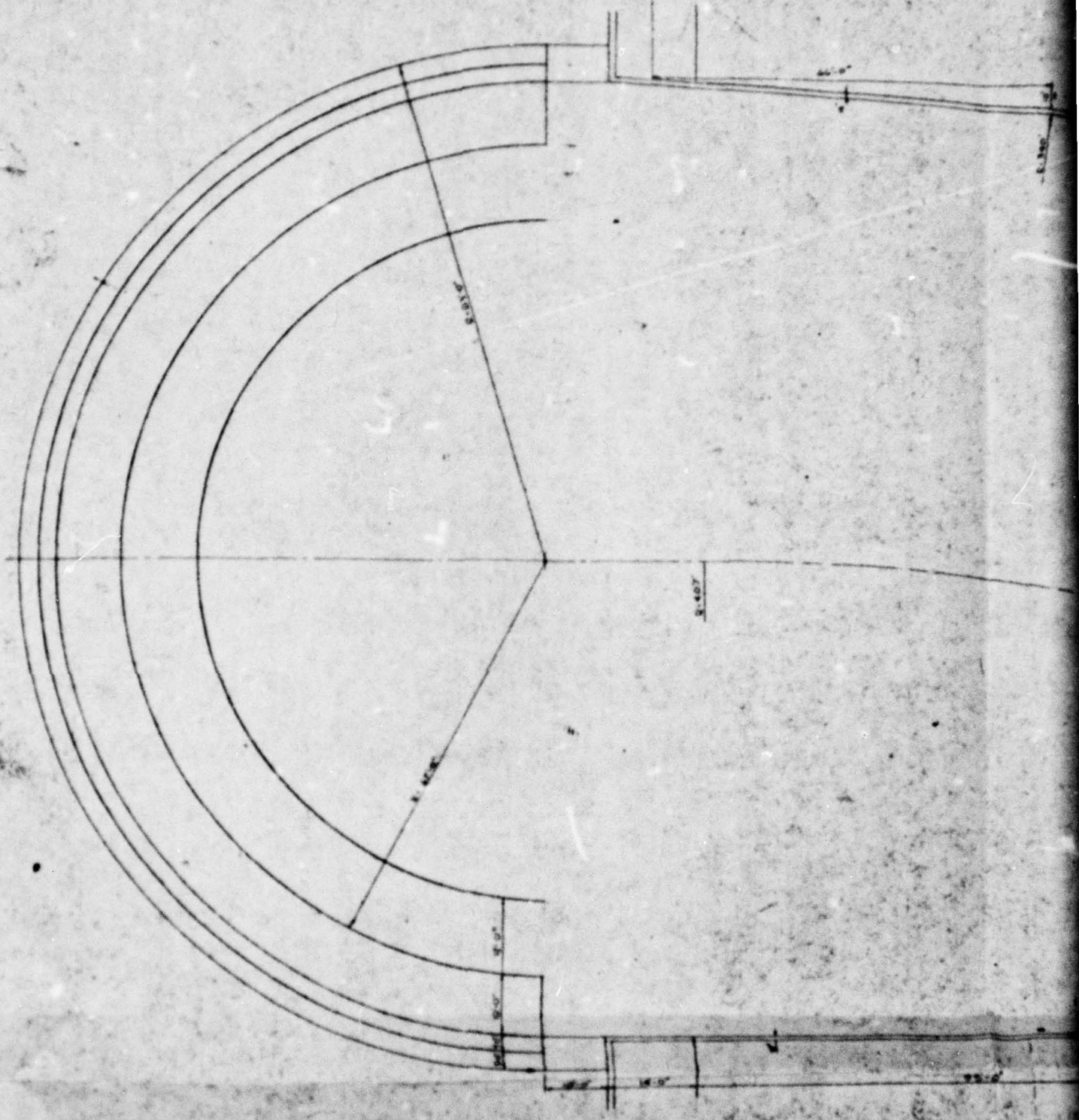
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APPROVED [illegible]

APPROVED BY Richard J. Wagner

SCALE: AS INDICATED

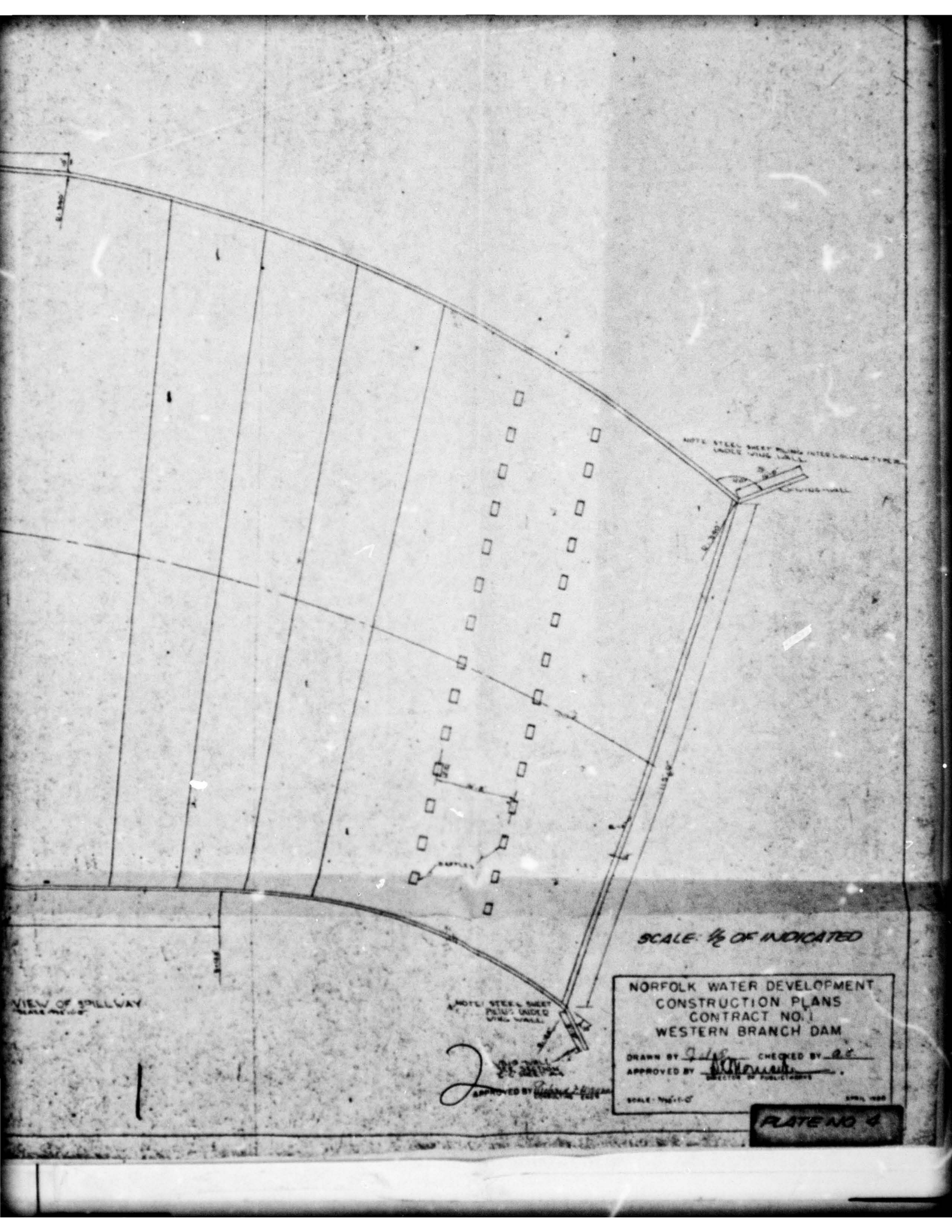
SHEET NO.

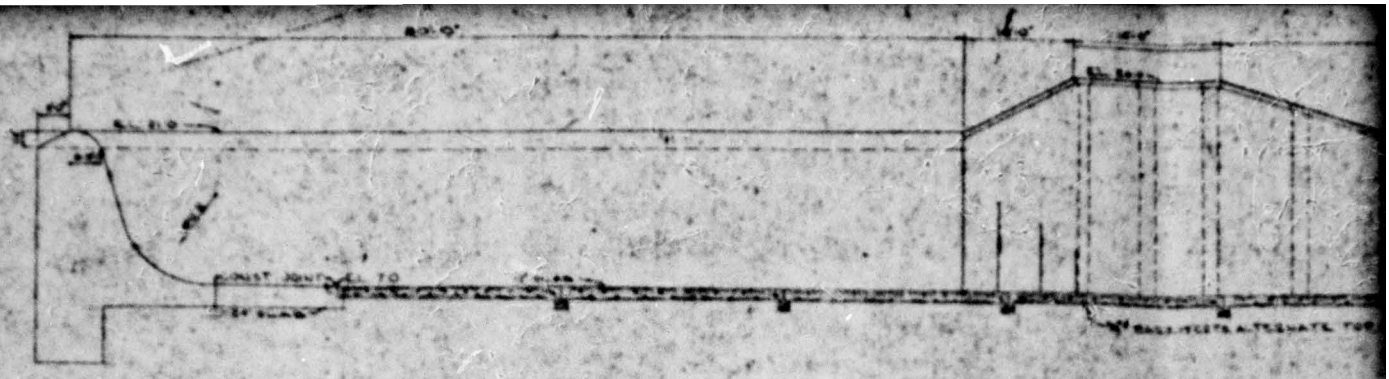
PLATE NO.



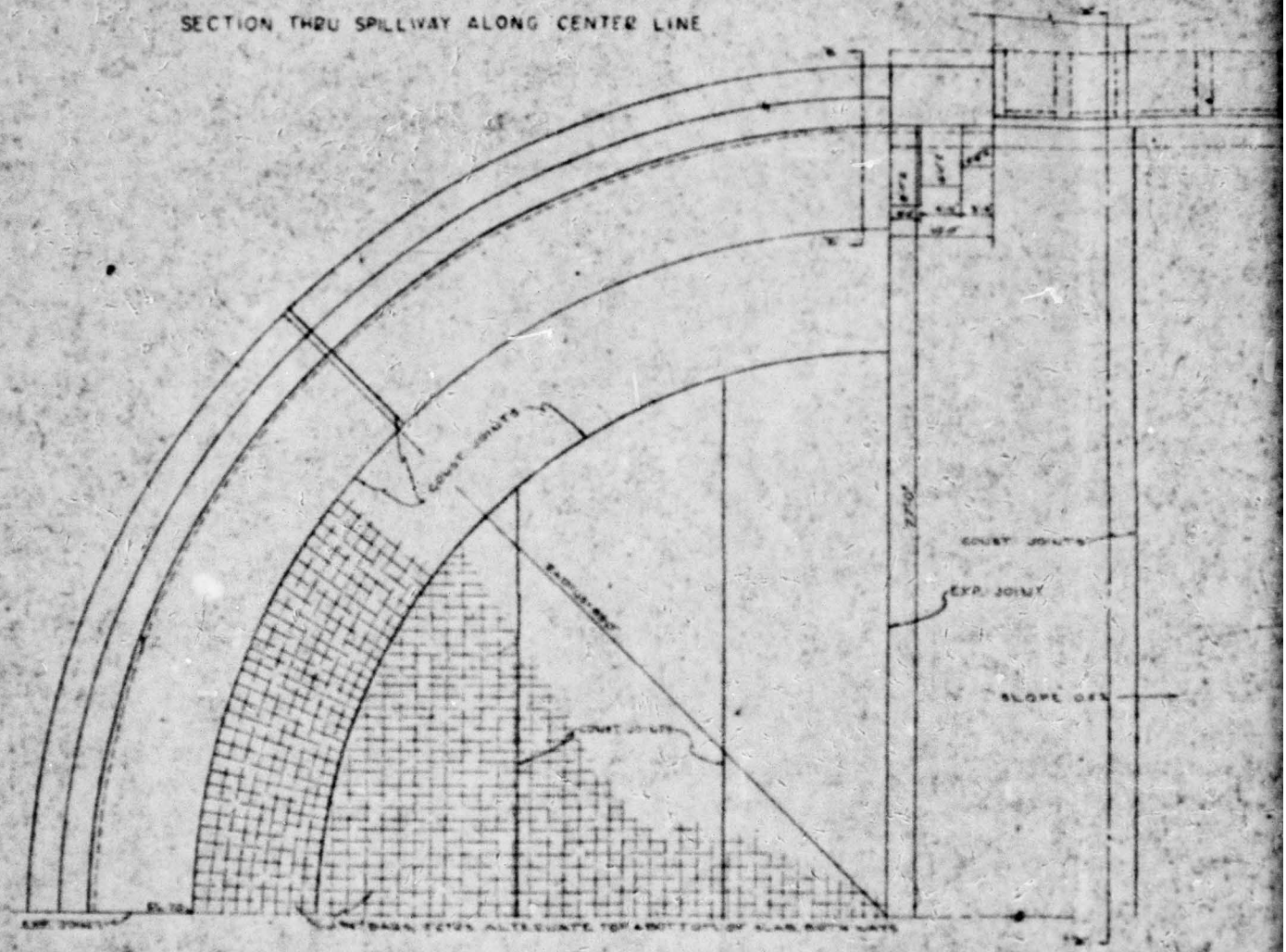
PLAN VIEW OF

1


VIEW OF SPILLWAY
SCALE: ½ OF INDICATED
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
CONTRACT NO. 1
WESTERN BRANCH DAM
DRAWN BY
CHECKED BY
APPROVED BY
DIRECTOR OF PUBLIC WORKS
PLATE NO 4

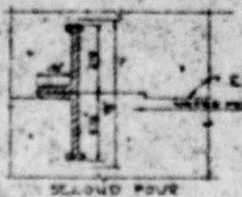


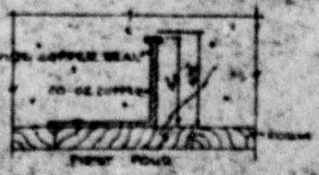
SECTION THRU SPILLWAY ALONG CENTER LINE



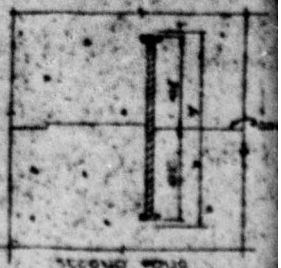
HALF PLAN OF SPILLWAY AT ELEVATIONS INDICATED



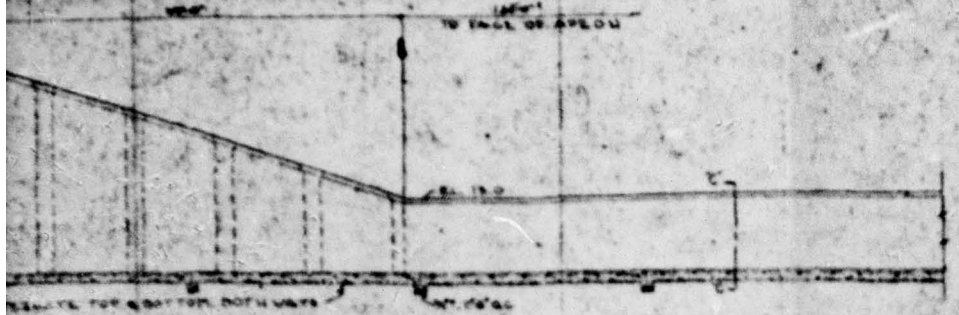


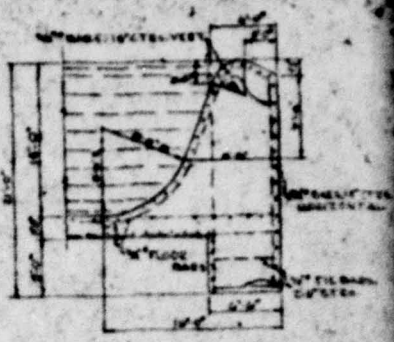


TYPE 'D' MAIN FOR CONST. JOINT

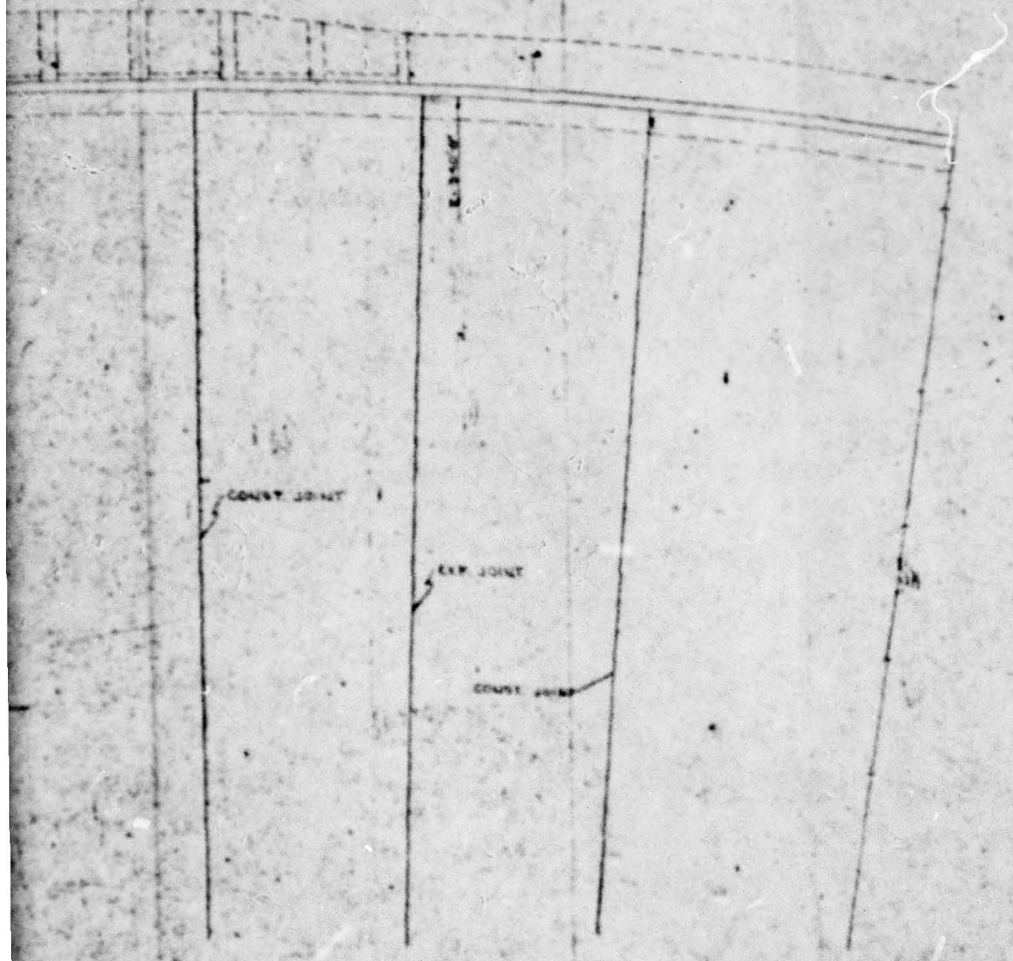


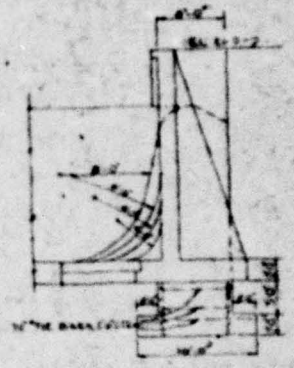
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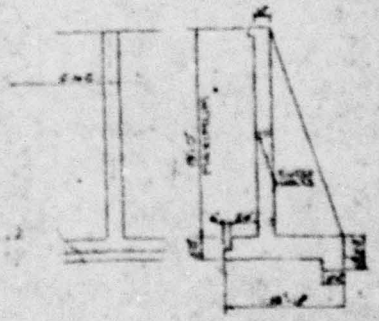


SECTION B-B





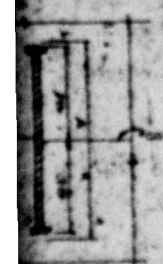
SECTION A-A

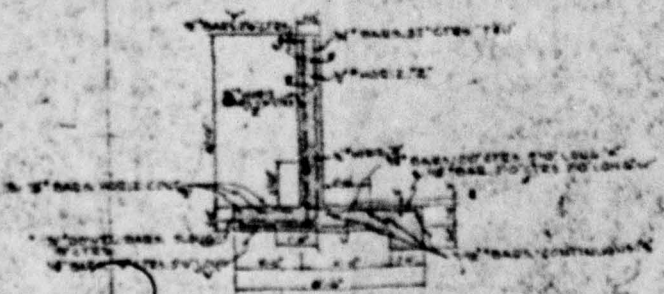


END ELEV SECTION
RETAINING WALL DETAILS

M.S.L. ELEV. = PLAN ELEV. -2.0'

SCALE ½ OF INDICATED





SECTION C-C
TYPICAL SECTION OF RETAINING WALL

APPROVED BY

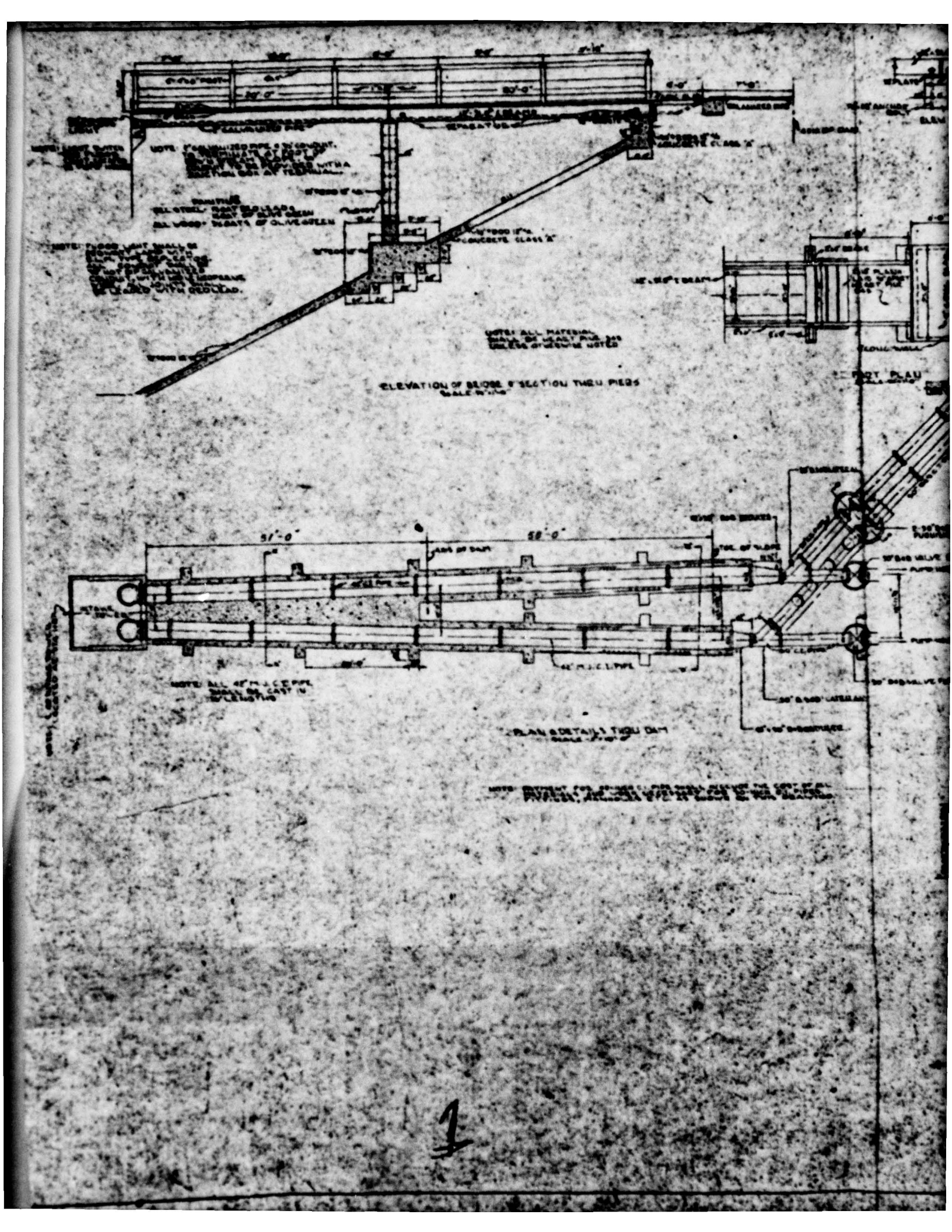
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
CONTRACT NO. 1
WESTERN BRANCH DAM

