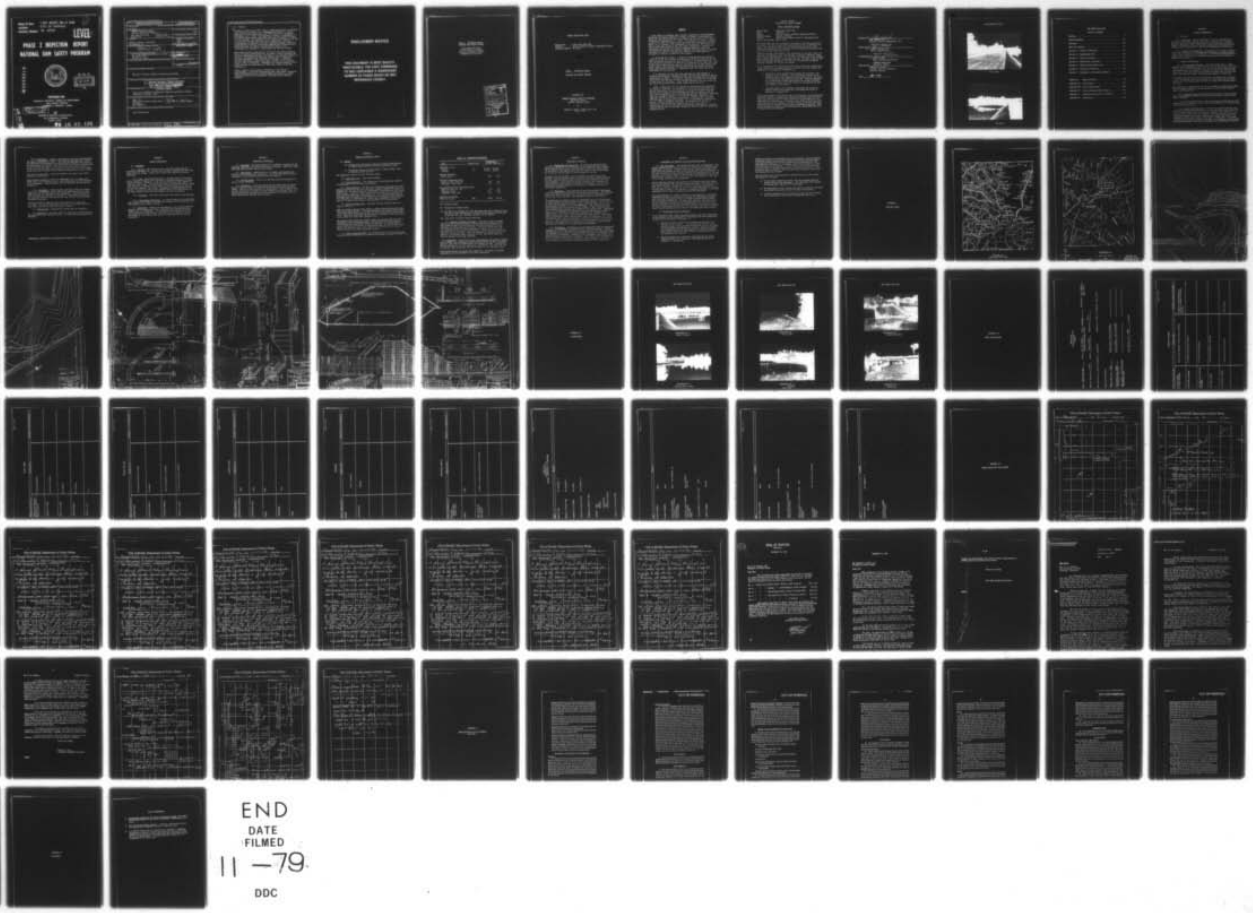
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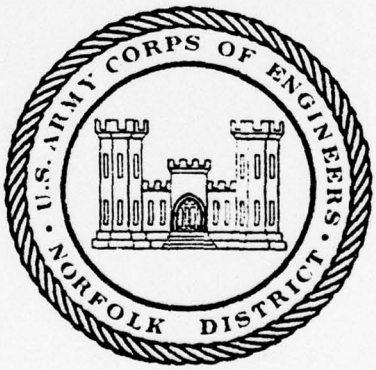
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**Name Of Dam:** LAKE BURNT MILLS DAM
**Location:** CITY OF SUFFOLK
**Inventory Number:** VA. 12303

LEVEL II

# PHASE I INSPECTION REPORT
# NATIONAL DAM SAFETY PROGRAM

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**PREPARED FOR**

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

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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.