DRAWN BY CHECKED BY

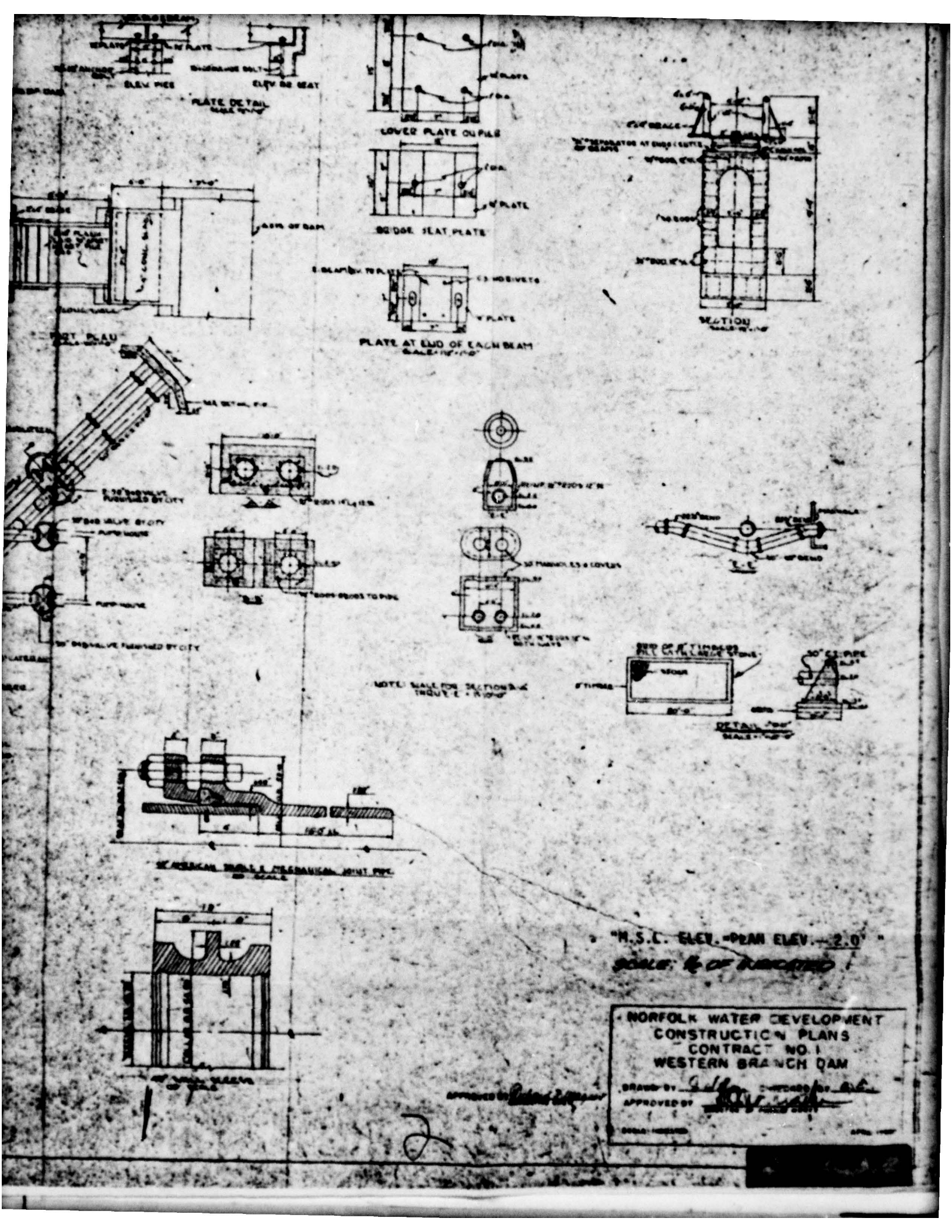
APPROVED BY

SCALE

PLATE NO.


ELEVATION OF BRIDGE & SECTION THRU PIERS
PLAN & DETAILS THRU DAM
51'-0"
58'-0"

1


PLATE DETAIL
LOWER PLATE ON PILE
BRIDGE SEAT PLATE
PLATE AT END OF EACH BEAM
SECTION
PLAN
DETAIL
"M.S.L. ELEV. = PLAN ELEV. - 2.0'"
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
CONTRACT NO. 1
WESTERN BRANCH DAM

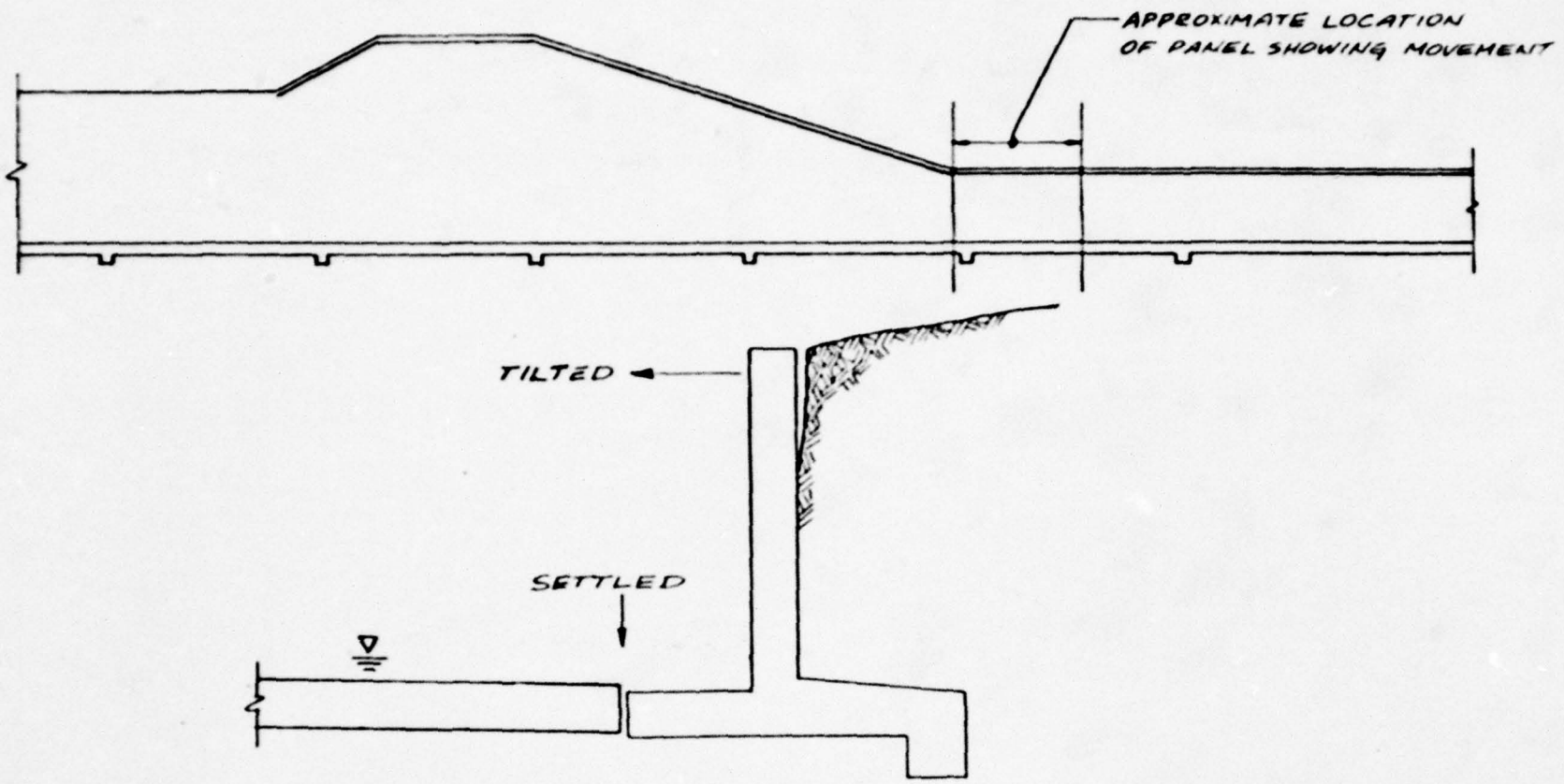


PLATE NO. 7

NORTHSIDE OF SPILLWAY

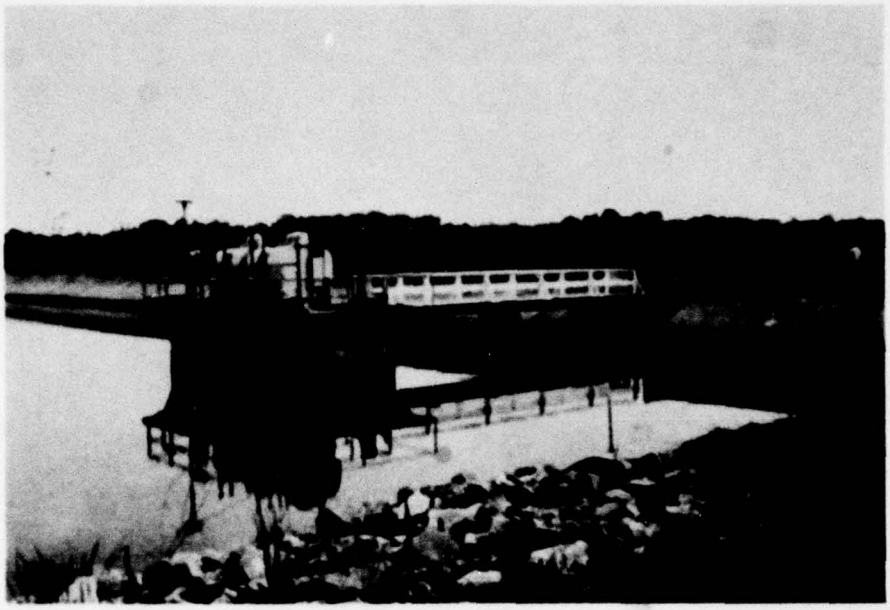
Western Branch Reservoir Dam

LAW ENGINEERING TESTING COMPANY
SOILS, MATERIALS, AND FOUNDATIONS ENGINEERS
7913 WESTPARK DRIVE, MCLEAN, VIRGINIA 22101

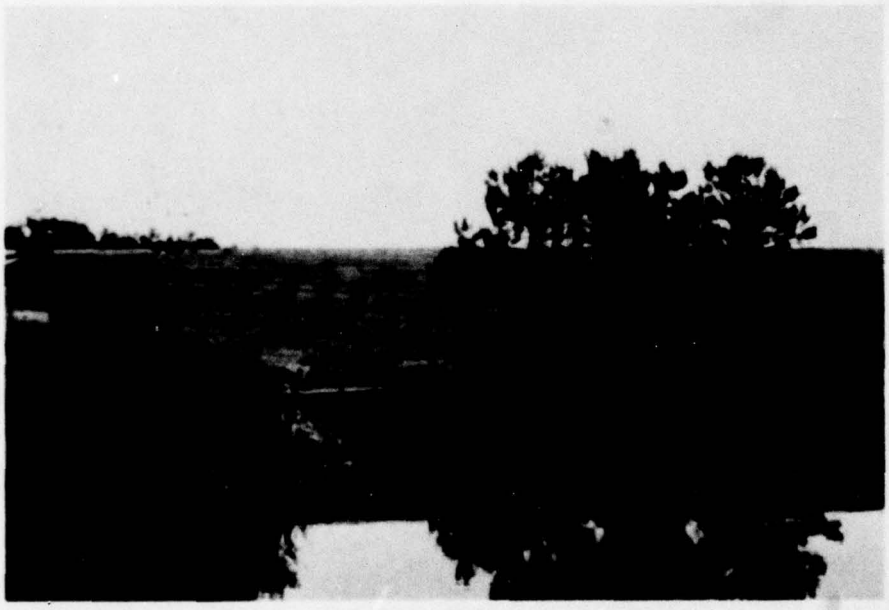
SCALE	Drawn:	Job No.
	Checked:	
	Date:	Dwg. No.

APPENDIX II

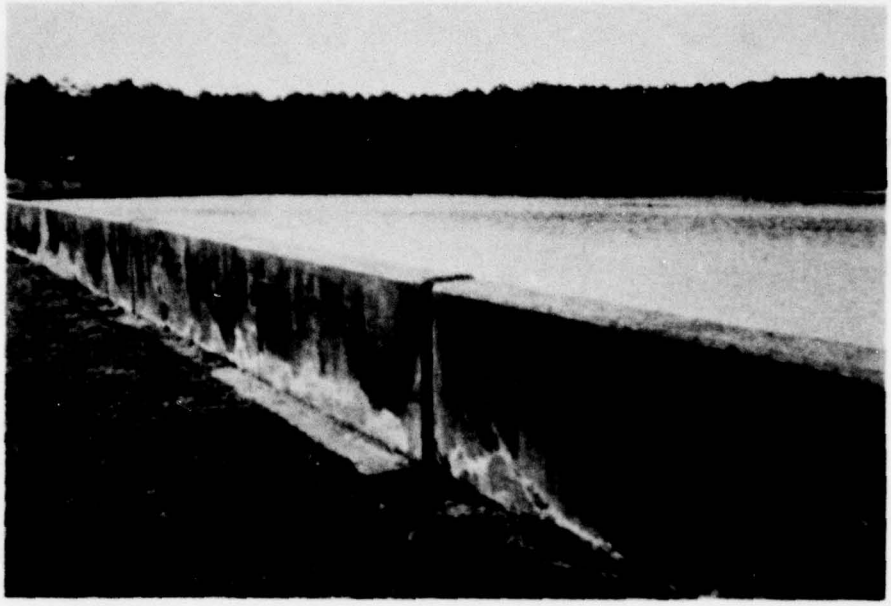
PHOTOGRAPHS



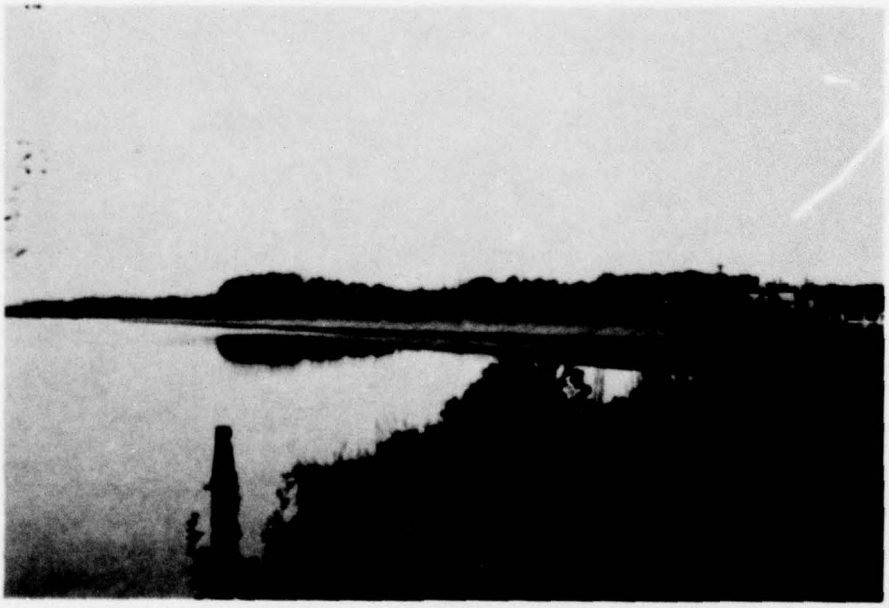
PHOTOGRAPH NO. 1
Intake Structure



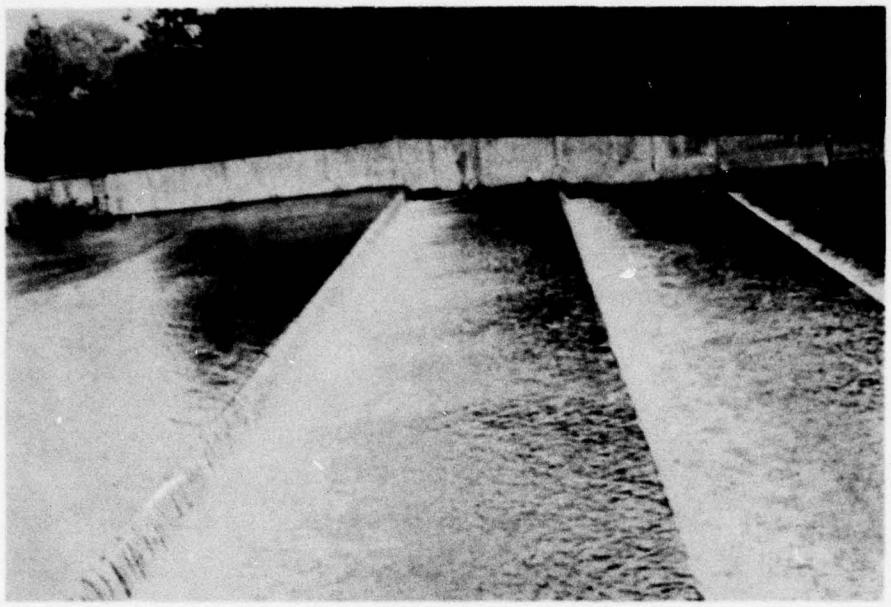
PHOTOGRAPH NO. 2
Discharging Culvert



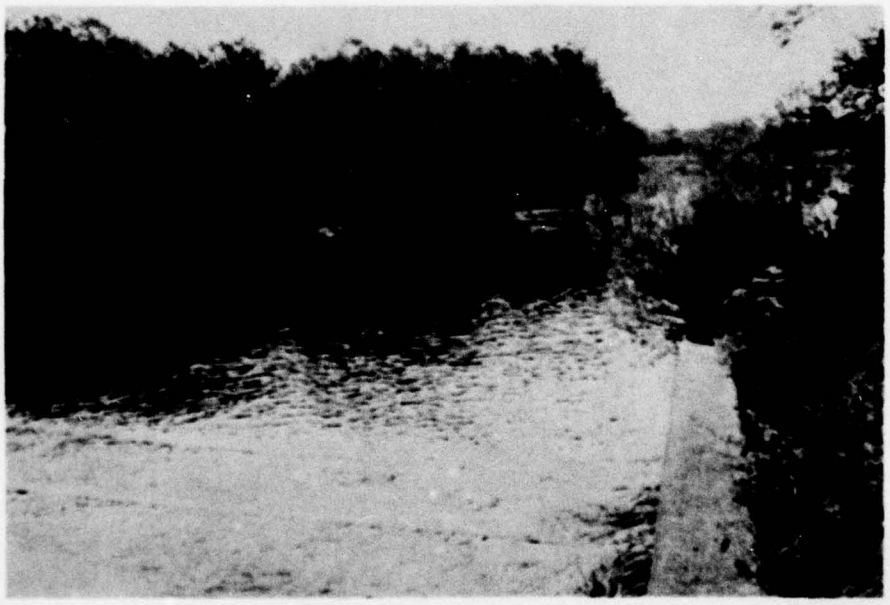
PHOTOGRAPH NO. 3
Parapet



PHOTOGRAPH NO. 4
Upstream Face of Dam



PHOTOGRAPH NO. 5
Spillway Channel



PHOTOGRAPH NO. 6
Downstream

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Western Branch Dam **County** City of Suffolk (formerly Nansemond Co.) **State** Virginia **Coordinates** Lat. 3648.2 Long. 7635.1

Date(s) Inspection 5/7/79 **Weather** Overcast **Temperature** 55° F

Pool Elevation at Time of Inspection 19 M.S.L. **Tailwater at Time of Inspection** 0 M.S.L.

Inspection Personnel:

Robert Gay, P.E.-SWCB

Thaddeus Ward-City of Norfolk

Tan Young , P.E.- DMM&A Hydrology/ Hydraulics

Craig Ziesemer-City of Norfolk

Mike Cowell, Law Engineering Soils & Geology

Paul Seiler, P.E. - DMM&A Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No obvious cracking on the top of dam.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No obvious movement or cracking.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None visible.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No horizontal misalignment on the top of the dam. The upstream side of the top of the dam has a wall. The wall has a sag about 400' from the riser. Appears to have been there for a long time.	
RIPRAP FAILURES	No obvious failures - upstream face of dam has concrete slab and wall at the top of the dam. Riprap added to toe for 600' from right abutment. This was done 2 years after construction to add weight to the toe.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONSTRUCTION MATERIAL		
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No visible cracking.	
ANY NOTICABLE SEEPAGE	Downstream of toe at woods, water stands in puddles. There is mud 15" below ground level. Clay 2' below furface, water in bottom of 1" diameter hand auger hole. Undulations of the ground were noted on the downstream slope.	No flowing water. Location is at curve in the top of the dam. Do not appear serious.
STAFF GAGE AND RECORDER	Staff gage is wired to city offices from top of the riser.	
DRAINS	None visible.	
FOUNDATION		

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not visible at the time of inspection	
INTAKE STRUCTURE	Riser did not show cracking or deterioration.	
OUTLET STRUCTURE	Connects to pump house - not visible.	
OUTLET CHANNEL		
EMERGENCY GATE		

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Semi-circular concrete emergency spillway. Spalling was observed in several areas of the spillway.	
APPROACH CHANNEL		
DISCHARGE CHANNEL	Concrete walled channel 104' to 70' wide, concrete lined streambed. Some settlement and tilting was detected in one section of the retaining wall on the north side of the spillway channel.	
BRIDGE AND PIERS		

INSTRUMENTATION

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

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Forested, flat slopes	
SEDIMENTATION	Not known.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Channel was formerly marshy. Trees in some sections below the dam not in channel.	
SLOPES	Flat.	
APPROXIMATE NO. OF HOMES AND POPULATION	Reids Ferry-about 20 homes. estimated population of 50 people	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	See Appendix I - Plans.
REGIONAL VICINITY MAP	See Appendix I - Maps
CONSTRUCTION HISTORY	Not available.
TYPICAL SECTIONS OF DAM	See Appendix I plans
HYDROLOGIC/HYDRAULIC DATA	See this Report
OUTLETS - PLAN and - DETAILS	See Appendix I - Plans
- CONSTRAINTS and - DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	
BORROW SOURCES	Not known.