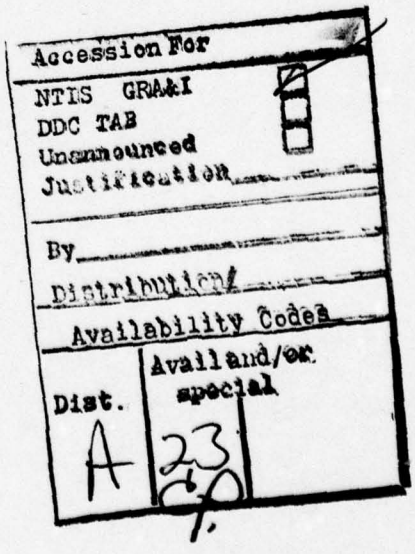
Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LAKE BURNT MILLS DAM
CITY OF SUFFOLK, VIRGINIA
(Formerly Nansemond County)
INVENTORY NO. VA 12303



LOWER JAMES RIVER BASIN

Name of Dam : Lake Burnt Mills Dam
Location : City of Suffolk (formerly Nansemond County)
Inventory Number: VA 12303

# 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: | Lake Burnt Mills Dam |
| State: | Virginia |
| County: | City of Suffolk (formerly Nansemond County) |
| USGS Quad Sheet: | Windsor, Virginia |
| Stream: | Great Swamp: Western Branch of Nansemond River |
| Date of Inspection: | May 7, 1979 |

Lake Burnt Mills Dam is an earthfill structure 1,735 feet long and 40 feet high. The dam is owned and operated by the City of Norfolk, Virginia. The dam is classified as intermediate in size with a high hazard classification. The spillway is a semi-circular concrete structure with a crest elevation of 35.0.

Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE) the spillway is rated as seriously inadequate, unsafe-non-emergency. The spillway will pass 26% of the Spillway Design Flood (SDF) without overtopping the dam. The PMF, which is the SDF, will overtop the dam by 3.0 feet for 17 hours with an average critical velocity of 7.9 feet per second.

It is recommended that within two 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 downstream flood plain and 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 1, Appendix VI.

Within six months of the notification to the Governor, the professional consultants 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 unusally heavy precipitation, around-the-clock surviellance should be provided.

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

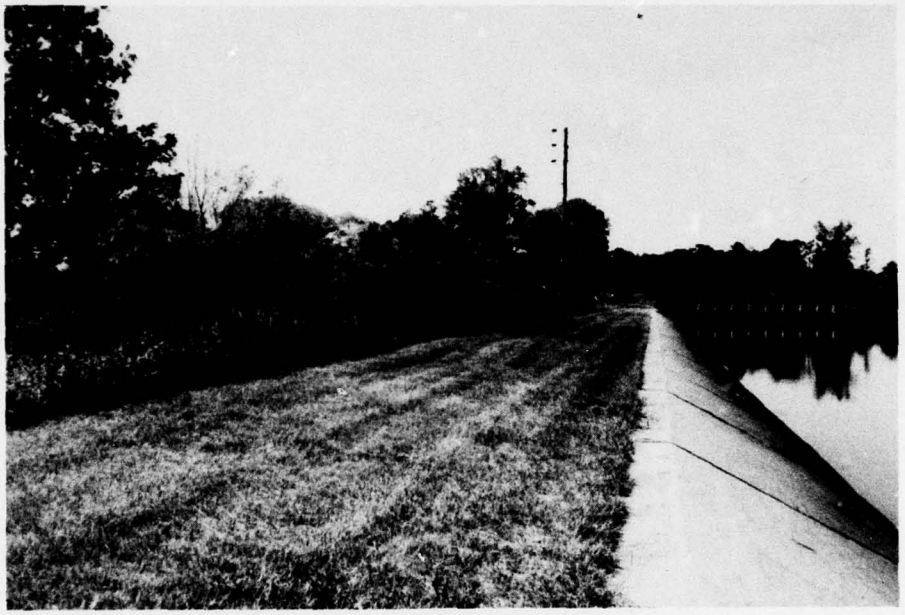
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Chief, Design Branch

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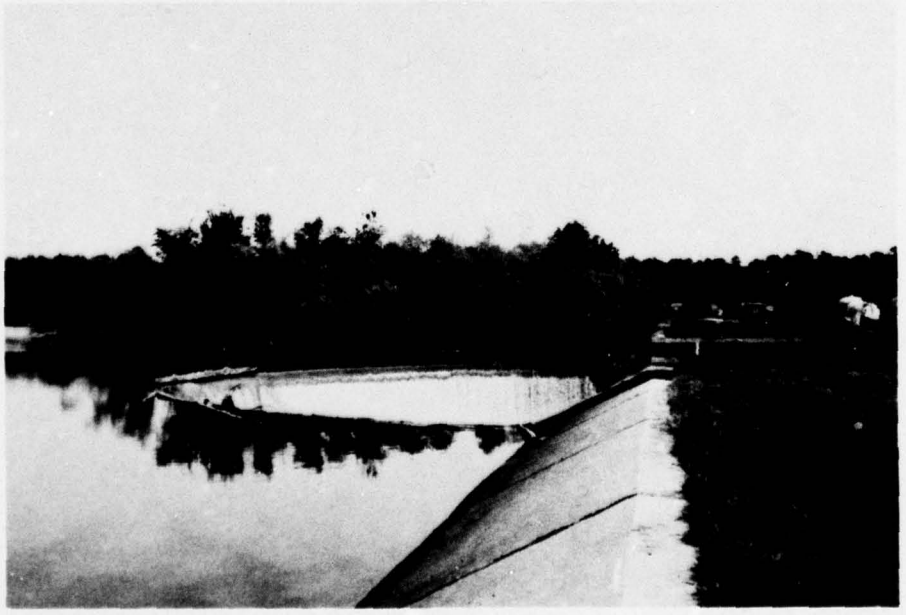
Original signed by:
Approved By: Douglas L. Haller
DOUGLAS L. HALLER
Colonel, Corps of Engineers
District Engineer

Date SEP 17 1979

LAKE BURNT MILLS DAM



Top of Dam



Spillway

LAKE BURNT MILLS 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 VI, Reference 1.) The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

### 1.2 Project Description:

1.2.1 Dam and Appurtenances: Lake Burnt Mills Dam is a homogeneous earth embankment 14 feet wide at the top and 40 feet high from the top of the dam at elevation 40 to the toe of the downstream slope at elevation 0.0. The length of the dam is 1,735 feet. The upstream slope has a 2(H):1(V) slope with an 8-inch concrete slab from the toe wall to the top of the dam. The downstream slope is 1.5(H):1(V).

A 170-foot semi-circular concrete spillway is located near the center of the dam and has a crest at elevation 35 and an ogee type spillway surface. The discharge channel is 103 feet wide with concrete sides 9 feet high.

The riser tower, connected to the top of the dam by a pedestrian bridge, has the manual control for the sluice gate for the 36-inch diameter pipe at elevation 0.00.

1.2.2 Location: Lake Burnt Mills Dam is located 3.3 miles Southeast of Chuckatuck, Virginia, along State Route 603 at Everets in the City of Suffolk.

1.2.3 Size Classification: Burnt Mills Dam is classified as intermediate due to a height of 40 feet and is intermediate by a storage capacity of 11,110 acre feet.

1.2.4 Hazard Classification: This dam is located about 600 feet upstream from Everets, Virginia, at the intersection of State Route 603 and State Route 602, where 16 houses are located. This dam is in the high hazard classification in accordance with Section 2.1.2 of the Recommended Guidelines for Safety Inspection of Dams, published by the Department of the Army, Office of the Chief of Engineers. The hazard classification used to categorize the dams is a function of the location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: City of Norfolk, Virginia, Division of Utilities.

1.2.6 Purpose of Dam: The dam creates the Lake Burnt Mills Reservoir used as a water source for the City of Norfolk treatment plant. Boating and fishing is permitted.

1.2.7 Design and Construction History: The dam was designed by the Office of the Director of Public Works, City of Norfolk, dated April 1942. There is no information on the construction such as photographs or tests.

1.2.8 Normal Operating Procedures: In times of high water, the spillway overflow water automatically adds to the Western Branch Reservoir. When Lake Burnt Mills is below spillway pool elevation, water can be released by manual operation of the valve. This is operated many times throughout the year to assure adequate water for treatment.

1.3 Pertinent Data:

1.3.1 Drainage Area: The dam controls a drainage area of 25.29 square miles.

1.3.2 Discharge at Dam Site:

Maximum Flood - Unknown

Spillway
pool level at top of dam . . . . . .6,270 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 Area, acres | Reservoir Capacity Acre, feet | Watershed, inches | Length, miles |
|---|---|---|---|---|---|
| Top of Dam | 40 | 869 | 11,110 | 8.2 | 6.3 |
| Spillway Crest | 35 | 596 | 7,449 | 5.5 | 4.4 |
| Streambed at the toe of the dam | 0± | | | | |

## SECTION 2

## ENGINEERING DATA

2.1 Design: Plans are on file in the offices of the City of Norfolk, Division of Utilities. The plans which show the general plan, spillway details and embankment cross section are in Appendix I. Original structural design calculations were not available.