ITEM	REMARKS
MONITORING SYSTEMS	Electrical to City Treatment Office.
MODIFICATIONS	Added heavy rocks to toe just after construction
HIGH POOL RECORDS	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available
PRIOR ACCIDENTS OF FAILURE OF DAM DESCRIPTION REPORTS	None reported.
MAINTENANCE OPERATION RECORDS	By treatment plant Pool elevation and pumping records.

ITEM	REMARKS
SPILLWAY PLAN	See Appendix I - Plans
SECTIONS	See Appendix I - Plans
DETAILS	See Appendix I - Plans
OPERATING EQUIPMENT PLANS & DETAILS	

APPENDIX IV

CONSTRUCTION SPECIFICATIONS

SECTION 4

EARTH EMBANKMENT

TP4-01 SCOPE:

The work covered by this section consists of furnishing all plant, labor material and equipment and performing all operations in connect ion with the preparation of the embankment foundation and placing and compacting all fills, as covered by this section of the specification and the applicable drawings. It includes also stripping of the embankment area.

TP4-02 TEST BORINGS:

(a) The City has made a number of test borings to determine the character and depth of the various strata of soil underlying the site of the dam, and the location and depth of these borings, as well as the information obtained by them, are approximately indicated on the profile on Drawing No. A-1 of the construction plans.

(b) The information obtained by these borings is the best information in the possession of the City on the Subject of the underlying soil, and it is furnished to the Contractor in all good faith; but it is expressly stipulated and mutually agreed that neither the City nor any of its agents guarantees the accuracy of said information, and that any use that the Contractor may make of any of said information shall be made entirely at his own risk, and that neither the City nor any of its agents shall be held responsible for any errors or ommissions in said information.

TP4-03 EXCAVATION BELOW EL. 2.5:

(a) Before depositing in place any material which will ultimately form a part of the earth embankment the Contractor shall first excavate the mud from beneath a portion of the width of the embankment down to the top of the underlying sand stratum without disturbing said stratum. The prism of mud thus excavated shall expose the sand stratum for a maximum width of 100 feet, the angle of the slope of the mud at the two sides of this prism being the actual natural angle of slope assumed by the med after the base of the prism has been excavated to its full depth.

(b) The Contractor shall be permitted to make the mud excavation in the wet if he shall elect to do so. In any event he shall first build at his own cost and expense low dykes of sufficient height to retain the mud removed from the excavation, and to prevent its flowing away into the channel of the stream and he shall maintain these dykes by raising them from time to time as the med is deposited behind them. These dykes shall be located approximately as shown on Drawing No. A-2, so as to enclose an area below the dam on the south side of the channel and the Contractor shall deposit the mud as it is excavated on this area as directed.

TP4-04 EXCAVATION ABOVE EL. 2.5:

The top soil of the area to be covered by the embankment shall be stripped or excavated to a depth of 12 inches. The soil removed shall be deposited wherever directed, provided that the straight line

CITY OF NORFOLK

distance from point of removal to point of deposit shall not exceed 1,000 feet. After stripping the foundation surface shall be compacted by first scarifying and adjusting the water content of the disturbed material to optimum for compacting and then rolling with the same procedure as discussed under "Compacted Fill". The volume of the earth material or top soil so removed shall, for purposes of payment be classified as "Fill above EL 2.5."

TP4-05 MATERIALS:

Materials for the embankment and for the refilling beneath it to replace the excavated mud, and for refilling the diversion channel shal be taken from borrow areas indicated on Drawing No. A-2 and from the required excavation. The Contractor shall strip the top soil or material containing an excess of fine particles from the surface of the borrow pits stockpiling it for later use in preparing slopes of dam for seeding.

TP4-06 PLACEMENT:

(a) No material shall be placed in the embankment, or in the refill under the same, or in the refill of the temporary channel, unless it shall have been first approved. No soil having any roots or other vegetable matter shall be used for any permanent part of the embankment or re-fills.

(b) After the re-fill under the embankment shall have been placed the Contractor shall immediately begin to spread over it and over the adjacent mud, the earth selected for the embankment, this earth to be spread in even layers of such thickness that, after compacting as required, they shall be six inches thick.

(c) The placing of earth in the embankment shall be done in such a manner as will provide at all times the maximum drainage and prevent the formation of mud or of puddles of water which might impede traffic across the surface or interfere with the proper compacting of the material. No material shall be placed in the embankment until after the diversion of the river has been accomplished, except as may be approved by the Engineer.

TP4-07 COMPACTION:

(a) Sheepsfoot Rollers: Sheepsfoot rollers shall be of standard manufacture and shall consist of metal drums that have metal studs with tamping feet projecting approximately seven inches from the surface of the drum. Tamping feet shall be spaced so as to provide approximately three tamping feet for each two square feet of cylindrical surface. The cross sectional area of each tamper foot, measured perpendicular to the axis of the stud shall not be less than 5 nor more than 7 square inches. The feet of the tamping rollers shall be such that the load on each tamper foot shall be not less than 250 pounds per square inch of cross sectional area. The load per tamper foot shall be determined by dividing the total weight of the roller by the number of tamper feet in one row parallel to the axis of the roller. The roller shall be equipped with cleaners. Other tamping rollers of an approved design may be used provided such rollers will produce the desired compaction. The design of rollers, their loading, and the character and efficiency of the propelling equipment shall be subject to the approval of the Engineer.

(b) Heavy Duty Rubber-Tired Rollers: Rubber-tired rollers shall be so constructed that the load per wheel may be varied as directed by

CITY OF NORFOLK

the Engineer from 18,000 to 25,000 pounds. The roller wheels shall be so arranged and so designed that all wheels will carry approximately equal loads when travelling over uneven ground. Tires should be capable of being inflated to a pressure of not less than 75 pounds per square inch.

(c) Hand Operated Power Tampers: Hand operated power tampers shall be approved by the Engineer.

TP4-08 COMPACTED FILL:

(1) General: Except as otherwise specified compacted fill shall be compacted by sheepsfoot rollers and/or heavy duty rubber tired rollers conforming to the requirements of paragraphs TP4-07 (a)(b) above, respectively.

(2) Compacted Fill Adjacent to Concrete Structures: No fill material or other load shall be placed on or against concrete surfaces before the expiration of 14 days after placing of concrete. Materials placed in portions of the embankment which lie within four feet of concrete walls shall be spread in four inch layers and compacted by means of power tampers. Drainage openings through concrete structures, as provided for on the drawings, shall be kept open at all times.

(3) Degree of Compaction: The fill material shall be placed on successive six-inch layers. Its moisture content at the time of placing shall be the optimum moisture content for maximum density as determined by the Engineer. Each six-inch layer shall be compacted by means of a sheepsfoot roller or other approved equipment to 95% of maximum density. In the event of excessive change in the moisture content of any layer prior to full compaction, the material shall be moistened by sprinkling, or scarified and dried as required, until optimum moisture content is restored.

TP4-09 MEASUREMENT:

The quantity of fill to be paid for will be the number of cubic yards of material, measured in the original position in borrow areas and computed by the average end-area method.

TP4-10 PAYMENT:

(a) Fill below elevation 2.5: Payment will be made at the Contract until price per cubic-yard for Item 4. "Fill below Elevation 2.5", and shall include all costs for furnishing all materials and equipment and for performing all work covered by this section. No extra compensation will be allowed for dredging, transportation and disposition of mud for dredging, transporting and disposing of mud to be removed from the area of the dam below Elevation 2.5 and such costs shall be included in the cost for "Fill below Elevation 2.5".

(b) Fill above Elevation 2.5: Payment will be made at the contract unit price per cubic-yard for item 5 "Fill above Elevation 2.5", and shall include all costs for furnishing all materials and equipment and for performing all work covered by this section.

CITY OF NORFOLK

APPENDIX V

REFERENCES

LIST OF REFERENCES

1. U S Weather Bureau and U S Army Corps of Engineers, "Seasonal Variation of Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours", Hydrometeorological Report No. 33, Washington, D.C., April 1956.

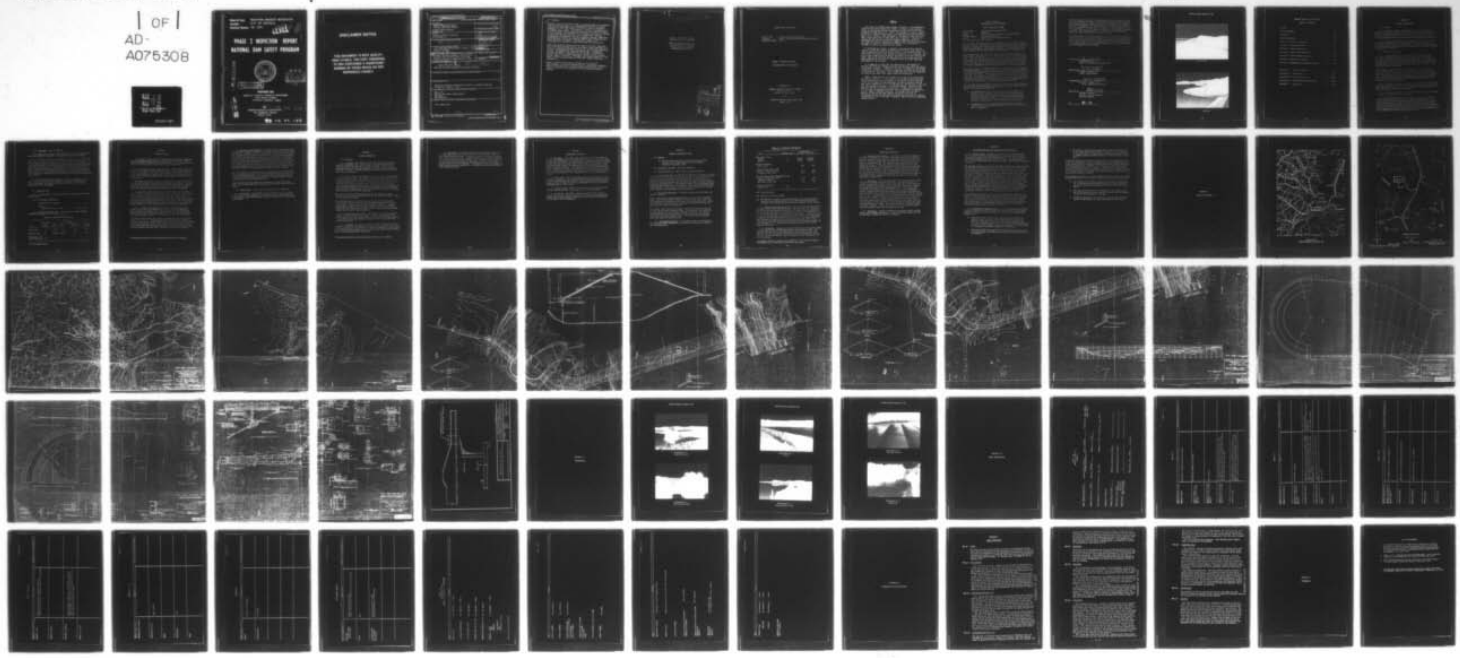
2. Clark, C. O., "Storage and the Unit Hydrograph", Trans. American Society of Civil Engineers, Vol. 110, PP. 1419-1488, 1945.

3. HEC-1 Flood Hydrograph Package, Hydrologic Engineering Center, U S Army Corps of Engineers, Davis, California, 1978.

4. Recommended Guidelines for Safety Inspection of Dams, Department of the Army, Office of the Chief of Engineers, Washington, DC 20314.

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NATIONAL DAM SAFETY PROGRAM. WESTERN BRANCH RESERVOIR DAM (VA-1--ETC(U)
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1 OF 1
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Name Of Dam: WESTERN BRANCH RESERVOIR
Location: CITY OF SUFFOLK
Inventory Number: VA. 12311

LEVEL II

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

AD A075308



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PREPARED FOR

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

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BY

DEWARD M. MARTIN & ASSOCIATES
WILLIAMSBURG, VIRGINIA

AUGUST, 1979

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20. Abstract

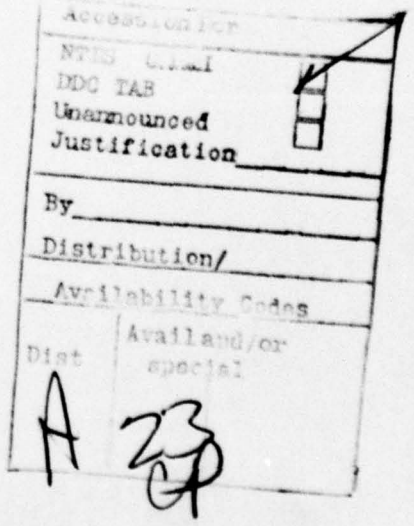
Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those 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.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

WESTERN BRANCH RESERVOIR DAM
CITY OF SUFFOLK, VIRGINIA
(Formerly Nansemond County)
INVENTORY NO. VA 12311



LOWER JAMES RIVER BASIN

Name of Dam : Western Branch Reservoir Dam
Location : City of Suffolk (formerly Nansemond County)
Inventory Number: 12311

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Prepared for

NORFOLK DISTRICT CORPS OF ENGINEERS
803 Front Street
Norfolk, Virginia 23510

by

Deward M. Martin & Associates, Inc.
August 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

BRIEF ASSESSMENT OF DAM

Name of Dam:	Western Branch Reservoir Dam
State:	Virginia
County:	City of Suffolk (formerly Nansemond County)
USGS Quad Sheet:	Chuckatuck, Virginia
Stream:	Western Branch of Nansemond River
Date of Inspection:	May 7, 1979

Western Branch Reservoir Dam is an earthfill structure 2,840 feet long and 30 feet high. The dam is owned and operated by the City of Norfolk, Virginia. The dam is classified an intermediate in size with a high hazard classification. The spillway consists of a semi-circular concrete approach 150 feet wide with a crest elevation of 19 feet m.s.l.

The spillway will pass 26% of the Spillway Design Flood (which is the PMF) without overtopping the dam. The SDF will overtop the dam by 2.8 feet. The water velocity of 9.5 feet per second and a 30 hour duration of flow over the dam, during the PMF, will cause the erosion and potential failure of the dam. Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway is rated as inadequate and the dam is assessed as unsafe-non-emergency.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

It is recommended that within 2 months from the date of notification to the Governor of the Commonwealth of Virginia, the owner engage the services of a professional consultant to:

a. Determine by more sophisticated methods and procedures the adequacy of the spillway. The study should include a more detailed study of the Spillway Design Flood appropriate to this dam. Remedial measures to be considered include modification to the dam, spillway, flood plain, and/or any other method of eliminating the danger imposed by the project.

b. Determine whether the stability conditions and the safety margins satisfy the requirements and guidelines given in Reference 4, Appendix V.

Within 6 months of the date of notification by the Governor, the professional consultant's report of appropriate remedial mitigating measures should have been completed and the Owner should have an agreement with the Commonwealth of Virginia to a reasonable time frame in which all remedial measures will be complete. In the interim, a detailed emergency operation plan and a warning system should be promptly developed. Also during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

The following items, although important, are not urgent and should be completed as part of the general maintenance of the dam: remove ponded water along the downstream toe of the dam, monitor settlements in the parapet wall on the crest of the dam and in the retaining wall panel. If settlement continues then remedial measures may be required to protect the integrity of the concrete.

Prepared By: Paul Seiler
PAUL SEILER, P.E.
Deward M. Martin & Associates, Inc.

ORIGINAL SIGNED BY:
Submitted By: JOHN E. KENNEDY
for JAMES A. WALSH, P.E.
Chief, Design Branch

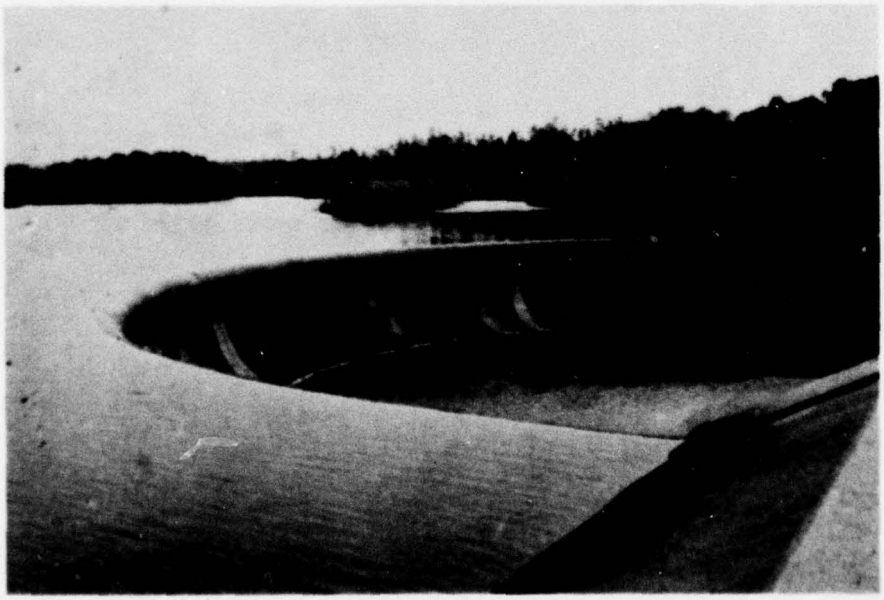
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Chief, Engineering Division

Original signed by:
Approved By: Douglas L. Haller
DOUGLAS L. HALLER
Colonel, Corps of Engineers
District Engineer

Date SEP 17 1979



Top of Dam



Spillway

WESTERN BRANCH RESERVOIR DAM

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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 V, Reference 4). 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: Western Branch Reservoir Dam is an earthen embankment dam about 2,840 feet long and 30 feet high. The top of the dam is 14 feet wide at an elevation of 24.0 feet m.s.l. The upstream slope is 2(H):1(V) and the entire slope is covered with an 8-inch concrete slab. A 3 foot high parapet wall was built at the upstream edge of the dam along the entire length of the crest. The downstream slope is 3(H):1(V).

The spillway, located near the left abutment, is a semi-cirular ogee shaped spillway with the crest at elevation 19.0. A water intake structure in the reservoir near the right abutment is used to withdraw water for treatment and to empty the reservoir. Two 42-inch diameter pipes from the intake tower run through the dam and then are reduced to 30-inches to the treatment plant and then become two 30-inch Y branches to the downstream creek.

1.2.2 Location: The dam is located 4.7 miles south of Chuckatuck, Virginia, along State Route 10/32 and 2.4 miles north of U S Route 460 interchange with State Route 10/32 between Red Top and Reids Ferry on the Western Branch of the Nansemond River.

1.2.3 Size Classification: The dam is classified as intermediate by a storage capacity of 27,970 acre-feet.

1.2.4 Hazard Classification: The dam is located in a predominately rural area where failure of the dam would endanger the pump station at the dam and about 20 homes at Reids Ferry, (which are within the flood plain for the PMF) 3,000 feet downstream from the dam. The dam is classified as high hazard in accordance with the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of the location only and unrelated to the stability or probable failure of the dam.

1.2.5 Ownership: City of Norfolk.

1.2.6 Purpose of the Dam: The reservoir is used as a source of water for the City of Norfolk. Boating and fishing is permitted.

1.2.7 Design and Construction History: This dam was designed in 1960 under the guidance of Richard E. Wagner, Consulting Engineer. In 1963, a reverse filter of gravel and 2 feet thick riprap was added along the downstream toe between Sta. 4+15 and Sta. 11+50, in accordance to Change Order No. 3 by Justin and Courtney, Consulting Engineers of Philadelphia, Pennsylvania. Construction specifications for the dam are included with this report as Appendix IV. The name of the principal contractor for the dam is not known and no construction records were available to confirm that the construction of the dam was performed as specified.

1.2.8 Normal Operating Procedures: Water is withdrawn to the water treatment plant for water supply. Otherwise, regulation of flows is automatic with water rising above the crest of the spillway passing freely downstream.

1.3 Pertinent Data:

1.3.1 Drainage Area: The dam controls a drainage area of 65.18 square miles.

1.3.2 Discharge at Dam Site:

Maximum flood - Unknown.

Spillway
pool level at top of dam . . . . . 18,700 c.f.s.

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 m.s.l.	Reservoir Capacity Area, Acres	Acre, feet	Watershed, inches	Length, miles
Top of Dam *	27	1,651	27,970	8.1	4.0
Spillway Crest	19	1,282	14,620	4.2	4.0
Streambed at the toe of the dam	-3+				

* Top of parapet wall

SECTION 2

ENGINEERING DATA

2.1 Design: Plans entitled "Norfolk Water Development Construction Plans Contract No. 1, Western Branch Dam", dated April 1960, signed by Richard F. Wagner, Consulting Engineer, are available in the files of the Department of Public Works, City of Norfolk.

*2.1.1 Geologic Setting of the Dam Site: Physiographically, the dam is located in the Coastal Plain Province. The geologic formations at the site consist of the Sedley and Yorktown formations of pliocene to miocene geologic age. Downstream of the dam are Quarternary, alluvium, estuarine-beach sediments and fluvial-estuarine fills of recent geologic age.

The Sedley formation consists of marine and estuarine silt, clay and fine sand deposits which overlie the Yorktown formation. The contact between the Sedley and underlying Yorktown formation is normally irregular. Relief of up to 25 feet has been observed in exposures along the James and Pagan Rivers several miles north of the site.

The Yorktown formation consists of marine sand, clay and broken shell material. Soils of this formation tend to be more compact than those of the overlying Sedley formation. In general, the upper part of the Yorktown formation ranges from fossiliferous clayey sand and clay to coquina (a limestone typically formed from broken shells, coral and organic debris) found in areas east of the site. The term "marl" is often used to describe the more compact mixtures of clay, sand and shells found at the site, which belong to the Yorktown formation.

*2.1.2 Geologic Investigations: Soil test borings have been drilled at the site in conjunction with its original construction. These borings were drilled by the City of Norfolk. The information obtained from these borings was compiled by the city in the form of a profile as shown on Plate No. 3 in Appendix I and dated April 1960.

As shown by the profile, marl exists at irregular depth varying from about 8 to -40 m.s.l. Overlying the marl were varying thicknesses of clay, sand, clayey sand and silty sand. This material was excavated prior to construction of the dam. A soil termed "mud", most likely an alluvial material, made up the majority of soil overlying the marl, between stations 3+00 and 11+00, just east of the Western Branch.

*Information provided By Law Engineering Associates of Virginia.

2.2 Foundation and Embankment: Original design calculations were not available. However, original construction plans and specifications are shown in Appendix I and IV, respectively. The plan and specifications called for excavation of existing mud in the proposed embankment area down to the underlying sand stratum. As shown by the subsurface profile along the axis of the dam (compiled by the City of Norfolk), the top of this sand stratum ranged from about 20 feet m.s.l. to about -28 feet m.s.l. The excavation was to have a maximum width of 100 feet and the angle of the slope of the exposed mud at the two sides of the prism formed, was to be the natural angle of slope assumed by the mud after the base of the prism was excavated to its full depth.