*2.2.1 Geologic Setting of the Dam Site: Physiographically, the dam is located in the Coastal Plain Province. The geologic formations at the site consists of the Windsor, Sedley, and Yorktown formations of Pleistocene to Miocene geologic age. The Windsor formation is the chief surficial unit exposed in the area surrounding the site of the dam. This formation unconformably overlies erosional remnants of the Sedley formation and in areas where the underlying formations have been removed by erosion, the Windsor overlies the Yorktown formation. The lower member of the Windsor typically consists of medium to coarse sand and rounded fine gravel, with silt and clay content, increasing upward in the member. The upper member typically consists of silty clay, silty sand and clayey sand.

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. It is within this marl formation that construction plans indicate cutoff walls for the dam were to be found.

*2.2.2 Geologic Investigations: Soil test borings have been drilled at the site in conjuction with its original construction, according to the construction specifications enclosed in Appendix V. 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, however this information is not available. Plate No. 1 in Appendix I does show the elevation of the surface of "blue Marl" as indicated by the borings drilled at various locations surrounding the spillway.

*Information provided by Law Engineering Associates of Virginia

*2.2.3 Foundation: Original construction plans and specifications are shown in Appendices I and V. The plans and specifications called for excavation of existing mud in the proposed embankment area down to the underlying sand stratum. 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.

Excavation in the spillway area was planned to go down to the "blue clay or so called marl".

Specifications generally called for embankment fill to consist of a sandy soil up to elevation 0 m.s.l. and a sandy clay for the remainder of the embankment. Specifications for fill placement are enclosed in Appendix V.

2.2.4 Embankment: Specifications generally called for embankment fill to consist of a sandy soil up to elevation 0 m.s.l. and a sandy clay for the remainder of the embankment. Specifications for fill placement are enclosed in Appendix V. Excavation in the spillway area was planned to go down to the "blue clay or so called marl" (Yorktown Formation.)

Construction plans (Plate 3) show the location of a steel sheet pile wall. The interlocking sheet piles were to be driven two feet into "Marl" and were to serve as a water barrier.

2.3 Construction: Construction records were not available.

2.4 Evaluation: The plans show the design for construction and the calculations are limited in scope. No construction information is available.

*Information provided by Law Engineering Associates of Virginia.

## SECTION 3

## VISUAL INSPECTIONS

### 3.1 Findings:

3.1.1 General: The results of the 7 May 1979 inspection are recorded in Appendix III. At that time the pool elevation was 35.0 feet m.s.l. which is normal. There are no known past inspection reports available.

3.1.2 Dam: The downstream slope of the dam right of the spillway is heavily overgrown with vegetation, consisting primarily of small shrubs and grass. However, at the toe of the slope a large number of 6-18 inch trees exist. The downstream slope is relatively steep, 1.5(H): 1(V); however, no bulging of the slope or tilting trees at the base of the dam was observed. No erosion, sloughing, or misalignment were observed. The concrete slab on the upstream face of the dam adjacent to the right endwall of the spillway showed a 2-3 inch settlement.

3.1.3 Spillway: Hair line cracks were also found in the spillway.

3.1.4 Appurtenant Structures: The visual inspection revealed hair line cracks to the right of the concrete spillway in the abutment walls and spalling in the outlet concrete.

3.2 Evaluation: Overall the dam appears to be in good condition. However, all the heavy vegetation, brush and root systems should be removed from the embankment. All subsequent holes should be dressed with compacted fill and seeded. The cracks in the spillway and the settlement of the concrete slab should be monitored during periodic inspection.

## SECTION 4

## OPERATIONAL PROCEDURES

4.1 Procedure: The normal operation is limited to control of the discharge when water is below spillway pool elevation. Otherwise, flows will pass automatically through the spillway.

4.2 Maintenance: Maintenance such as mowing and painting are handled by the Public Works Department. Any other maintenance such as treatment of the spillway surface is done by contract.

4.3 Warning System: There is no warning system established for use in case of emergency.

4.4 Evaluation: Extensive operational procedures are not necessary for this dam since its function is storage to be used only when needed. Records of any operation of adding water to the treatment system are refelected in records of water pumped from the lower lake. An annual maintenance and inspection program should be initiated to help detect and control problems that may occur.

## SECTION 5

## HYDRAULIC/HYDROLOGIC DATA

5.1 Design:

a) Norfolk Water Department Construction Plans from Director of Public Works, Norfolk, Virginia, dated April 1942.

b) Computation sheets from Department of Public Works, City of Norfolk, dated May 1941.

The computation sheets show the spillway design.