The construction specifications do not indicate the type of fill used for the embankment; however, shallow hand auger probes performed on the downstream embankment slopes revealed soils consisted of brown medium fine sand with little silt and clay. Specifications for fill placement are enclosed in Appendix IV.

Construction plans also showed the location of a steel sheet pile wall. The interlocking sheet piles were to be driven three feet into "marl."

2.3 Construction: Construction records were not available.

2.4 Operations: The operation record indicated that the riprap along the toe of the embankment was added in 1963 by change order No. 3, designed by Justin and Courtney, Consulting Engineers, Philadelphia, Pennsylvania.

SECTION 3

VISUAL INSPECTION

3.1 Findings:

3.1.1 General: The results of the 7 May 1979 inspection are included in Appendix III. At the time of the inspection the pool elevation was at 19.0 feet m.s.l. which is normal. There are no known past inspection reports available. The area around the dam is flat and forested. Trees are growing in the downstream flood plain but not in the channel.

3.1.2 Dam: There is no evidence of any horizontal misalignment of the crest of the dam. The dam has a concrete slab on the upstream side attached to a wall 3 feet high on the crest. This wall has a vertical settlement of 2 inches to 3 inches and appears to have been like this for a long time, since any shift of the wall at joints equally as weathered as other surfaces of the wall. The settlement in the wall may be related to the need for stabilization of the embankment just after construction. The embankment was stabilized by adding large rock to the toe of the embankment.

*There were several small undulations along the downstream slope, probably due to differential settlement of the underlying soils. None of these appeared serious.

*The downstream area of the dam, in the wooded section, had water puddled about 30 feet from the toe and several hundred feet east of the spillway. There is mud 15 inches below the surface. The topography was generally flat and water, probably runoff, was drained toward the toe, rather than a nearby ditch. There were no toe drains visible at the time of the inspection.

*3.1.3 Appurtenant Structures: Settlement of the wall (parapet) running along the crest of the dam was observed approximately 400 feet to the left of the intake tower. The area of settlement consists of two panels which have settled, forming a slight dip in the wall where they intersect.

3.1.4 Spillway: The concrete spillway shows evidence of surface spalling. Settlement and tilting was observed in a retaining wall panel on the north side of the spillway (see Plate 7, Appendix I). The top of the panel has tilted forward, and the front of the panel's base has settled. Both have moved about two inches.

*Information provided by Law Engineering Associates of Virginia.

3.2 Evaluation: The visual inspection revealed that there is a 2-3 inch sag in the wall on the crest of the dam and that there is water puddled below the dam. It appears there is no flow in an auger hole placed in the wet areas. Corrective measures are under consideration for the spalling of the spillway. The settlement and tilting in the retaining wall pond should be monitored regularly to determine whether or not it is still moving. If movement is still occurring, the owner should secure the services of a professional engineer to recommend corrective action.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure: The normal pool elevation is 19.0 feet which is the crest of the spillway. The reservoir is used as a source of water for the City of Norfolk. The Public Works Department maintains records of the lake level and water taken from the lake for treatment. Water is taken from the dam by the pump station 200 feet downstream of the dam at the right abutment. The pump station is manned during working hours. A water level guage is connected by direct wiring to the city office of the water treatment plant where records are maintained of the lake level and drawdown to the pumping station. Water is diverted as needed.

4.2 Maintenance: The Public Works Department of the City of Norfolk has responsibility for maintaining the dam and pumping facilities as well as maintaining the grounds. Other maintenance or grounds improvements are by order of the City and would be on file at the city treatment plant or city office.

4.3 Warning System: There is no warning system established for this dam to warn persons in the area in case of an emergency.

4.4 Evaluation: The Public Works Department for the city of Norfolk has a well established system for operation and routine maintenance of the dam, however, a warning system should be established for the dam in case of emergency.

SECTION 5

HYDRAULIC/HYDROLOGIC DATA

5.1 Design:

a) Norfolk Water Development Construction Plans from the Director of Public Works, City of Norfolk, Virginia, dated April 1960.

5.2 Hydrologic Records: None were available.

5.3 Flood Experience: There were no records available.

5.4 Flood Potential: The PMF and 1/2 PMF were developed and routed through the Lake Burnt Mills, Lake Prince, and Western Branch Reservoir by use of the HEC-1 computer program (Reference 3, Appendix V) and appropriate unit hydrograph, precipitation, ans storage-outflow data. Clark's Tc and R coefficients for the local drainage area were estimated from basin characteristics. The rainfall applied to the developed unit hydrograph was obtained from a U S Weather Bureau Publication (Reference 1, Appendix V). Losses were estimated at an initial loss of 1.0 inch and a constant loss thereafter of 0.05 inch/hour.

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

Water is passed from Western Branch Reservoir to the water treatment plant. Two 42-inch diameter pipelines from a water intake tower in the reservoir run through the dam to the water treatment plant. Water also flows past the dam over the spillway in the event water in the reservoir rises above elevation 19.0.

The storage curve above the spillway crest was calculated by use of U S Geological Survey Quadrangle Maps. Rating curves were developed for the spillway and non-overflow section of the dam. In routing hydrographs through the reservoir, it was assumed that the initial pool level was at the spillway crest. Flow to the water treatment plant was neglected during routing.

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

Table 5.1 RESERVOIR PERFORMANCE

Item	Normal flow	Hydrograph 1/2 PMF	Hydrograph PMF (c)
Peak Flow, c.f.s.			
Inflow	3	44,671	104,525
Outflow	--	35,057	96,363
Maximum elevation feet, m.s.l.		28.4	31.4
Spillway (elevation 19.0)			
Depth of flow, feet (a)		6.6	8.6
Velocity, f.p.s. (b)		14.5	16.7
Non-overflow section (elevation 27.0)			
Depth of flow, feet (a)		0.9	2.8
Duration , hours		11	20
Velocity, f.p.s. (b)		5.4	9.5
Tailwater elevation, feet, m.s.l.	0±		

(a) Critical Depth.

(b) Velocity at Critical Depth.

(c) The PMF is an estimate of flood discharged that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

5.7 Reservoir Emptying Potential: The two 42-inch pipelines from the water intake tower can also be used for dewatering the reservoir. The two 42-inch pipelines are reduced to 30-inches near the downstream toe of the dam and then have two 30-inch laterals to the downstream creek and the main lines to the water treatment plant. Four gate valves on the 30-inch pipelines at elevation 0.0 are available for dewatering to within 3 feet of the bottom of the reservoir. The valves will permit withdrawal of about 350 c.f.s. with the reservoir level at the crest of the spillway and essentially dewater the reservoir in about 60 days assuming 3 c.f.s. inflow into the reservoir and no flow from upstream reservoirs.

5.8 Evaluation: Based on the size (intermediate) and hazard (high) classifications, the recommended Spillway Design Flood is PMF. The spillway will pass 26% of the PMF without overtopping the dam. The PMF will overtop the dam for 20 hours and reach a maximum of 2.8 feet over the top of the parapet, with an average critical velocity of 9.5 feet per second.

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

SECTION 6

STRUCTURAL STABILITY

6.1 Foundation and Abutments: A profile of the dam is shown on Plate No. 3, Appendix I. A soil termed "mud", probably an alluvial material, overlies a thin layer of sand which lies above a layer of "marl". The layer of mud above the marl was excavated prior to construction and backfilled. The construction specifications do not indicate the type of fill used, however, hand auger probes of the embankment revealed a soil consisting of brown medium fine sand with little silt or clay (see section 2.2.) Sheet piles were driven in the area of the spillway. The sheet piles were driven 3 feet into the marl layer and they provide a firm foundation for the toe wall. The piling appears to have been installed as a cutoff wall to aid in preventing seepage through the dam, however, there are no records available to verify this.

6.2 Embankment: The downstream slope of the embankment is 3(H):1(V) and the upstream slope is 2(H):1(V). The upstream slope is covered with an 8-inch thick concrete slab, over the entire length of the dam, probably for seepage control and slope protection although no records were available to substantiate this. The construction records do not indicate the type of fill used for the embankment, however, shallow auger probes performed on the downstream embankment slopes revealed soils consisting of brown medium fine sand with little silt or clay. In compliance with the Contract Specifications, (Appendix IV), the embankment was to be placed in layers with a compacted thickness of 6 inches. Compaction was by sheepsfoot and/or heavy duty rubber-tired rollers 95% maximum density in accordance with the specifications and the fill was to be placed so that proper drainage was maintained at all times. The above information indicates proper procedures, however, construction records were not available and no stability analyses have been performed on the dam.

6.3 Evaluation: Without information regarding the soil stratigraphy, soil strength parameters or lines of seepage within the dam, the stability conditions can not be assessed.

SECTION 7

ASSESSMENT AND REMEDIAL MEASURES/RECOMMENDATIONS

7.1 Dam Assessment: Design calculations, construction records and structural stability evaluations of the dam were not available. Ponded water exists along the downstream toe of the dam in a wooded area several hundred feet east of the spillway. The ponded water may soften the underlying soils with time, thus reducing their strength properties.

The spillway will pass 26% of the SDF (PMF) without overtopping the dam. The SDF will overtop the dam by 2.8 feet with a velocity of 9.5 feet per second for a duration of 30 hours. This flow will cause serious erosion and probable failure of the dam. Due to these facts, and based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway is rated as inadequate and the dam is assessed as "unsafe-non-emergency". The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

The ponded water located at the toe of the embankment could cause the soil to become soft and muddy unless the drainage conditions are corrected. The settlement in the parapet wall appears to have occurred some time ago and does not show signs of recent movements or major structural damage. Settlement and tilting detected in one section of the spillway wall may, if movement is still continueing, indicate potential failure of that section of the wall.

7.2 Recommended Remedial Measures: It is recommended that within 2 months from the date of notification to the Governor of the Commonwealth of Virginia, the owner engage the services of a professional consultant to :

a. Determine by more sophisticated methods and procedures the adequacy of the spillway. The study should include a more detailed study of the Spillway Design Flood appropriate to this dam. Remedial measures to be considered include modification to the dam, spillway, flood plain, and/or any other method of eliminating the danger imposed by the project.

b. Determine whether the stability conditions and the safety margins satisfy the requirements and guidelines given in Reference 4, Appendix V.

c. Determine if the settlement and tilting detected in one panel of the north side of the spillway channel is still occurring. If movement is still taking place, the owners engineer should recommend remedial measures designed to prevent failure of the wall.

Within six months of the date of notification by the Governor, the professional consultant's report of appropriate remedial mitigating measures should have been completed and the Owner should have an agreement with the Commonwealth of Virginia to a reasonable time frame in which all remedial measures will be complete. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

The following items do not require immediate action, however they should be corrected as part of the regular operation and maintenance program:

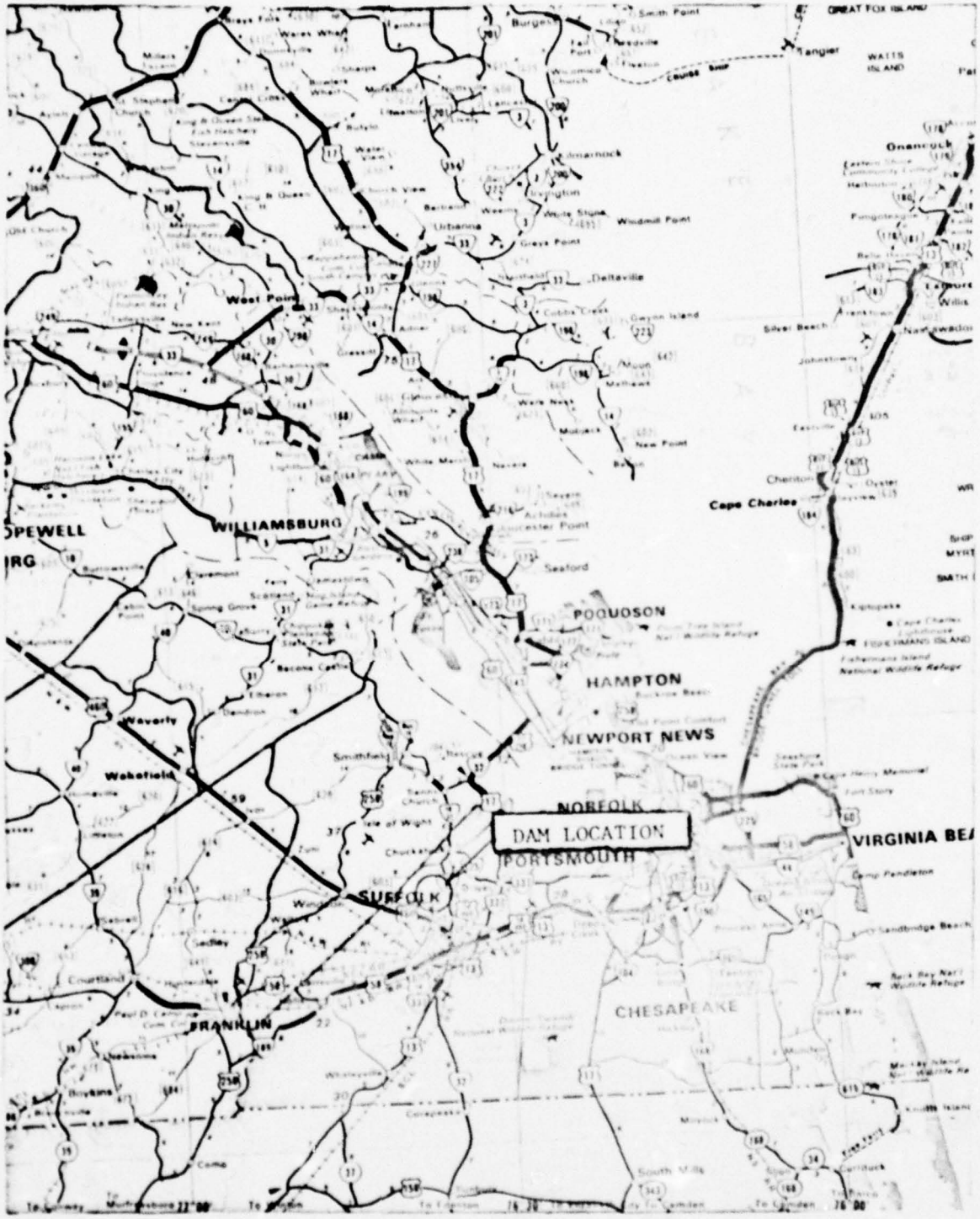
a. The ponded water should be removed from along the downstream toe of the dam and steps should be taken to insure that surface water drains away from the toe of the dam to the nearby ditch.

b. The owner should monitor the settlement of the parapet wall and if settlement continues, remedial measures may be required to protect the integrity of the dam.

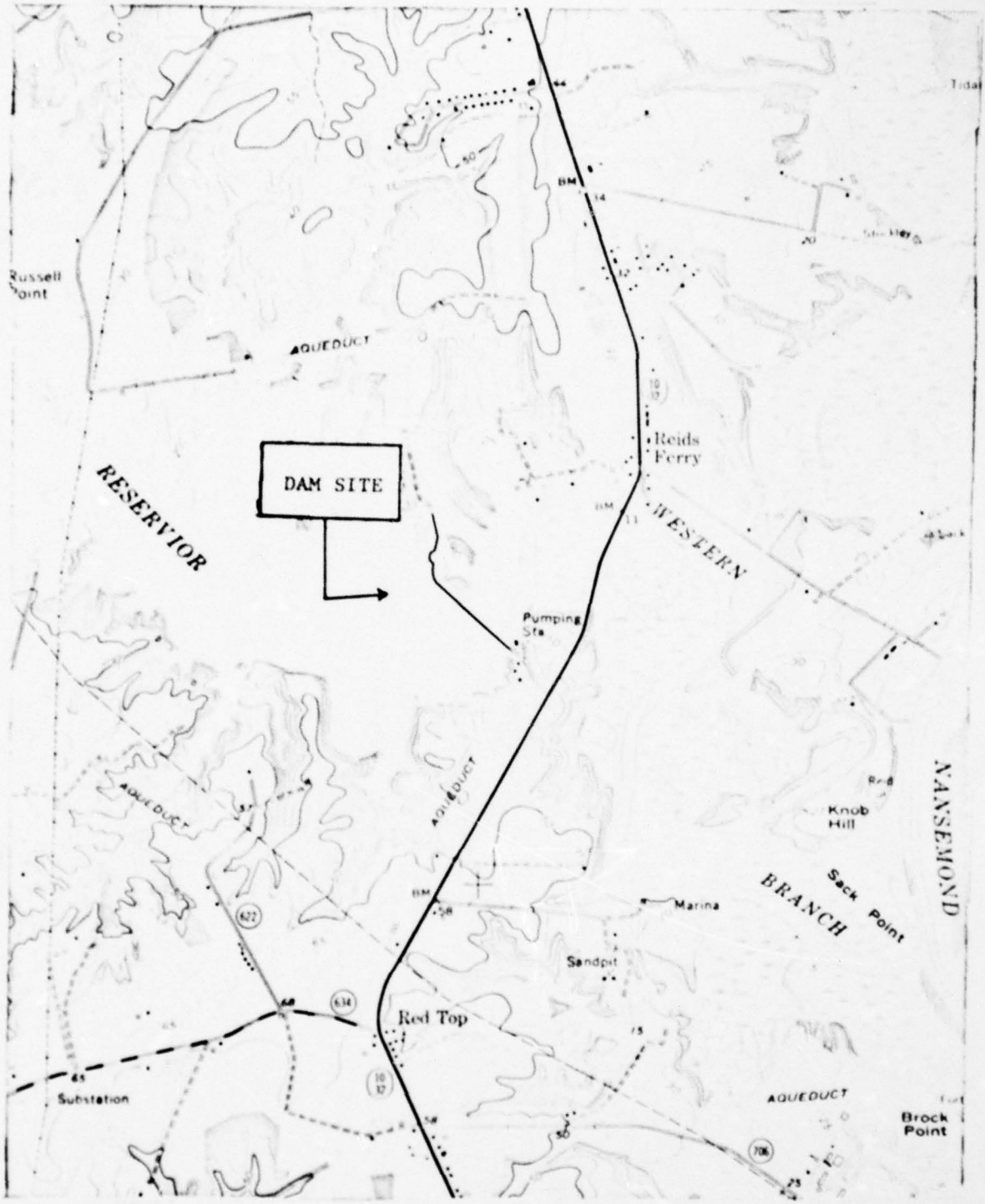
c. An annual maintenance and inspection program should be initiated to help detect and control problems that may occur.

APPENDIX I

MAPS AND DRAWINGS



REGIONAL MAP
WESTERN BRANCH RESERVIOR DAM



MN
GN

UTM GRID AND 1972 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

scale 1"=2000'
10' contours

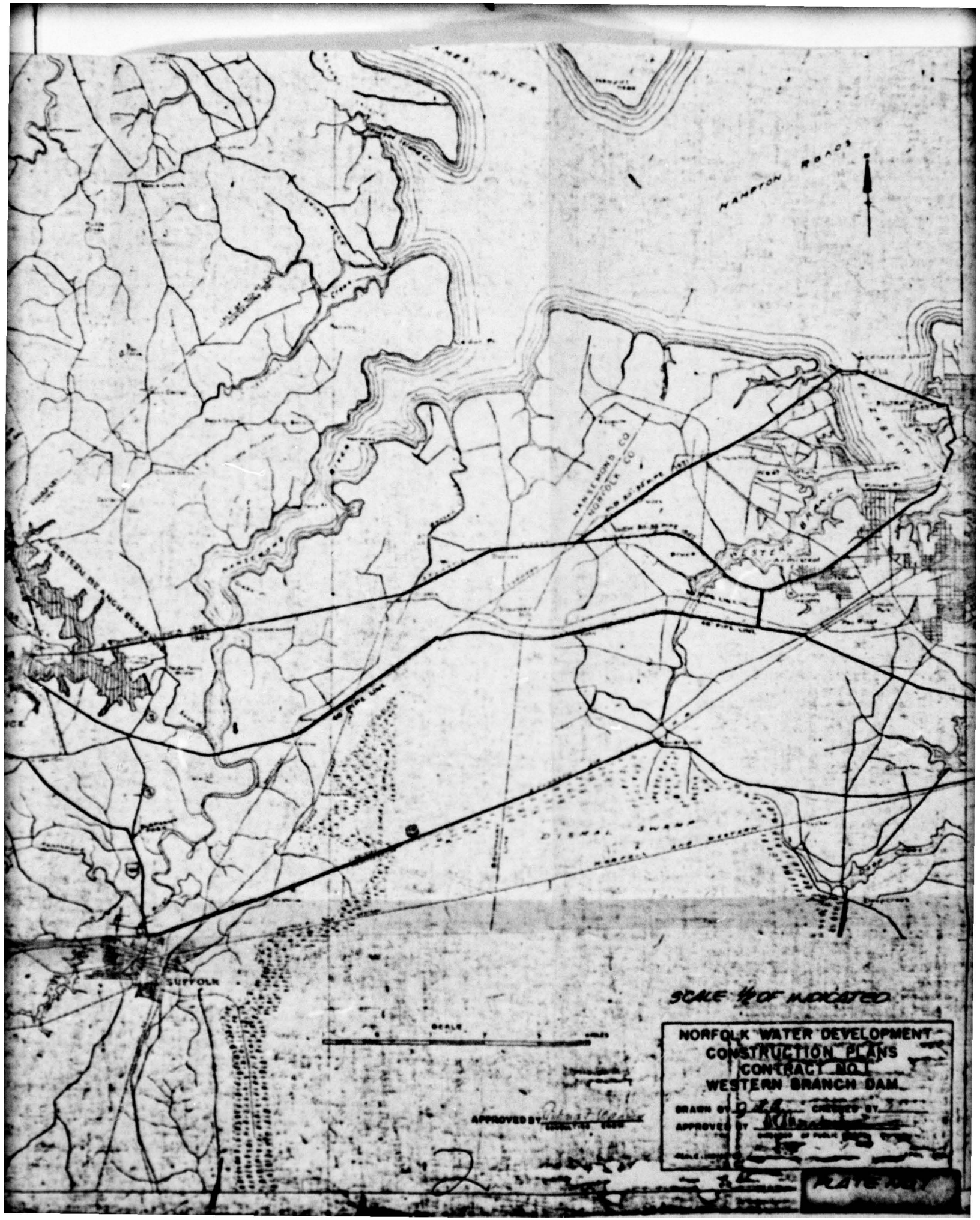
CHUCKATUCK, VA.