5.2 Hydrologic Data: None were available.

5.3 Flood Experience: The maximum pool level which has occurred is estimated at 0.5 foot over the spillway.

5.4 Flood Potential: The PMF and 1/2 PMF were developed and routed through the reservoir by use of the HEC-1 Computer program (Reference 2, Appendix VI), and appropriate unit hydrograph, precipitation, and 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 3, Appendix VI). 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 Lake Burnt Mills to Western Branch Reservoir during high water demand periods. A 36-inch pipeline from a water intake tower in the Lake Burnt Mills runs through the dam to the Western Branch Reservoir. Water also flows past the dam over the spillway in the event water in the reservoir rises above elevation 35.0.

The storage curve above the spillway crest was calculated by use of U S Geological Survey Quandrangle 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 through the 36-inch pipe to Western Branch Reservoir was neglected during routing.

5.6 Overtopping Potential: The probable rise of the reservoir and other pertinent information on reservoir performance is shown in table 5.1.

## Table 5.1 RESERVOIR PERFORMANCE

| Item | Normal flow | Hydrograph 1/2 PMF | Hydrograph PMF (c) |
|---|---|---|---|
| **Peak flow, c.f.s.** | | | |
| Inflow | 3 | 18,743 | 37,486 |
| Outflow | -- | 17,447 | 36,290 |
| **Maximum Elevation** | | | |
| feet, m.s.l. | | 41.5 | 43.0 |
| **Spillway (elevation 35.0)** | | | |
| Depth of flow, feet (a) | | 4.5 | 5.6 |
| Velocity, f.p.s. (b) | | 12.1 | 13.4 |
| **Non-overflow section (elevation 40.0)** | | | |
| Depth of flow, ft. (a) | | 1.0 | 1.9 |
| Duration, hours | | 11 | 17.0 |
| Velocity, f.p.s. (b) | | 5.6 | 7.9 |
| **Tailwater elevation,** | | | |
| feet, m.s.l. (d) | 19± | 28.4± | 31.4± |

(a) Critical depth.

(b) Velocity at critical depth.

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

(d) Pool level in Western Branch Reservoir.

5.7 Reservoir Emptying Potential: Two sluice gates at intake tower with one having a 36-inch x 36-inch opening at elevation 23.3 and another having a 36-inch diameter opening at elevation 0.0 are available for dewatering the reservoir. The gates along with a 36-inch diameter pipe will permit withdrawal of about 175 c.f.s. with the reservoir at the crest of the spillway and essentially dewater the reservoir in about 40 days. With the downstream reservoir, Western Branch, at the normal water elevation (19.0), Lake Burnt Mills can only be lowered to the same elevation.

5.8 Evaluation: Based on the size (intermediate) and hazard classification (high), 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 17 hours and reach a maximum of 3 feet over the top of the dam, with an average critical velocity of 7.9 feet per second.

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

## SECTION 6

## STRUCTURAL STABILITY

6.1 Foundations and Abutments: The plans and specifications called for excavation of existing mud in the underlying sand stratum. 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.

Excavation in the spillway area was planned to extend to the marl stratum. The term is often used to describe the more compact mixtures of clay, sand and shells found at the site, which belong to the Yorktown formation. It is within this marl formation that construction plans indicate cutoff walls for the dam to be founded. The soil containing the largest proportion of sand will be selected for the refill below elevation 0.

6.2 Embankment: Lake Burnt Mills Dam is an earthfill embankment 1,735 feet long, 14 feet wide at the top and 40 feet high. The upstream slope has a 2(H):1(V) slope with an 8-inch concrete slab from the toe wall to the top of the dam. The downstream slope is 1.5(H):1(V).

The specifications indicate that the embankment was to be constructed of soils having less sand and more clay in their makeup. No soil having an objectionable amount of roots or other vegetable matter was to be used for any permenant part of the embankment. The earth selected for the embankment was to be spread in even layers of such thickness that after compacting as required they should be six inches thick. Compacting was to be accomplished with approved rollers having grooved, banded or lugged rolls. In order to allow for shrinkage, the embankment was built no more than 2 feet above elevation 30 at any point. Steel sheet piling were driven 2 feet into the marl after fill was made. The steel sheet piling were used as foundation to prevent settling of the concrete toe wall. Without information such as soil stratigraphy, strength parameters of the insitu soil or knowledge of the phreatic surface within the dam, the stability of the dam cannot be determined.

6.3 Evaluation: The geometry of the downstream slope is relatively steep for an embankment constructed with a sand-clay material. Without information such as soil profiles, strength parameters of the insitu soil or knowledge of the phreatic surface within the dam, the stability of the dam cannot be determined. Therefore it is recommended that further stability analyses of the dam be developed. The cracks in the spillway and the settlement of the concrete slab do not need immediate remedial measures; however; they should be monitored during periodic inspection.