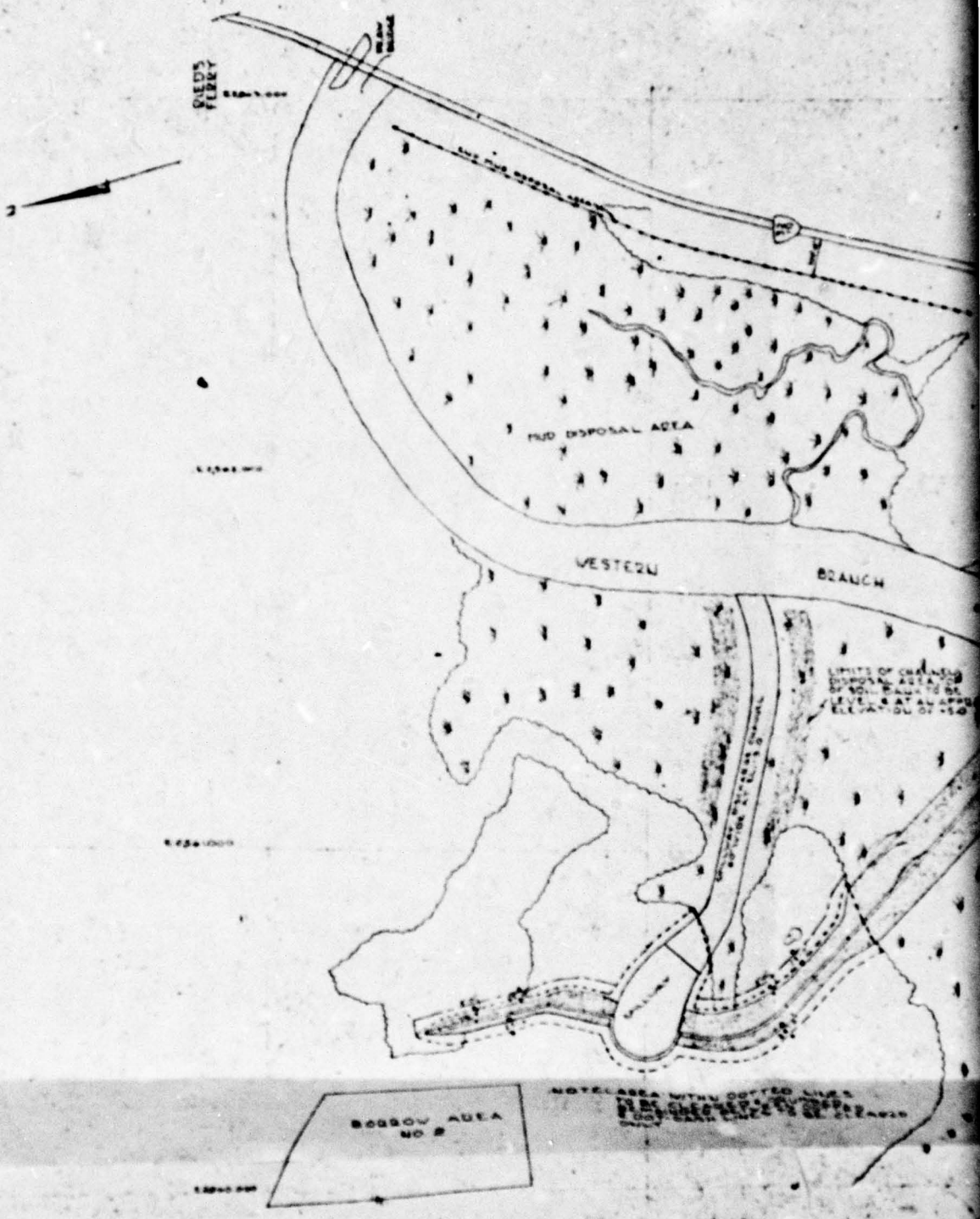
N3645—W7630/7.5

1965
PHOTOREVISED 1972
AMS 5657 I SE-SERIES V834

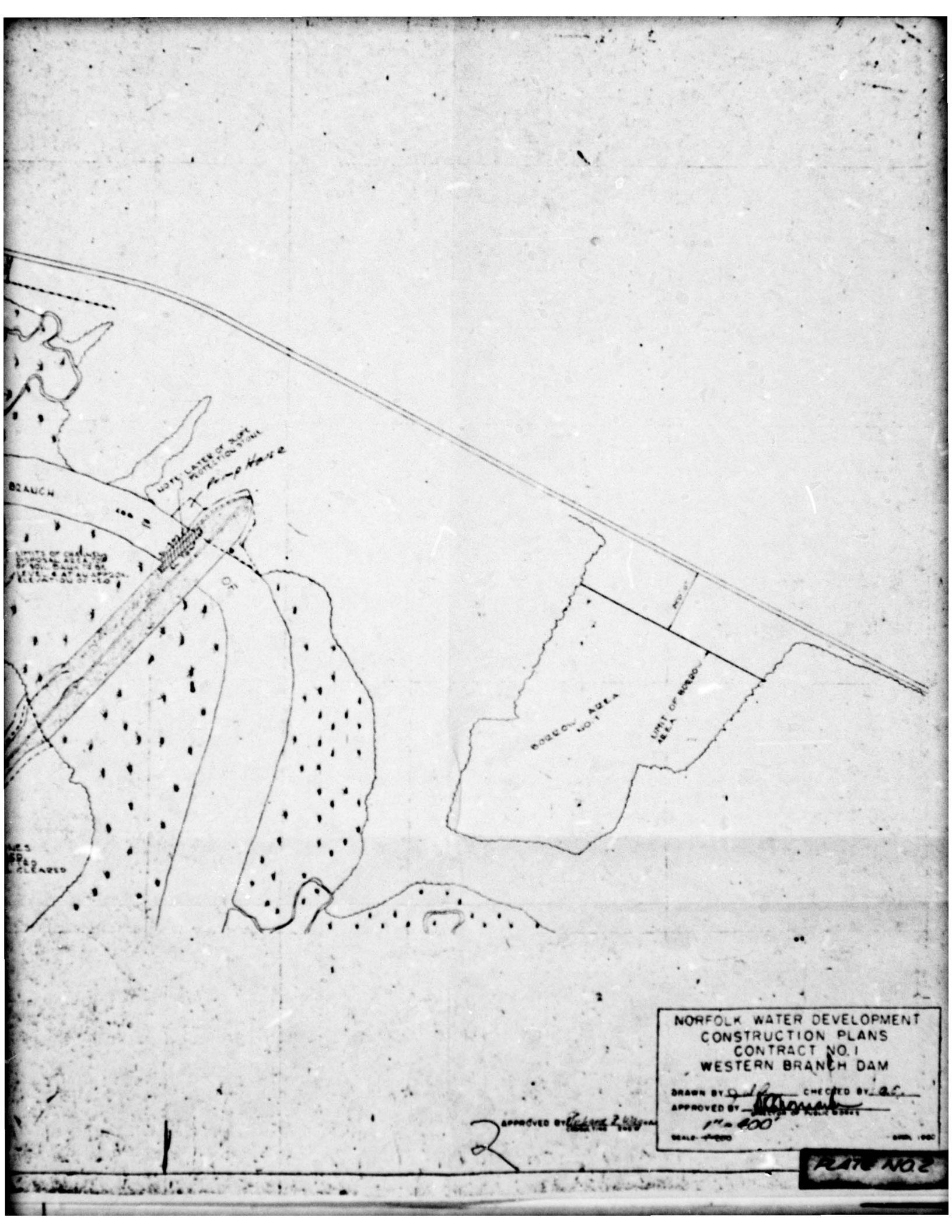
VICINITY MAP
WESTERN BRANCH RESERVOIR DAM
WESTERN BRANCH LAKE

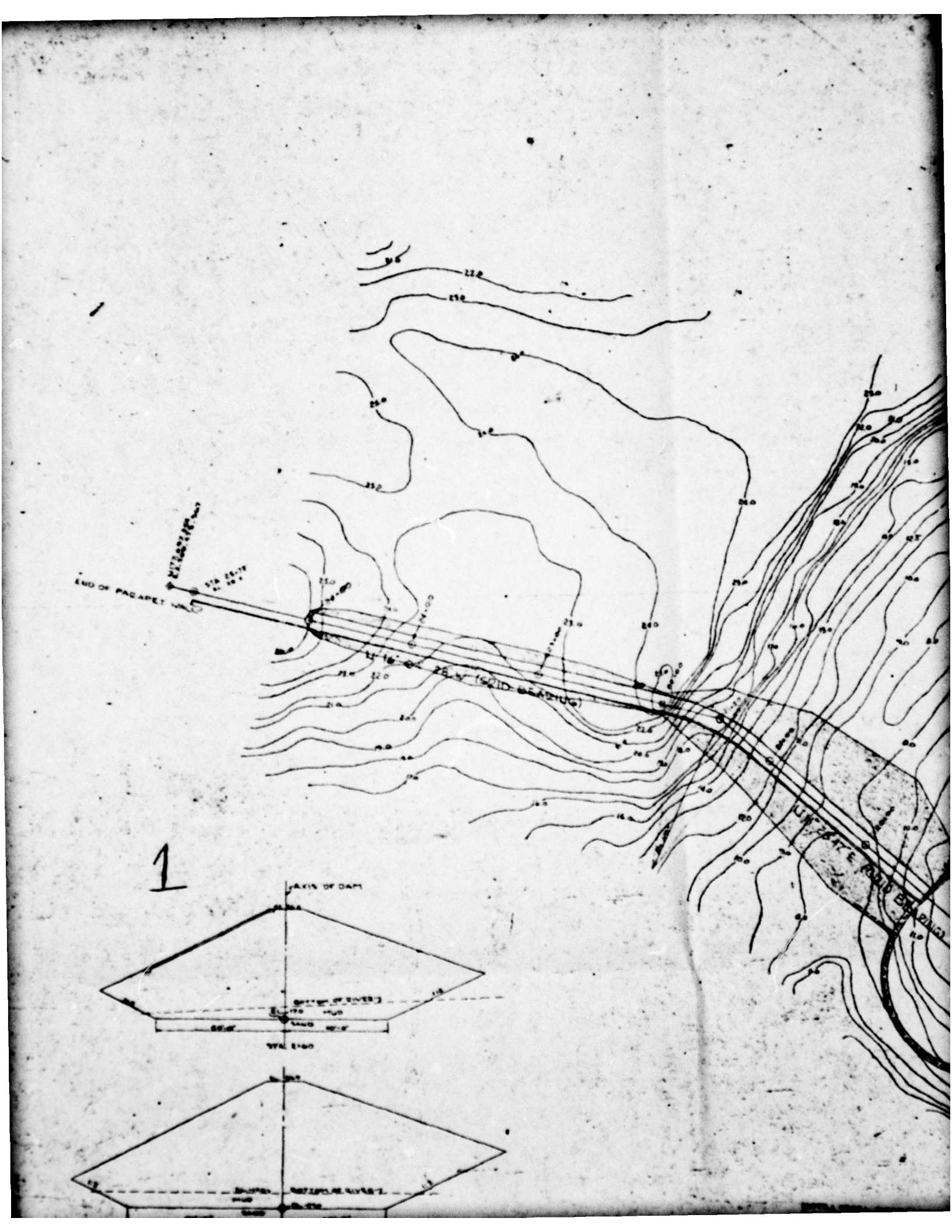

DRAINAGE AREA
234.56 MILES
DRAINAGE AREA
80.2 56 MILES
LAKE PRINCE

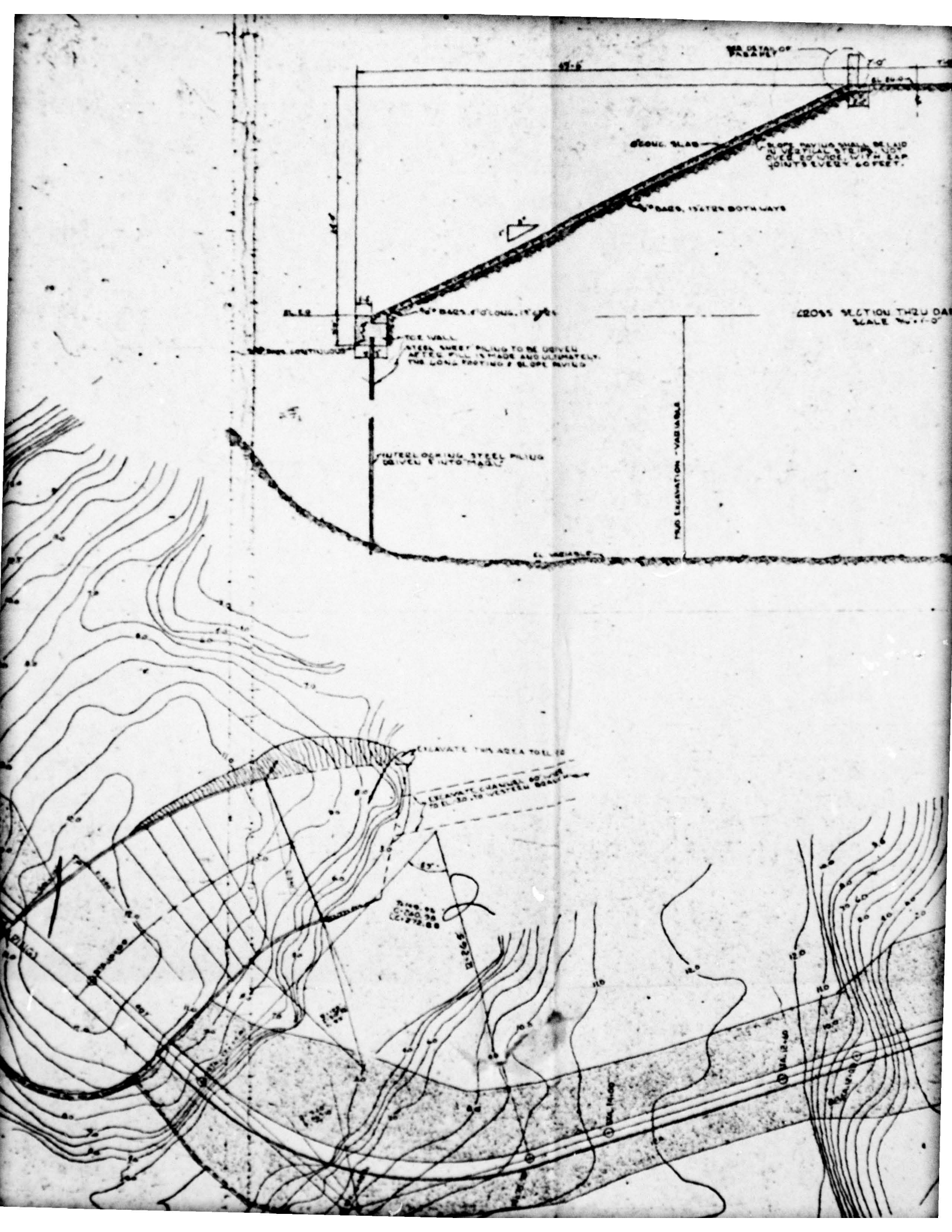

HAMPTON ROADS
SUFFOLK
SCALE
SCALE ½ OF INDICATED
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
CONTRACT NO. 1
WESTERN BRANCH DAM
APPROVED BY
PLATE NO. 1

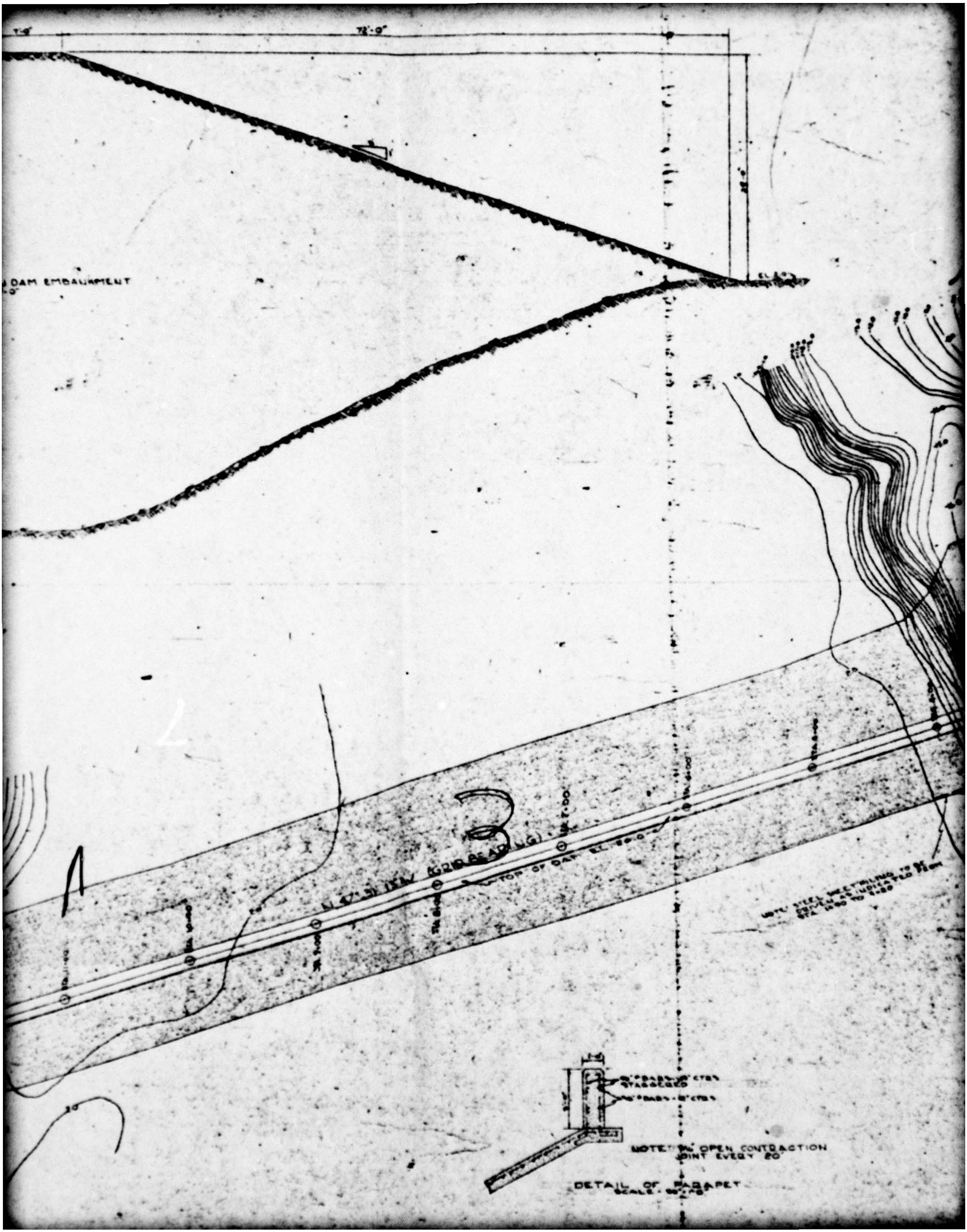

REED'S FERRY
MUD DISPOSAL AREA
WESTERN BRANCH
BORROW AREA NO 2

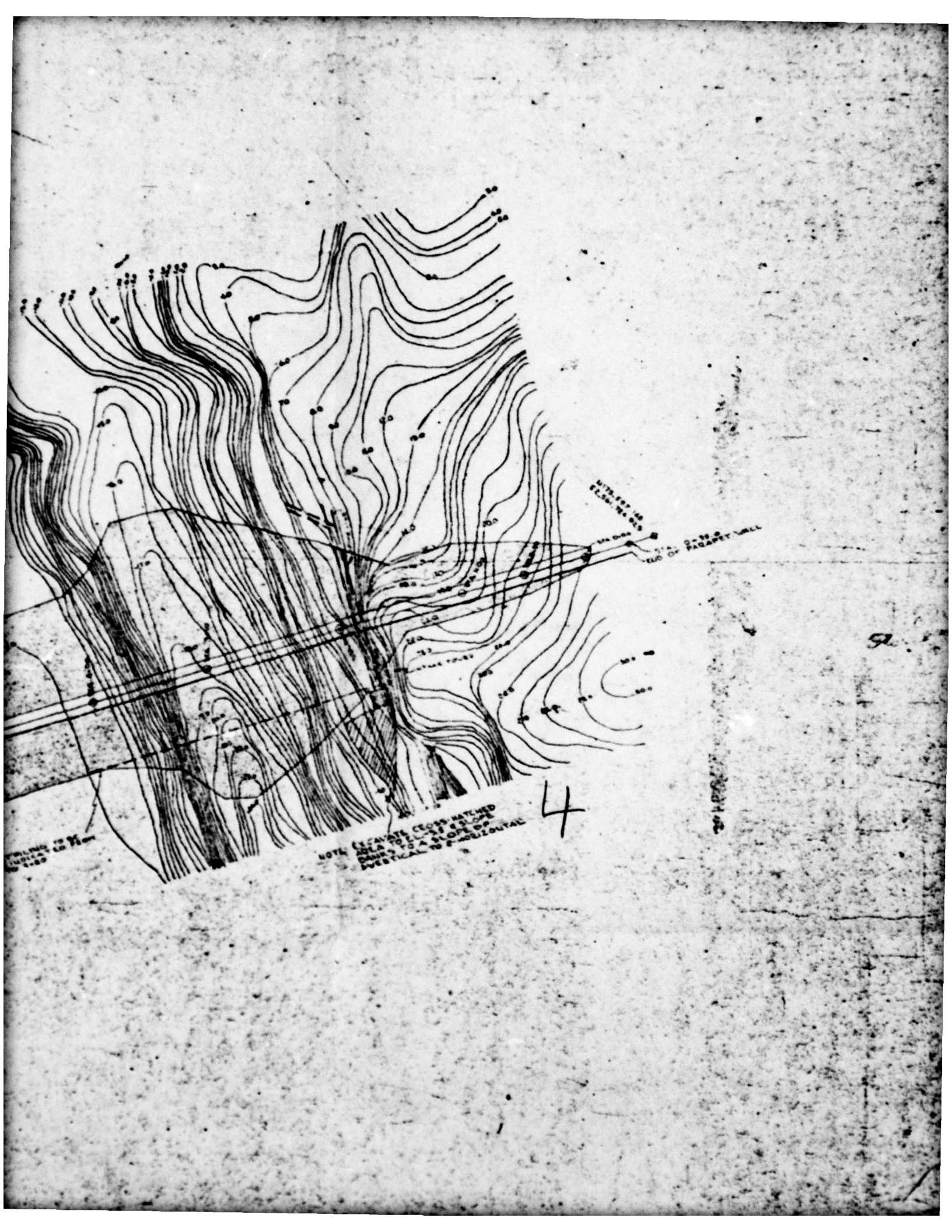
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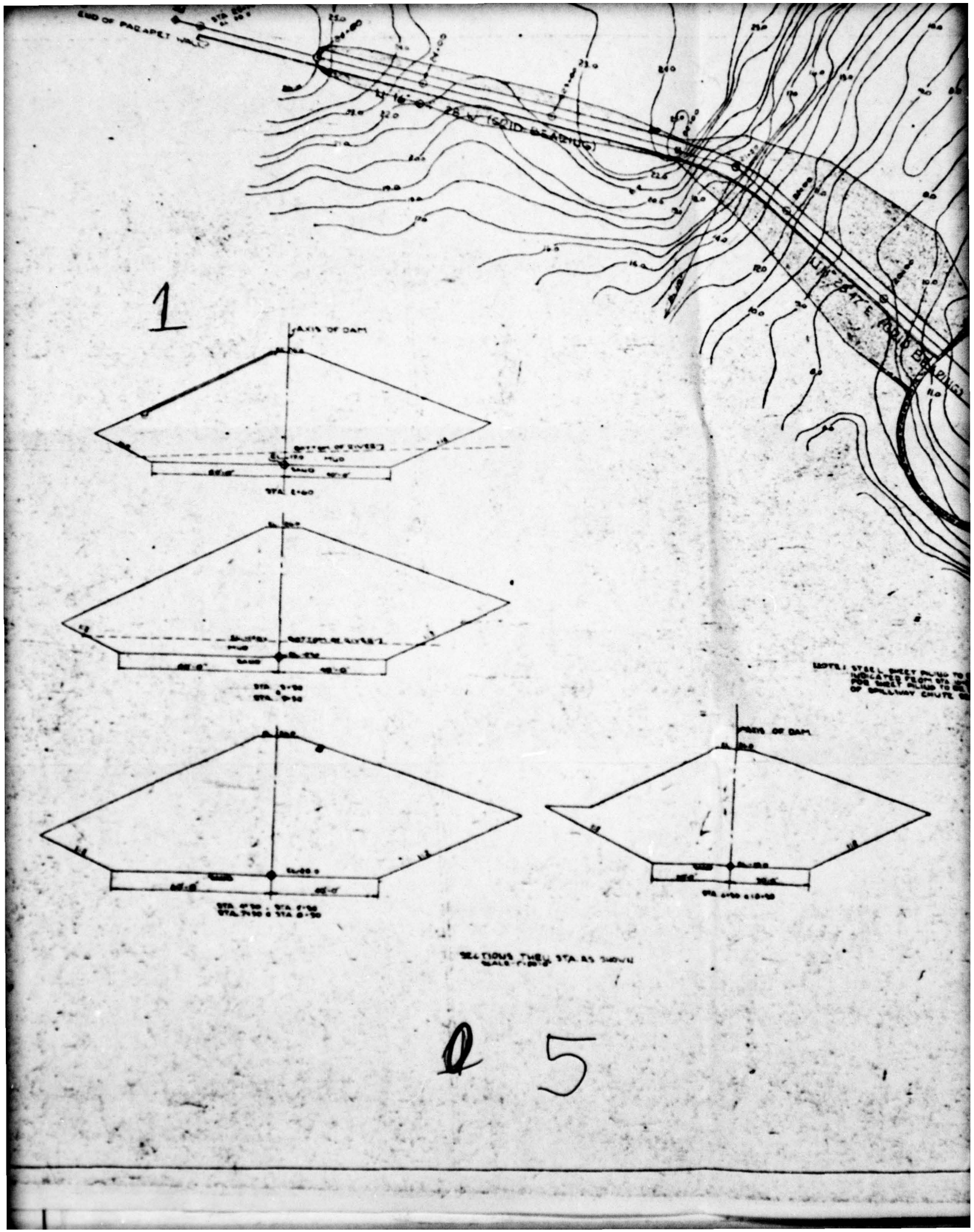