## SECTION 7

## ASSESSMENT AND REMEDIAL MEASURES/RECOMMENCATIONS

7.1 Dam Assessment: The available design data is inadequate. The visual inspection revealed no findings that proved to be unsound during normal pool operations. However, there is no regular maintenance program which has sllowed the dam to be overgrown with heave vegetation. A 2-3 inch settlement of the concrete slab on the upstream face of the dam adjacent to the right endwall of the spillway and hairline cracks in the spillway were observed. Due to lack of data, the stability of the dam is an unknown and therefore questionable.

Corps guidelines indicate the appropriate Spillway Design Flood (SDF) for an intermediate size and high hazard dam is PMF. The spillway will pass 26% of the PMF. The SDF will overtop the dam by a maximum of 3 feet with a critical velocity of 7.9 f.p.s. and remain above the top of the dam about 17 hours. The spillway is therefore adjudged as seriously 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 serious deficiency in spillway capacity so that if a severe storm were to cuure, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

7.2 Recommended Remedial Measures:

It is recommended that within two 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 dpillway. The study should include a more detailed study of the downstream flood plain and 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 1, Appendix VI.

Within six months of the notification to the Governor, the professional consultants 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 surviellance should be provided.

The following repair items should be completed as part of the annual maintenance of the dam:

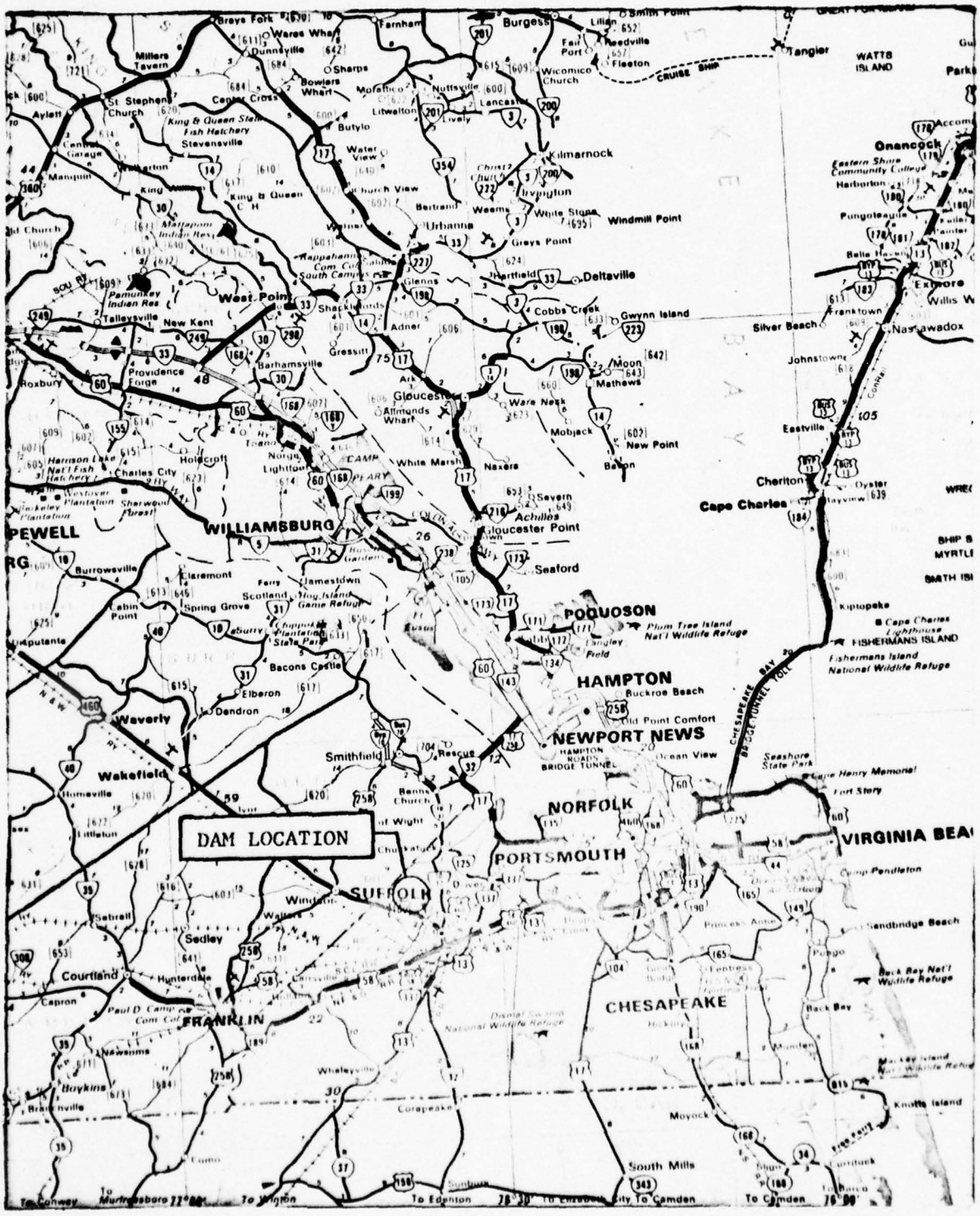
a) All the heavy vegetation, brush, and root systems should be removed from the dam embankment. All subsequent holes should be dressed with compacted fill and seeded.