BRAUCH
LIMIT OF CLEARING
BORROW AREA NO. 1
LIMIT OF BORROW AREA
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
CONTRACT NO. 1
WESTERN BRANCH DAM
DRAWN BY
CHECKED BY
APPROVED BY
1" = 400'
PLATE NO. 2


END OF PARAPET WALL
1
AXIS OF DAM


SEE DETAIL OF PARAPET
GROUT SLAB
SLOPE PAVING SHALL BE LAID IN VERTICAL STRIPS 100' OVER EQUIDE WITH EXP JOINTS EVERY 60 FEET.
BARS, 12" CTRS BOTH WAYS
CROSS SECTION THRU DAM
SCALE
ICE WALL
STEEL SHEET PILING TO BE DRIVEN AFTER FILL IS MADE AND ULTIMATELY THE LONG FOOTING & SLOPE PAVED
TUTTERLOPING STEEL PILING DRIVEN INTO ROCK
EXCAVATE THIS AREA TO EL 20
EXCAVATE CHANNEL 50' WIDE TO EL 20.0 WESTERN BOUNDARY
DIKE
DIKE
DIKE

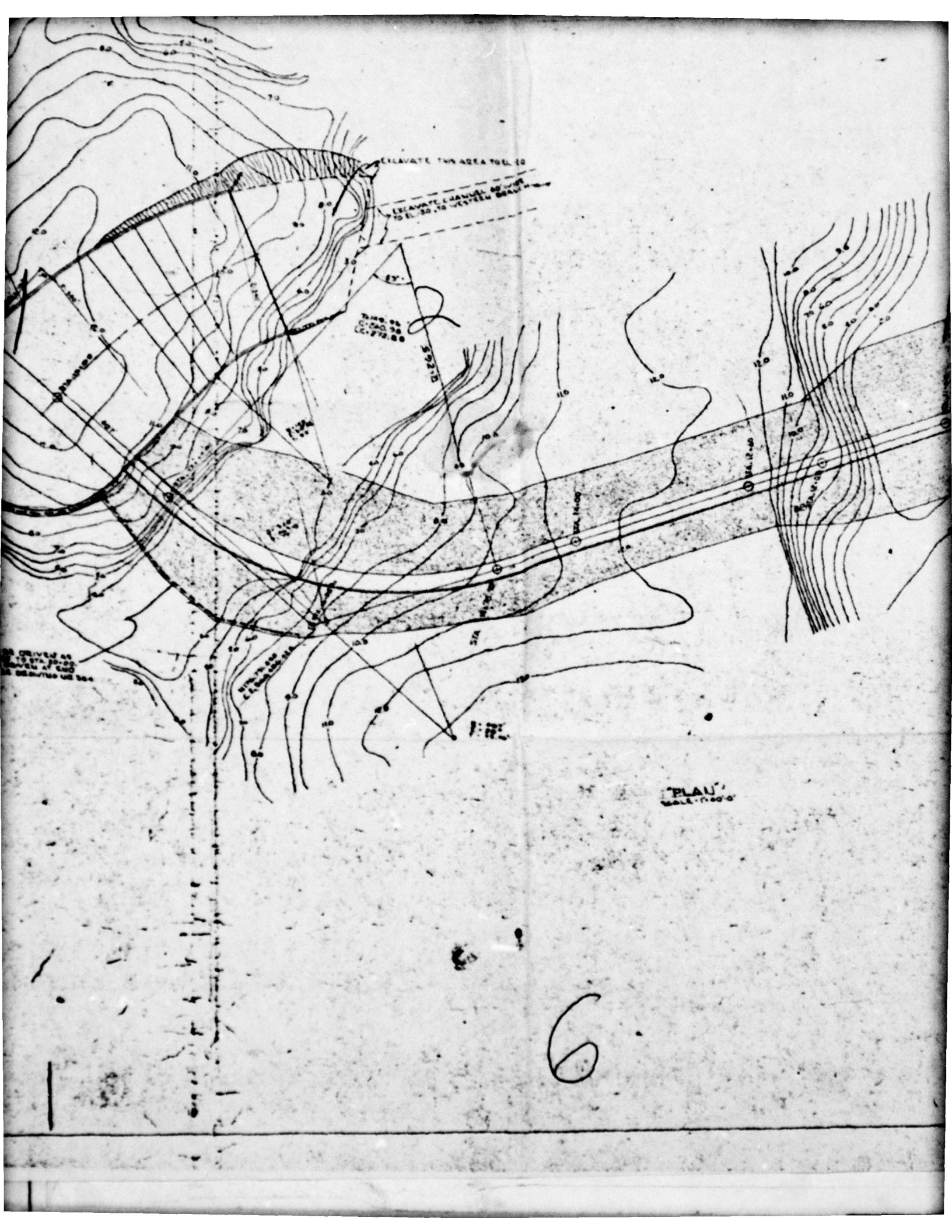

72'-0"
DAM EMBANKMENT
TOP OF DAM EL. 88.0
NOTE: IN OPEN CONTRACTION JOINT EVERY 20'
DETAIL OF PARAPET

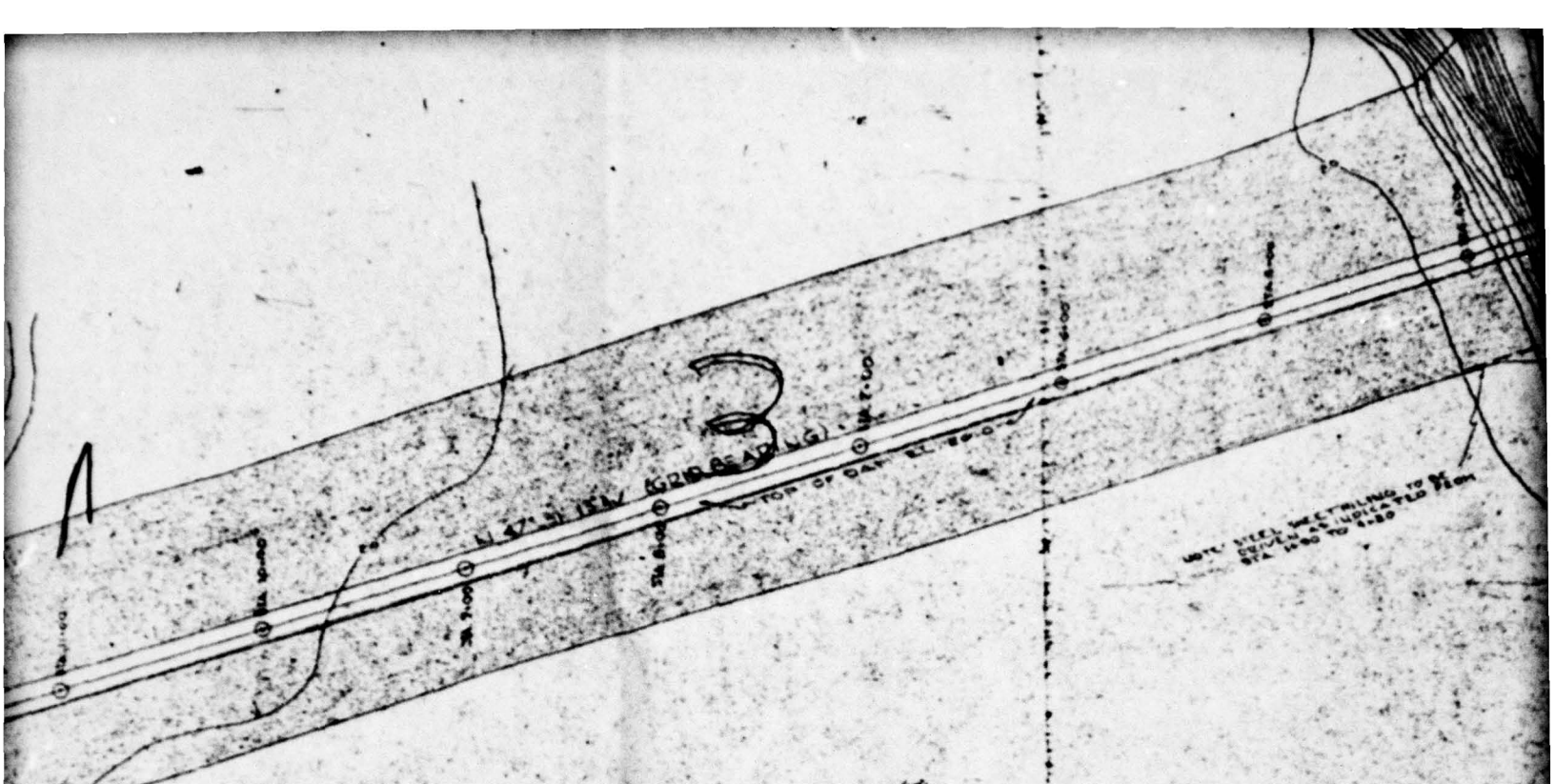

4

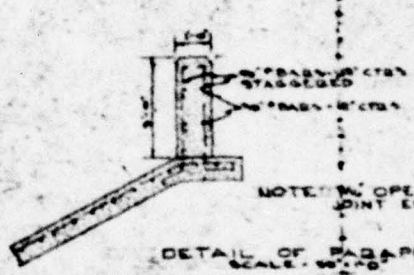

END OF PARAPET WALL
AXIS OF DAM
STA 1+60
STA 0+50
STA 0+50
STA 0+50 & STA 1+50
STA 1+50 & STA 2+50
AXIS OF DAM
STA 4+50 & 10+50
SECTIONS THRU STA AS SHOWN

1

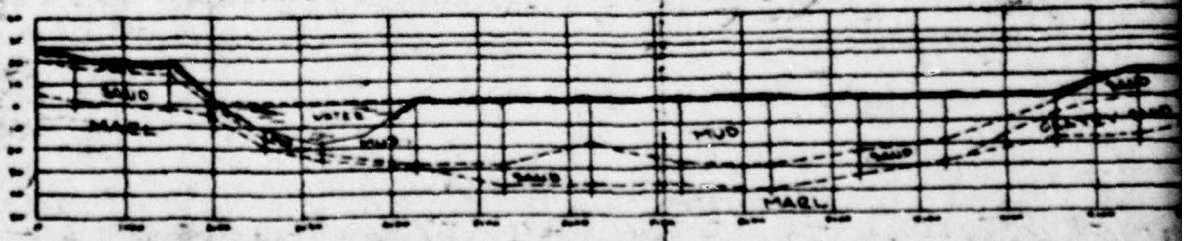
2 5


EXCAVATE THIS AREA TO EL 20
PLAN
SCALE: 1"=100'-0"





DETAIL OF PARAPET

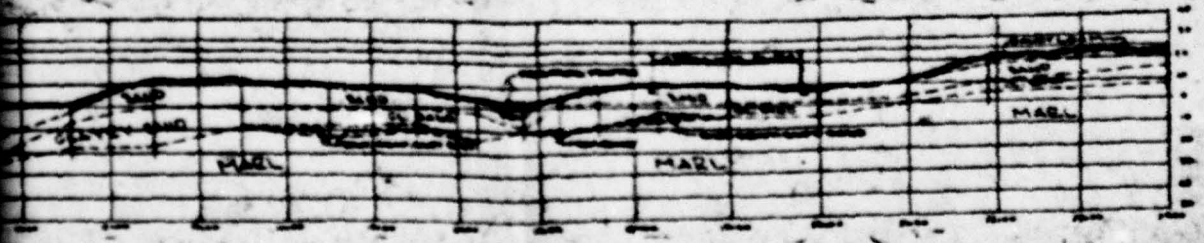


PROP

7



4



PROFILE

"M.S.L. ELEV. PLANE"

NORFOLK WATER DEVELOPM
CONSTRUCT PLANS
CONTRACT NO.1
WESTERN BRANCH DAM

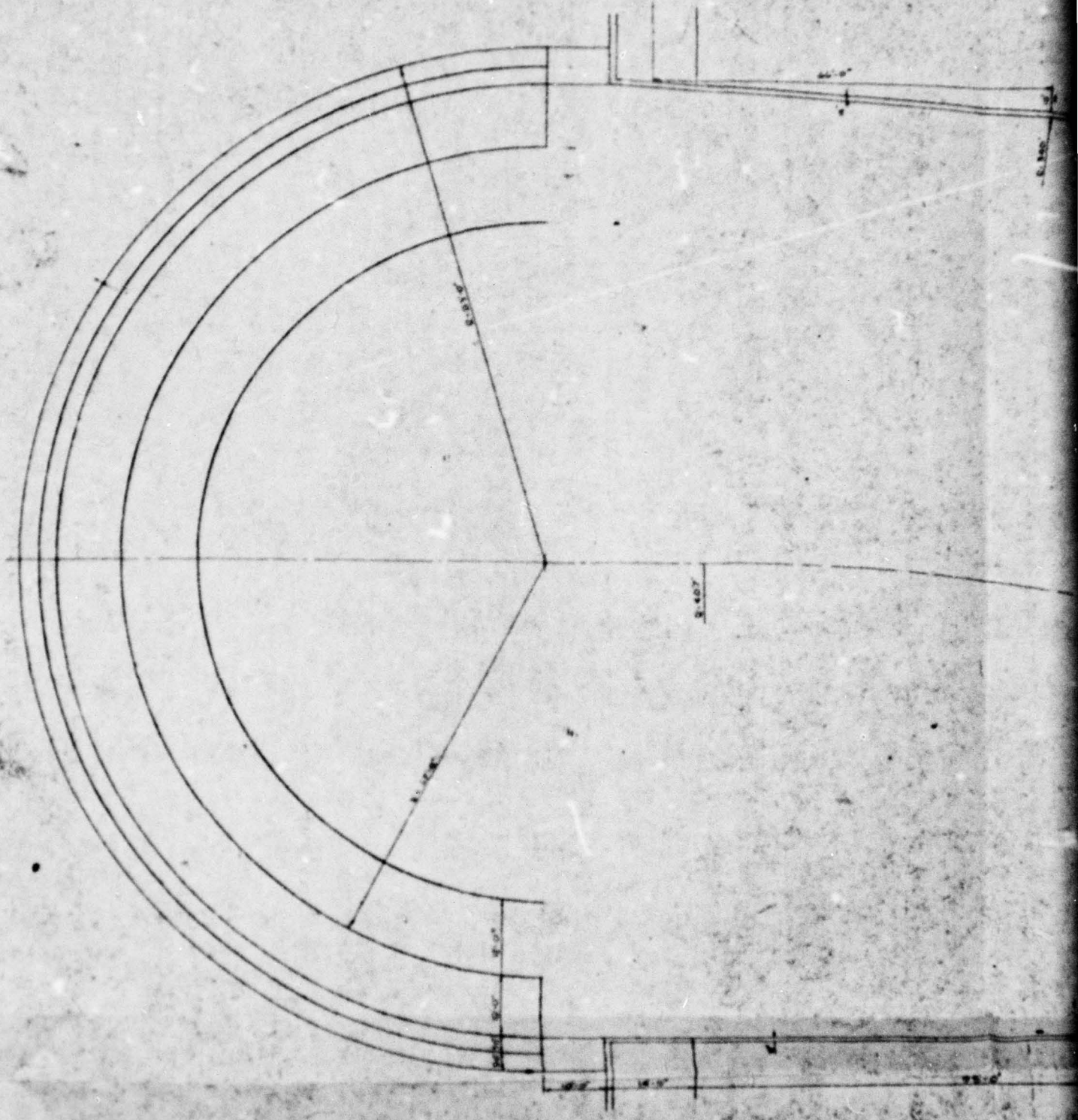
DRAWN BY [illegible] CHECKED BY [illegible]
APPROVED [illegible]

APPROVED BY [illegible]

SCALE: 1" = 40' UNLESS INDICATED

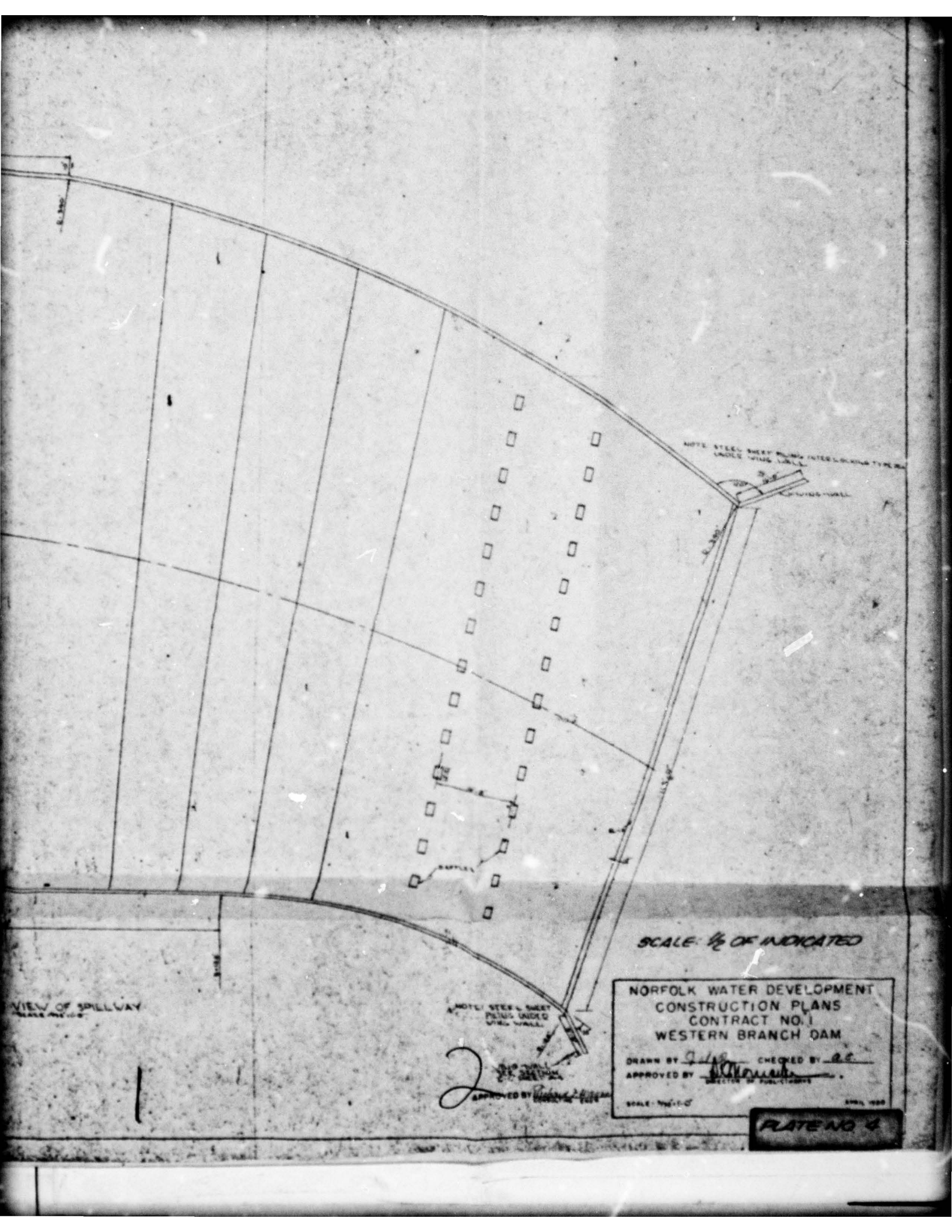
SHEET NO.

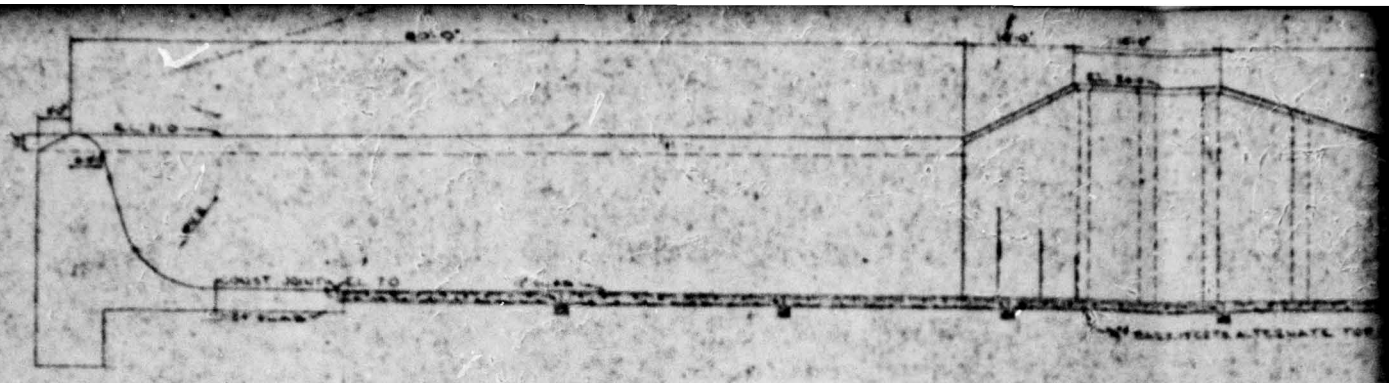
PLATE NO.



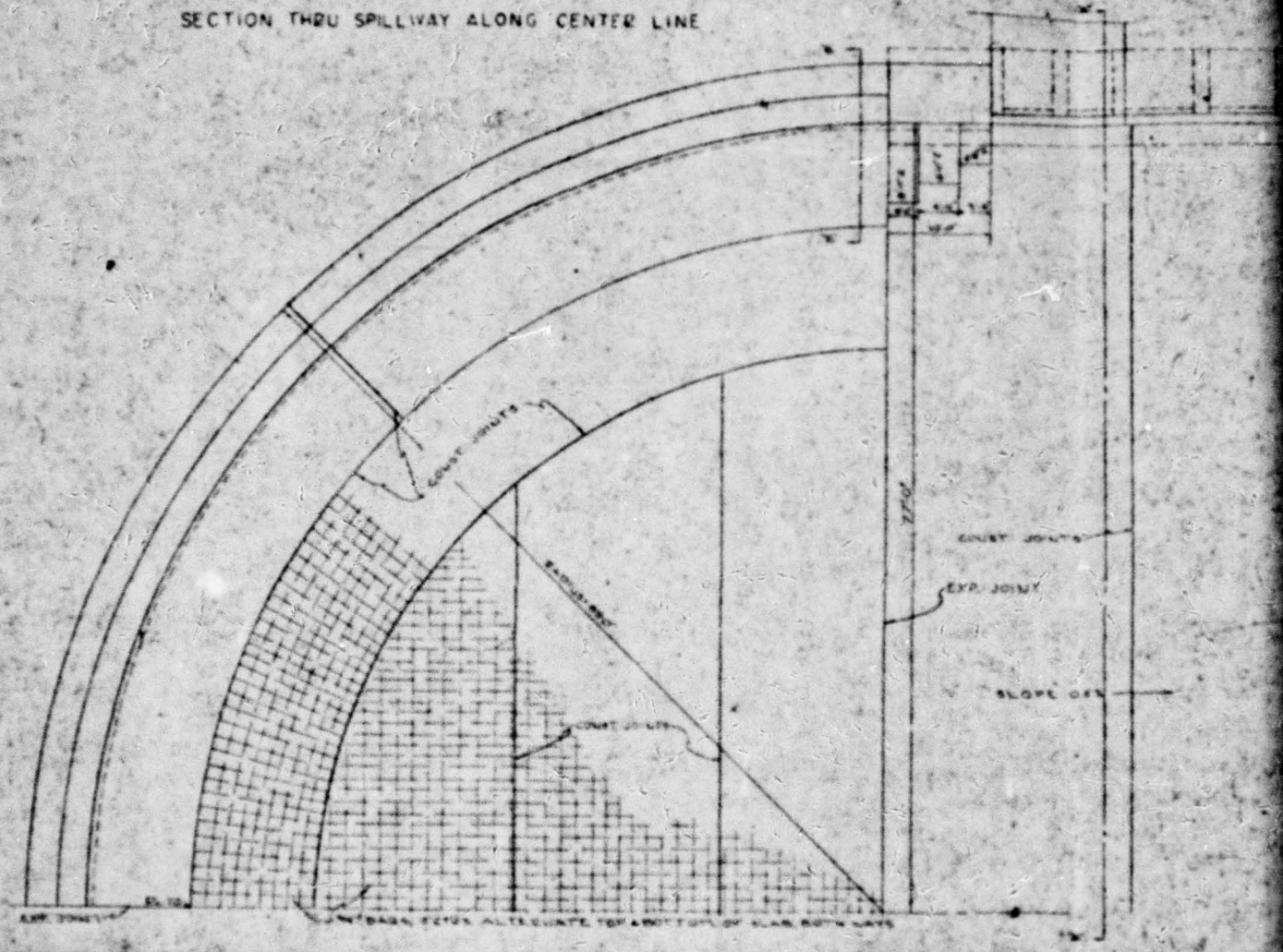
PLAN VIEW O

1

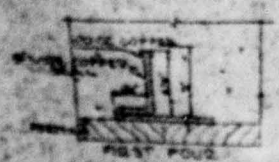

SCALE: ½ OF INDICATED
VIEW OF SPILLWAY
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
CONTRACT NO. 1
WESTERN BRANCH DAM
DRAWN BY
CHECKED BY
APPROVED BY
DIRECTOR OF PUBLIC WORKS
PLATE NO 4



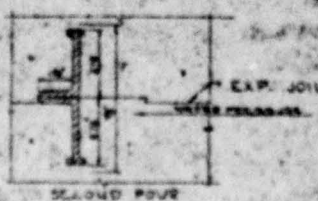
SECTION THRU SPILLWAY ALONG CENTER LINE



HALF PLAN OF SPILLWAY AT ELEVATIONS INDICATED

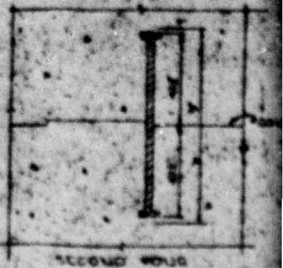


TYPE 'A' SEAL FOR EXP. JOINT

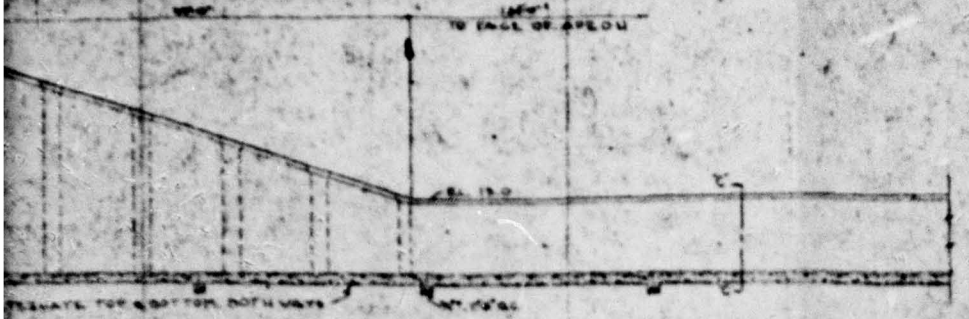


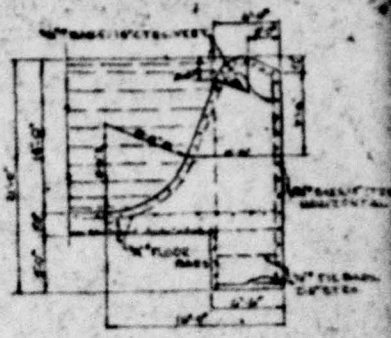


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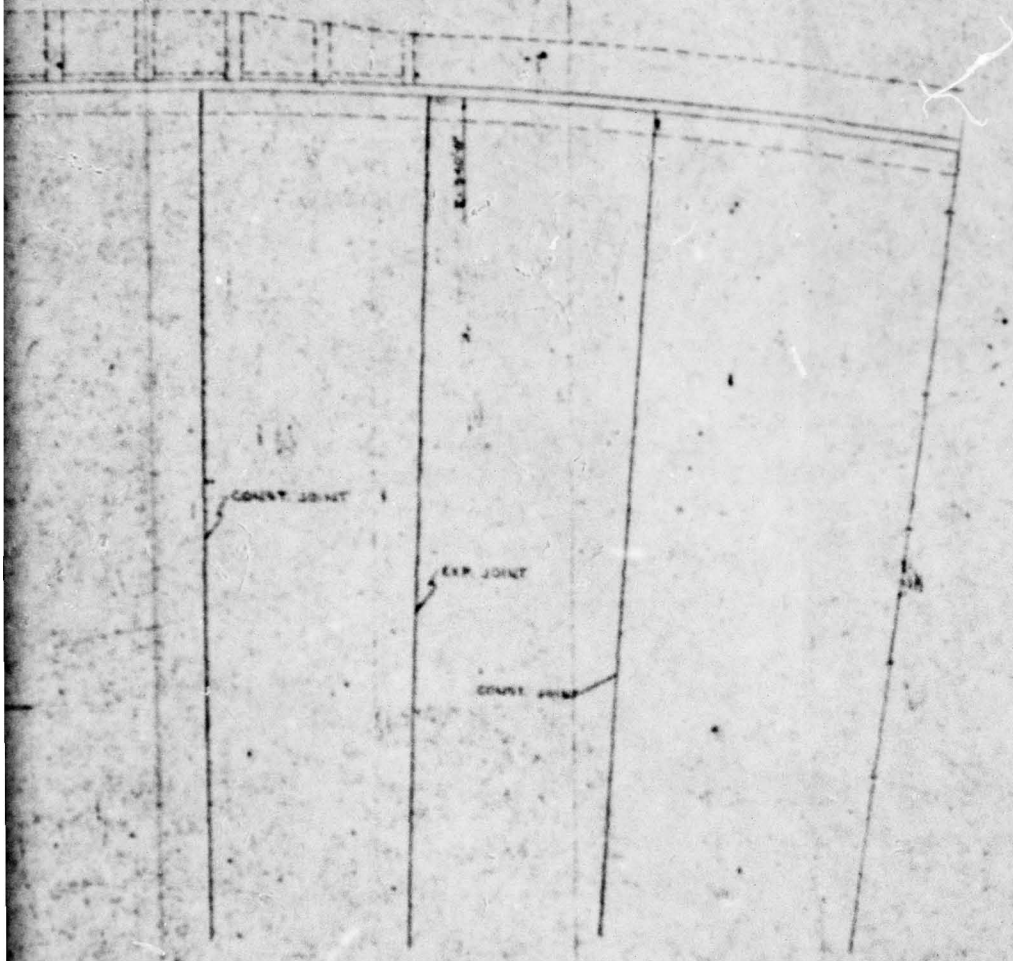


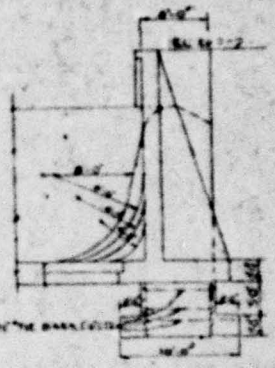
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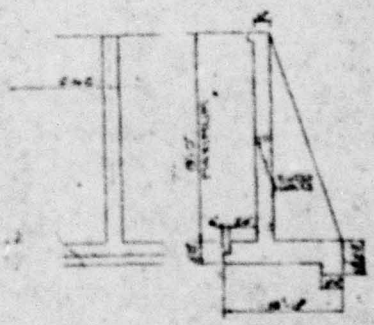


SECTION B-B





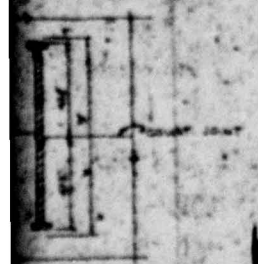
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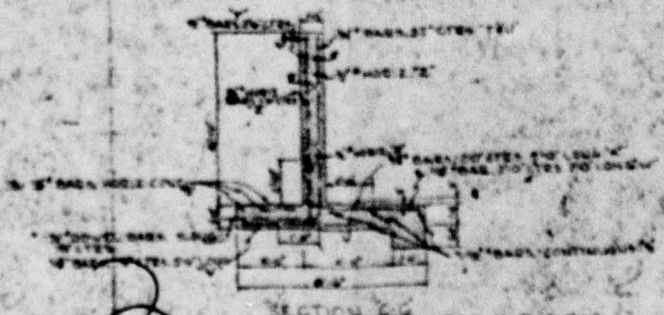


END ELEV SECTION
RETAINING WALL DETAILS

M.S.L. ELEV. = PLAN ELEV. -2.0'

SCALE 1/2 OF INDICATED





SECTION C-C
TYPICAL SECTION OF RETAINING WALL

APPROVED BY

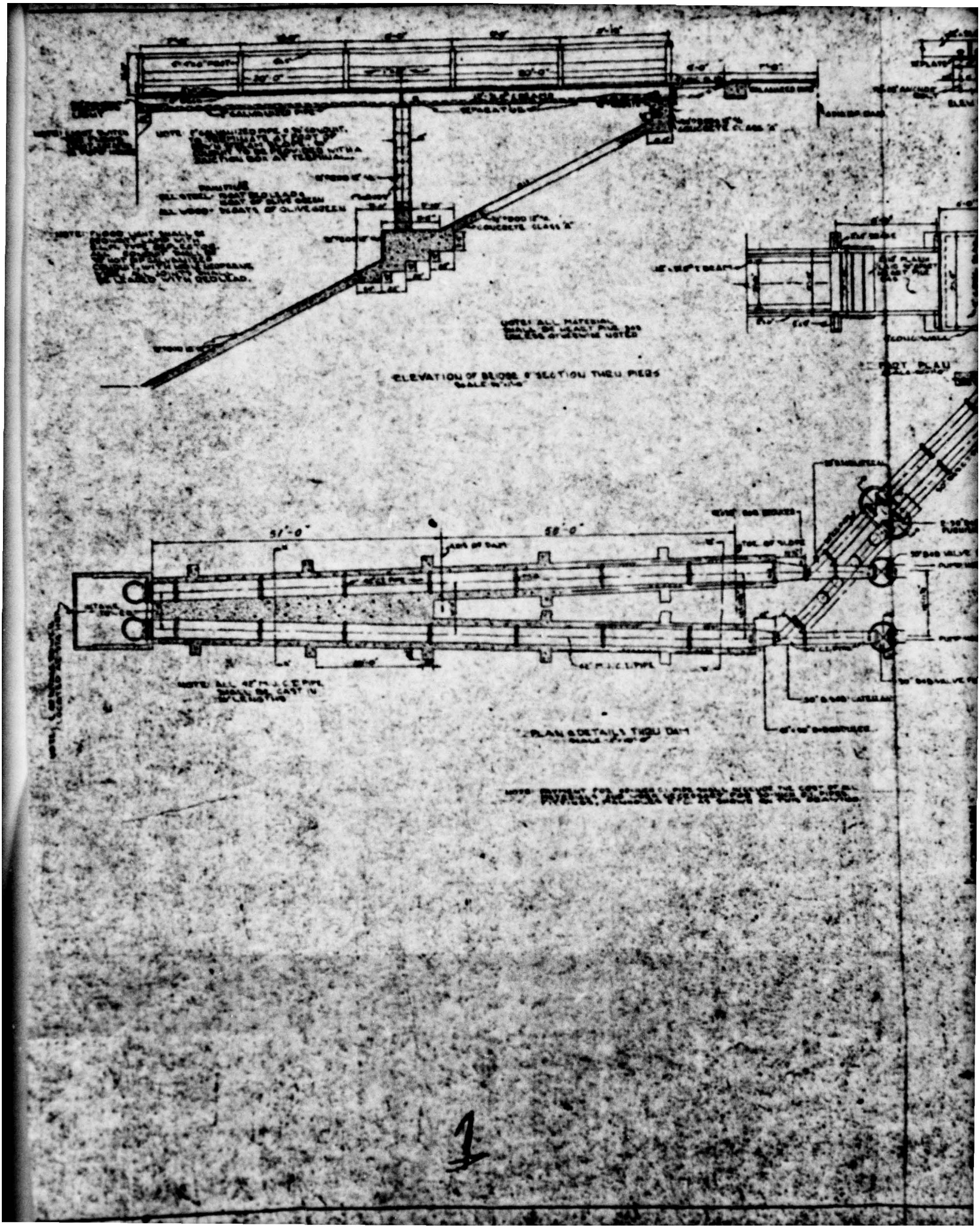
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
CONTRACT NO. 1
WESTERN BRANCH DAM

DRAWN BY CHECKED BY

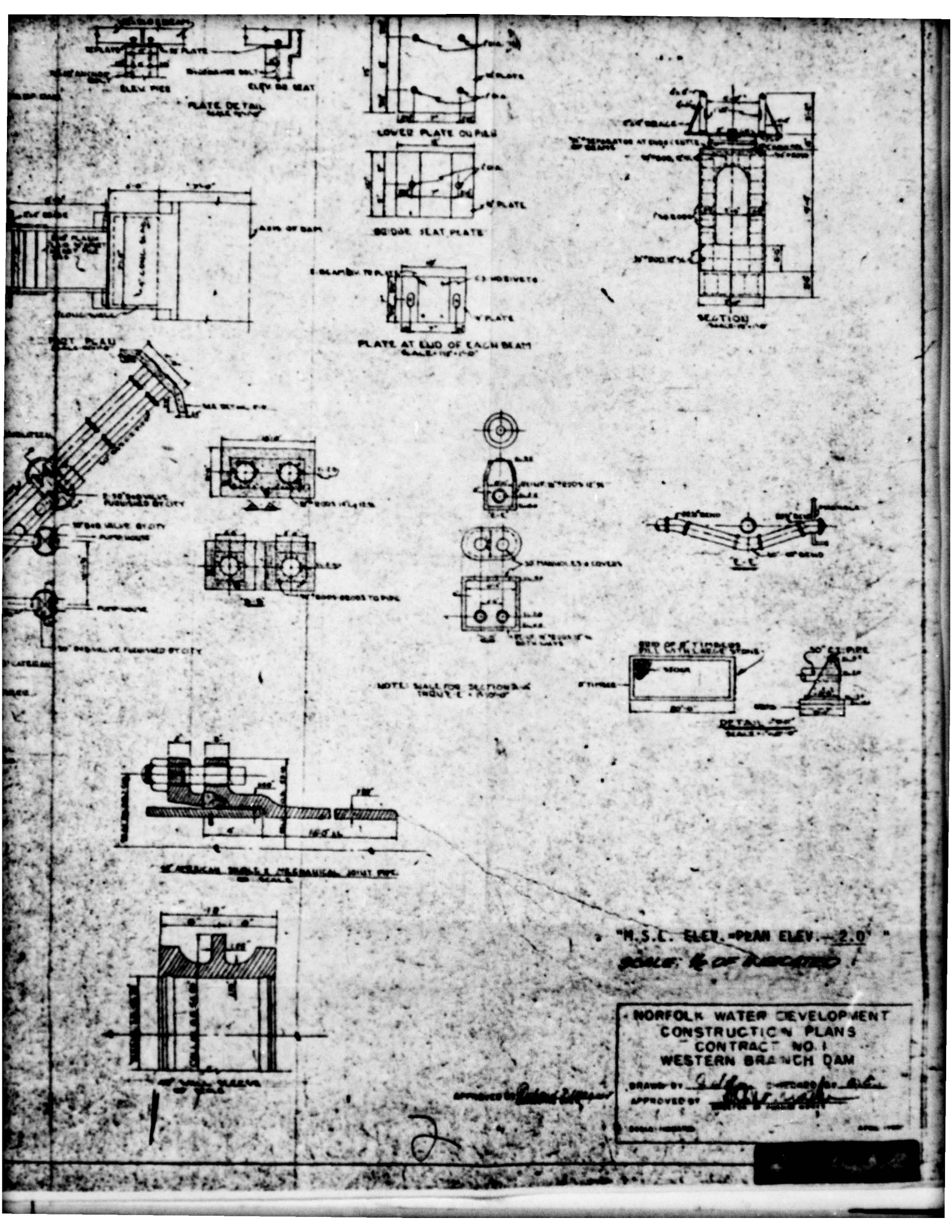
APPROVED BY

SCALE

PLATE NO


ELEVATION OF BRIDGE & SECTION THRU PIERS
PLAN & DETAILS THRU DAM
51'-0"
58'-0"

1


ELEV. PIER
ELEV. END SEAT
PLATE DETAIL
LOWER PLATE ON PIER
BRIDGE SEAT PLATE
PLATE AT END OF EACH BEAM
SECTION
PLAN
NOTE: SCALE FOR SECTIONS &
"M.S.L. ELEV. = PLAN ELEV. - 2.0'"
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
CONTRACT NO. 1
WESTERN BRANCH DAM