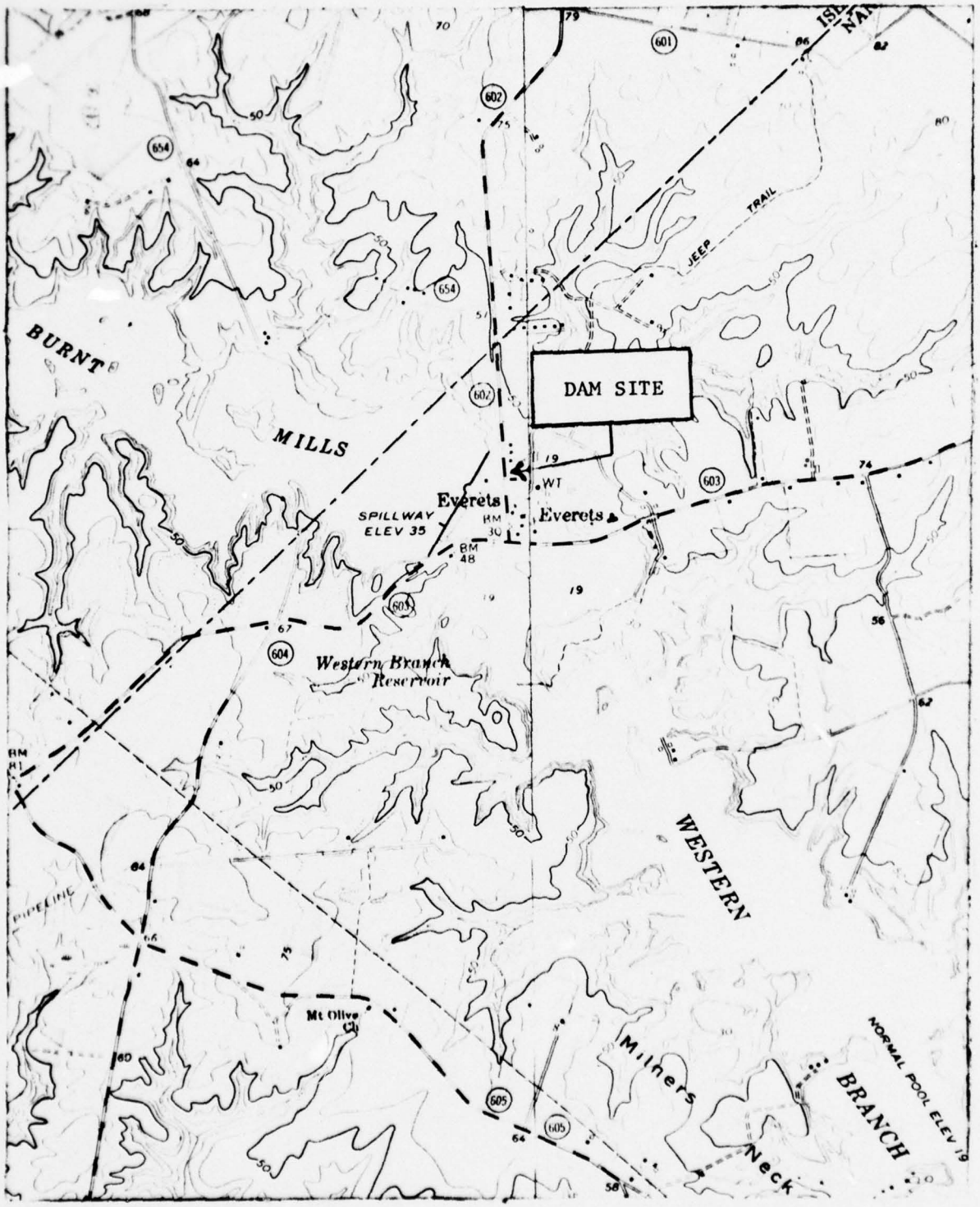
b) The settlement of the concrete slab and the cracks in the spillway should be monitored during the annual inspections.