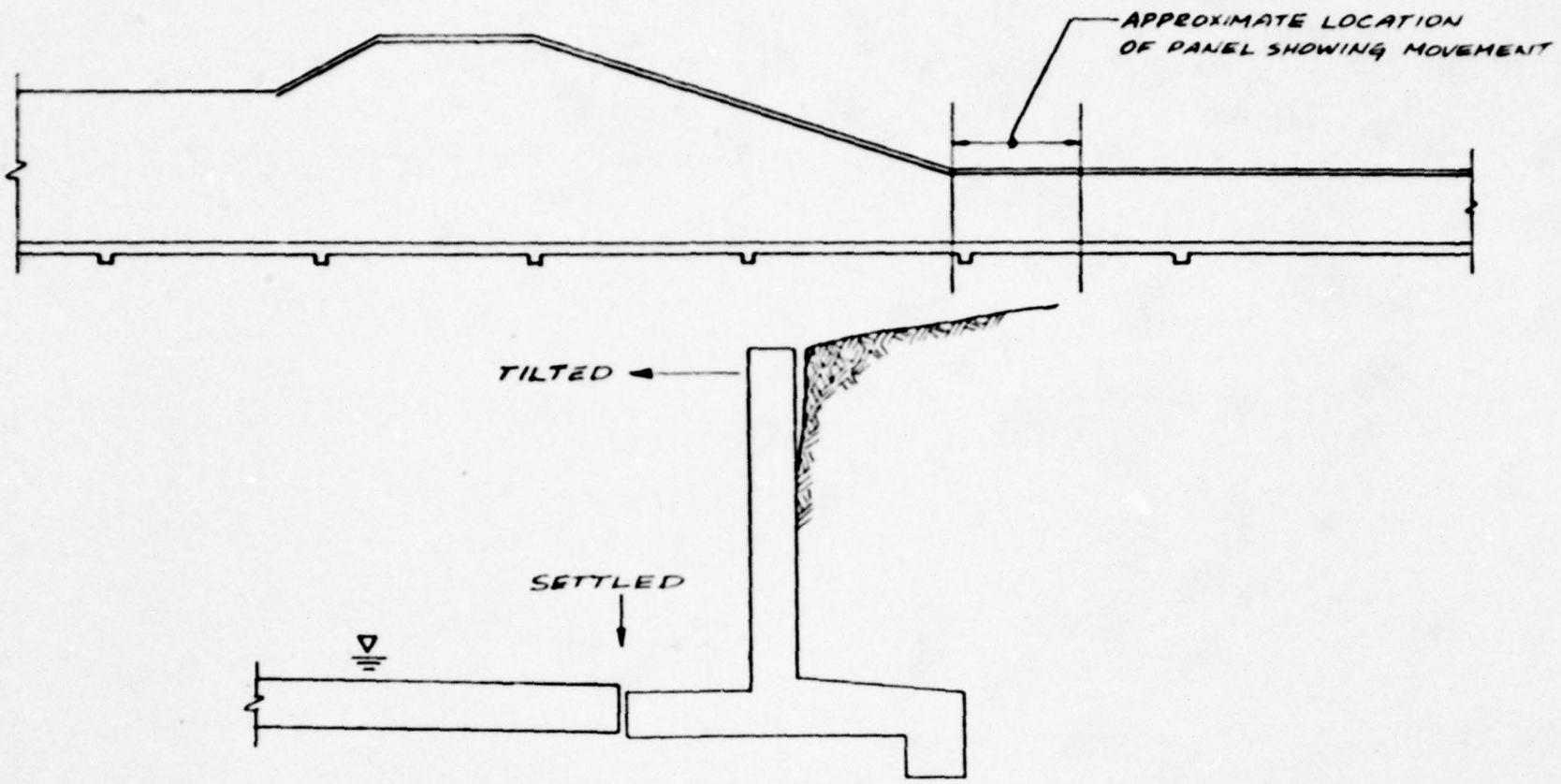


PLATE NO. 7

NORTHSIDE OF SPILLWAY

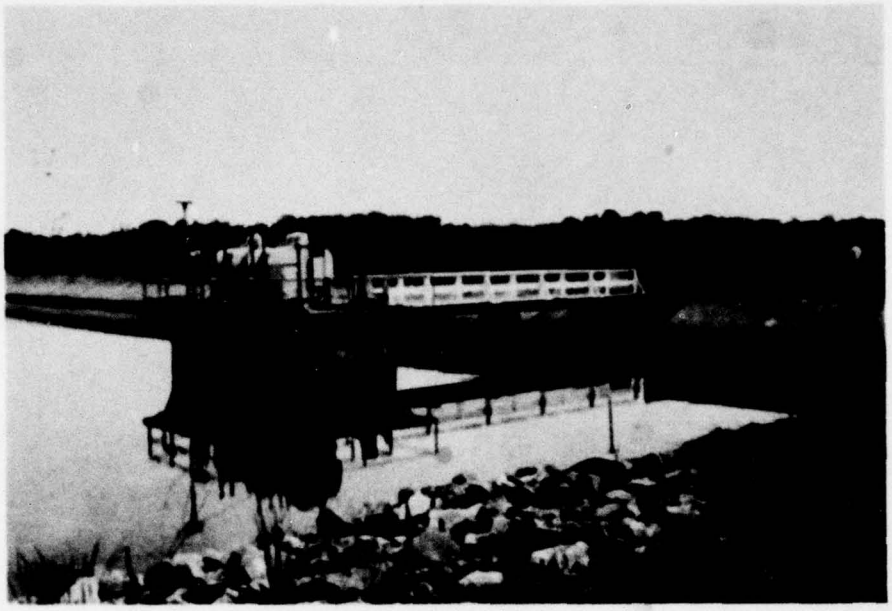
Western Branch Reservoir Dam

LAW ENGINEERING TESTING COMPANY
SOILS, MATERIALS, AND FOUNDATIONS ENGINEERS
7913 WESTPARK DRIVE, MCLEAN, VIRGINIA 22101

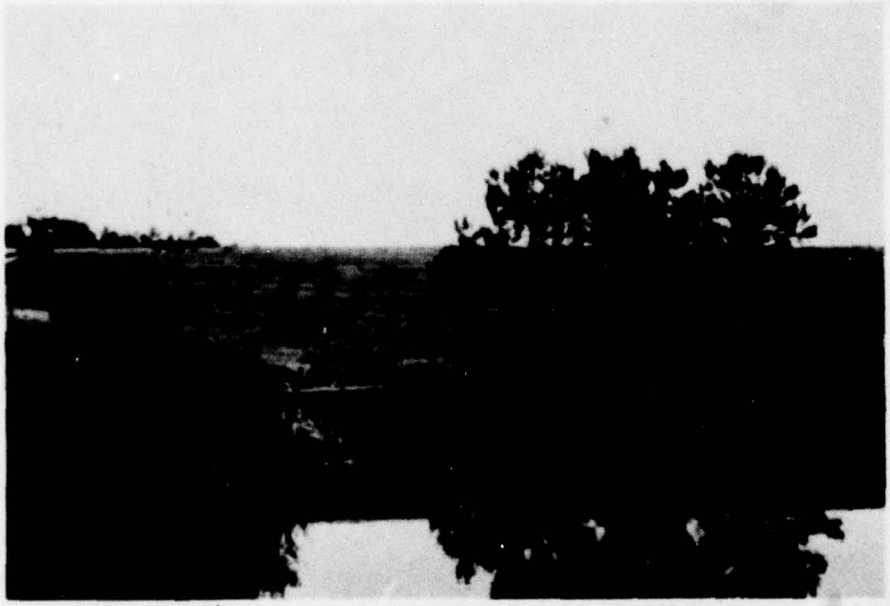
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	Checked:	
	Date:	Dwg. No.

APPENDIX II

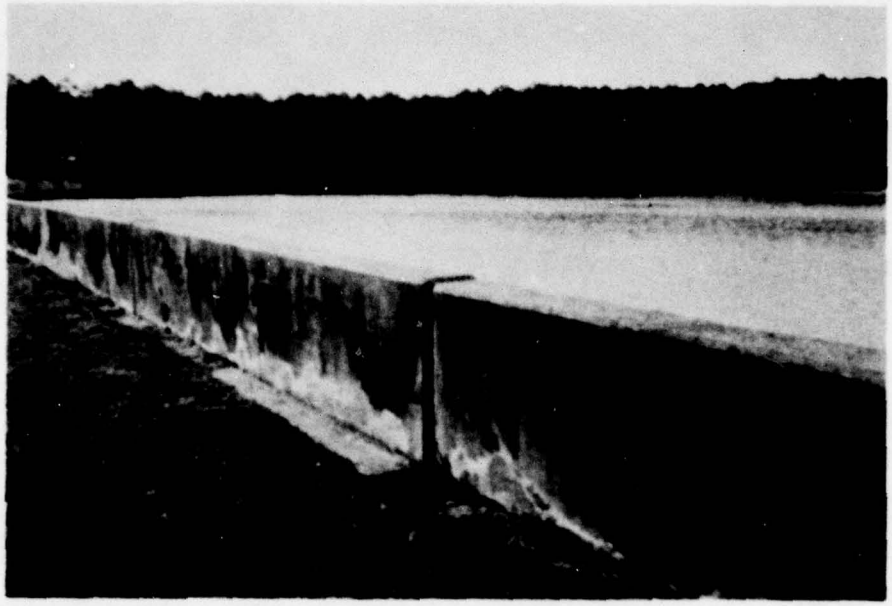
PHOTOGRAPHS



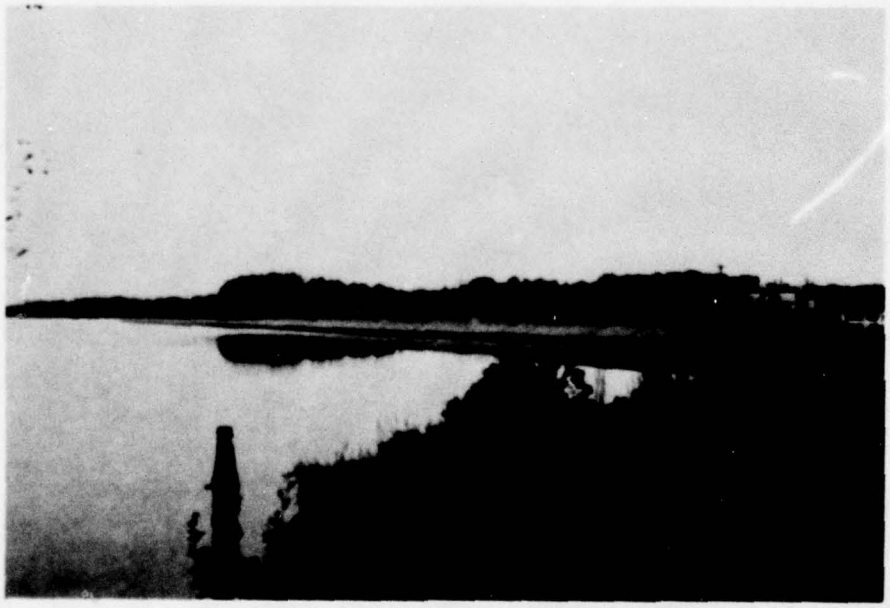
PHOTOGRAPH NO. 1
Intake Structure



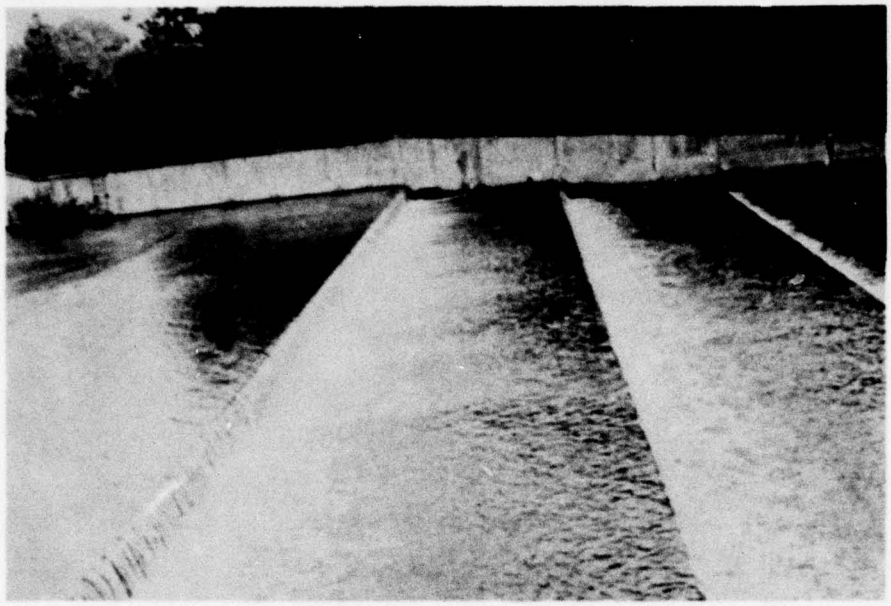
PHOTOGRAPH NO. 2
Discharging Culvert



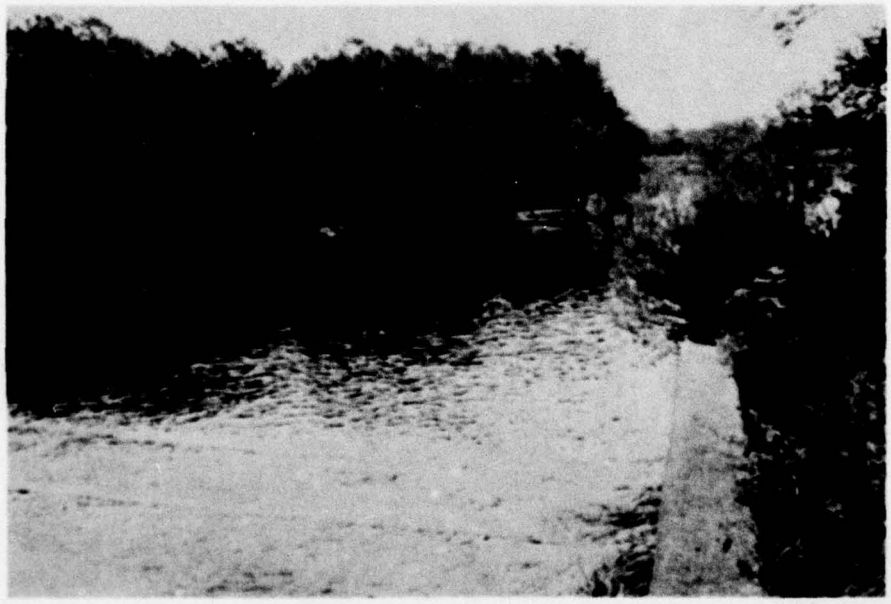
PHOTOGRAPH NO. 3
Parapet



PHOTOGRAPH NO. 4
Upstream Face of Dam



PHOTOGRAPH NO. 5
Spillway Channel



PHOTOGRAPH NO. 6
Downstream

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Western Branch Dam **County** City of Suffolk (formerly Nansemond Co.) **State** Virginia **Coordinates** Lat. 3648.2 Long. 7635.1

Date(s) Inspection 5/7/79 **Weather** Overcast **Temperature** 55° F

Pool Elevation at Time of Inspection 19 M.S.L. **Tailwater at Time of Inspection** 0 M.S.L.

Inspection Personnel:

Robert Gay, P.E.-SWCB

Thaddeus Ward-City of Norfolk

Tan Young , P.E.- DMM&A Hydrology/ Hydraulics

Craig Ziesemer-City of Norfolk

Mike Cowell, Law Engineering Soils & Geology

Paul Seiler, P.E. - DMM&A Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No obvious cracking on the top of dam.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No obvious movement or cracking.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None visible.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No horizontal misalignment on the top of the dam. The upstream side of the top of the dam has a wall. The wall has a sag about 400' from the riser. Appears to have been there for a long time.	
RIPRAP FAILURES	No obvious failures - upstream face of dam has concrete slab and wall at the top of the dam. Riprap added to toe for 600' from right abutment. This was done 2 years after construction to add weight to the toe.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONSTRUCTION MATERIAL		
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No visible cracking.	
ANY NOTICABLE SEEPAGE	Downstream of toe at woods, water stands in puddles. There is mud 15" below ground level. Clay 2' below furface, water in bottom of 1" diameter hand auger hole. Undulations of the ground were noted on the downstream slope.	No flowing water. Location is at curve in the top of the dam. Do not appear serious.
STAFF GAGE AND RECORDER	Staff gage is wired to city offices from top of the riser.	
DRAINS	None visible.	
FOUNDATION		

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not visible at the time of inspection	
INTAKE STRUCTURE	Riser did not show cracking or deterioration.	
OUTLET STRUCTURE	Connects to pump house - not visible.	
OUTLET CHANNEL		
EMERGENCY GATE		

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Semi-circular concrete emergency spillway. Spalling was observed in several areas of the spillway.	
APPROACH CHANNEL		
DISCHARGE CHANNEL	Concrete walled channel 104' to 70' wide, concrete lined streambed. Some settlement and tilting was detected in one section of the retaining wall on the north side of the spillway channel.	
BRIDGE AND PIERS		

INSTRUMENTATION

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

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Forested, flat slopes	
SEDIMENTATION	Not known.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Channel was formerly marshy. Trees in some sections below the dam not in channel.	
SLOPES	Flat.	
APPROXIMATE NO. OF HOMES AND POPULATION	Reids Ferry-about 20 homes. estimated population of 50 people	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	See Appendix I - Plans.
REGIONAL VICINITY MAP	See Appendix I - Maps
CONSTRUCTION HISTORY	Not available.
TYPICAL SECTIONS OF DAM	See Appendix 1 plans
HYDROLOGIC/HYDRAULIC DATA	See this Report
OUTLETS - PLAN and - DETAILS	See Appendix I - Plans
- CONSTRAINTS and - DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	
BORROW SOURCES	Not known.

ITEM	REMARKS
MONITORING SYSTEMS	Electrical to City Treatment Office.
MODIFICATIONS	Added heavy rocks to toe just after construction
HIGH POOL RECORDS	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available
PRIOR ACCIDENTS OF FAILURE OF DAM DESCRIPTION REPORTS	None reported.
MAINTENANCE OPERATION RECORDS	By treatment plant Pool elevation and pumping records.

ITEM	REMARKS
SPILLWAY PLAN	See Appendix I - Plans
SECTIONS	See Appendix I - Plans
DETAILS	See Appendix I - Plans
OPERATING EQUIPMENT PLANS & DETAILS	

APPENDIX IV

CONSTRUCTION SPECIFICATIONS

SECTION 4

EARTH EMBANKMENT

TP4-01 SCOPE:

The work covered by this section consists of furnishing all plant, labor material and equipment and performing all operations in connection with the preparation of the embankment foundation and placing and compacting all fills, as covered by this section of the specification and the applicable drawings. It includes also stripping of the embankment area.

TP4-02 TEST BORINGS:

(a) The City has made a number of test borings to determine the character and depth of the various strata of soil underlying the site of the dam, and the location and depth of these borings, as well as the information obtained by them, are approximately indicated on the profile on Drawing No. A-1 of the construction plans.

(b) The information obtained by these borings is the best information in the possession of the City on the Subject of the underlying soil, and it is furnished to the Contractor in all good faith; but it is expressly stipulated and mutually agreed that neither the City nor any of its agents guarantees the accuracy of said information, and that any use that the Contractor may make of any of said information shall be made entirely at his own risk, and that neither the City nor any of its agents shall be held responsible for any errors or ommissions in said information.

TP4-03 EXCAVATION BELOW EL. 2.5:

(a) Before depositing in place any material which will ultimately form a part of the earth embankment the Contractor shall first excavate the mud from beneath a portion of the width of the embankment down to the top of the underlying sand stratum without disturbing said stratum. The prism of mud thus excavated shall expose the sand stratum for a maximum width of 100 feet, the angle of the slope of the mud at the two sides of this prism being the actual natural angle of slope assumed by the med after the base of the prism has been excavated to its full depth.

(b) The Contractor shall be permitted to make the mud excavation in the wet if he shall elect to do so. In any event he shall first build at his own cost and expense low dykes of sufficient height to retain the mud removed from the excavation, and to prevent its flowing away into the channel of the stream and he shall maintain these dykes by raising them from time to time as the med is deposited behind them. These dykes shall be located approximately as shown on Drawing No. A-2, so as to enclose an area below the dam on the south side of the channel and the Contractor shall deposit the mud as it is excavated on this area as directed.

TP4-04 EXCAVATION ABOVE EL. 2.5:

The top soil of the area to be covered by the embankment shall be stripped or excavated to a depth of 12 inches. The soil removed shall be deposited wherever directed, provided that the straight line

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distance from point of removal to point of deposit shall not exceed 1,000 feet. After stripping the foundation surface shall be compacted by first scarifying and adjusting the water content of the disturbed material to optimum for compacting and then rolling with the same procedure as discussed under "Compacted Fill". The volume of the earth material or top soil so removed shall, for purposes of payment be classified as "Fill above EL 2.5."

TP4-05 MATERIALS:

Materials for the embankment and for the refilling beneath it to replace the excavated mud, and for refilling the diversion channel shal be taken from borrow areas indicated on Drawing No. A-2 and from the required excavation. The Contractor shall strip the top soil or material containing an excess of fine particles from the surface of the borrow pits stockpiling it for later use in preparing slopes of dam for seeding.

TP4-06 PLACEMENT:

(a) No material shall be placed in the embankment, or in the refill under the same, or in the refill of the temporary channel, unless it shall have been first approved. No soil having any roots or other vegetable matter shall be used for any permanent part of the embankment or re-fills.

(b) After the re-fill under the embankment shall have been placed the Contractor shall immediately begin to spread over it and over the adjacent mud, the earth selected for the embankment, this earth to be spread in even layers of such thickness that, after compacting as required, they shall be six inches thick.

(c) The placing of earth in the embankment shall be done in such a manner as will provide at all times the maximum drainage and prevent the formation of mud or of puddles of water which might impede traffic across the surface or interfere with the proper compacting of the material. No material shall be placed in the embankment until after the diversion of the river has been accomplished, except as may be approved by the Engineer.

TP4-07 COMPACTION:

(a) Sheepsfoot Rollers: Sheepsfoot rollers shall be of standard manufacture and shall consist of metal drums that have metal studs with tamping feet projecting approximately seven inches from the surface of the drum. Tamping feet shall be spaced so as to provide approximately three tamping feet for each two square feet of cylindrical surface. The cross sectional area of each tamper foot, measured perpendicular to the axis of the stud shall not be less than 5 nor more than 7 square inches. The feet of the tamping rollers shall be such that the load on each tamper foot shall be not less than 250 pounds per square inch of cross sectional area. The load per tamper foot shall be determined by dividing the total weight of the roller by the number of tamper feet in one row parallel to the axis of the roller. The roller shall be equipped with cleaners. Other tamping rollers of an approved design may be used provided such rollers will produce the desired compaction. The design of rollers, their loading, and the character and efficiency of the propelling equipment shall be subject to the approval of the Engineer.

(b) Heavy Duty Rubber-Tired Rollers: Rubber-tired rollers shall be so constructed that the load per wheel may be varied as directed by

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the Engineer from 18,000 to 25,000 pounds. The roller wheels shall be so arranged and so designed that all wheels will carry approximately equal loads when travelling over uneven ground. Tires should be capable of being inflated to a pressure of not less than 75 pounds per square inch.

(c) Hand Operated Power Tampers: Hand operated power tampers shall be approved by the Engineer.

TP4-08 COMPACTED FILL:

(1) General: Except as otherwise specified compacted fill shall be compacted by sheepsfoot rollers and/or heavy duty rubber tired rollers conforming to the requirements of paragraphs TP4-07 (a)(b) above, respectively.

(2) Compacted Fill Adjacent to Concrete Structures: No fill material or other load shall be placed on or against concrete surfaces before the expiration of 14 days after placing of concrete. Materials placed in portions of the embankment which lie within four feet of concrete walls shall be spread in four inch layers and compacted by means of power tampers. Drainage openings through concrete structures, as provided for on the drawings, shall be kept open at all times.

(3) Degree of Compaction: The fill material shall be placed on successive six-inch layers. Its moisture content at the time of placing shall be the optimum moisture content for maximum density as determined by the Engineer. Each six-inch layer shall be compacted by means of a sheepsfoot roller or other approved equipment to 95% of maximum density. In the event of excessive change in the moisture content of any layer prior to full compaction, the material shall be moistened by sprinkling, or scarified and dried as required, until optimum moisture content is restored.

TP4-09 MEASUREMENT:

The quantity of fill to be paid for will be the number of cubic yards of material, measured in the original position in borrow areas and computed by the average end-area method.

TP4-10 PAYMENT:

(a) Fill below elevation 2.5: Payment will be made at the Contract until price per cubic-yard for Item 4. "Fill below Elevation 2.5", and shall include all costs for furnishing all materials and equipment and for performing all work covered by this section. No extra compensation will be allowed for dredging, transportation and disposition of mud for dredging, transporting and disposing of mud to be removed from the area of the dam below Elevation 2.5 and such costs shall be included in the cost for "Fill below Elevation 2.5".

(b) Fill above Elevation 2.5: Payment will be made at the contract unit price per cubic-yard for item 5 "Fill above Elevation 2.5", and shall include all costs for furnishing all materials and equipment and for performing all work covered by this section.

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APPENDIX V

REFERENCES

LIST OF REFERENCES

1. U S Weather Bureau and U S Army Corps of Engineers, "Seasonal Variation of Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours", Hydrometeorological Report No. 33, Washington, D.C., April 1956.

2. Clark, C. O., "Storage and the Unit Hydrograph", Trans. American Society of Civil Engineers, Vol. 110, PP. 1419-1488, 1945.

3. HEC-1 Flood Hydrograph Package, Hydrologic Engineering Center, U S Army Corps of Engineers, Davis, California, 1978.

4. Recommended Guidelines for Safety Inspection of Dams, Department of the Army, Office of the Chief of Engineers, Washington, DC 20314.