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

# APPENDIX I

## MAPS AND PLANS


DAM LOCATION
WILLIAMSBURG
NEWPORT NEWS
HAMPTON
POQUOSON
NORFOLK
PORTSMOUTH
SUFFOLK
CHESAPEAKE
FRANKLIN
VIRGINIA BEA
Cape Charles
Onancock
Exmore
Nassawadox
Eastville
Cheriton
Kiptopeke
Seaford
Gloucester Point
Achilles
Yorktown
West Point
Tappahannock
Deltaville
Urbanna
Windmill Point
Kilmarnock
Irvington
Lancaster
Burgess
Tangier
WATTS ISLAND
Waverly
Wakefield
Sedley
Courtland
Smithfield
Surry
Bacons Castle
Elberon
Dendron
Claremont
Jamestown
Scotland
Burrowsville
Providence Forge
Barhamsville
New Kent
Talleysville
Roxbury
Gressitt
Adner
Cobbs Creek
Gwynn Island
Mobjack
New Point
Mathews
Moon
Ware Neck
Naxera
White Marsh
Holcroft
Charles City
Harrison Lake Nat'l Fish Hatchery
Sherwood Forest
Pamunkey Indian Res
Mattaponi Indian Res
King & Queen Stella Fish Hatchery
Stevensville
Bowlers Wharf
Sharps
Dunnsville
Wares Wharf
Millers Tavern
Greys Fork
Farnham
Morattico
Litwalton
Butylo
Lively
Nuttsville
Weems
Bertrand
White Stone
Greys Point
Hartfield
Silver Beach
Johnstown
Franktown
Willis W
Belle Haven
Pungoteague
Harborton
Eastern Shore Community College
Accomac
Fairport
Reedville
Fleeton
Wicomico Church
Lilian
Smith Point
CRUISE SHIP
Parke
Hayman
Oyster
Achilles
Severn
Ferry
Scotland
Jamestown
Island Game Refuge
Chippokes Plantation State Park
Spring Grove
Cabin Point
Lawnes Point
Hopewell
Prince George
Petersburg
Richmond
Williamsburg
Yorktown
Gloucester
Mathews
Middlesex
Essex
King William
King & Queen
King William
New Kent
James City
Surry
Isle of Wight
Southampton
Sussex
Greensville
Emporia
Brunswick
Dinwiddie
Chesterfield
Powhatan
Goochland
Fluvanna
Louisa
Spotsylvania
Caroline
Hanover
Henrico
Charles City
Prince George
Amelia
Nottoway
Lunenburg
Mecklenburg
Halifax
Pittsylvania
Danville
Martinsville
Henry
Patrick
Franklin
Roanoke
Salem
Botetourt
Craig
Giles
Montgomery
Pulaski
Wythe
Bland
Tazewell
Buchanan
Dickenson
Russell
Washington
Smyth
Grayson
Carroll
Galax
Floyd
Pulaski
Radford
Blacksburg
Christiansburg
Roanoke
Salem
Vinton
Bedford
Lynchburg
Amherst
Appomattox
Buckingham
Cumberland
Prince Edward
Farmville
Charlotte
Lunenburg
Nottoway
Dinwiddie
Petersburg
Hopewell
Prince George
Surry
Sussex
Isle of Wight
Suffolk
Chesapeake
Norfolk
Portsmouth
Virginia Beach
Accomack
Northampton
Eastern Shore
Chincoteague
Wallops Island
Assateague Island
Chincoteague National Wildlife Refuge
Back Bay National Wildlife Refuge
Back Bay
Sandbridge Beach
Virginia Beach
Fort Story
Cape Henry Memorial
Seashore State Park
Ocean View
Buckroe Beach
Old Point Comfort
Fort Monroe
Langley Field
Plum Tree Island National Wildlife Refuge
Fishermans Island National Wildlife Refuge
Cape Charles Lighthouse
Hampton Roads Bridge Tunnel
Chesapeake Bay Bridge Tunnel
Kiptopeke
Cheriton
Eastville
Nassawadox
Onancock
Exmore
Accomac
Harborton
Pungoteague
Belle Haven
Franktown
Silver Beach
Johnstown
Oyster
Cape Charles
Seaford
Yorktown
Gloucester Point
Achilles
Severn
Gloucester
Mathews
Middlesex
Essex
King William
King & Queen
New Kent
James City
Surry




MN
GN
7°
124 MILS
1°01'
18 MILS

scale 1"=2000'

WINDSOR, VA.

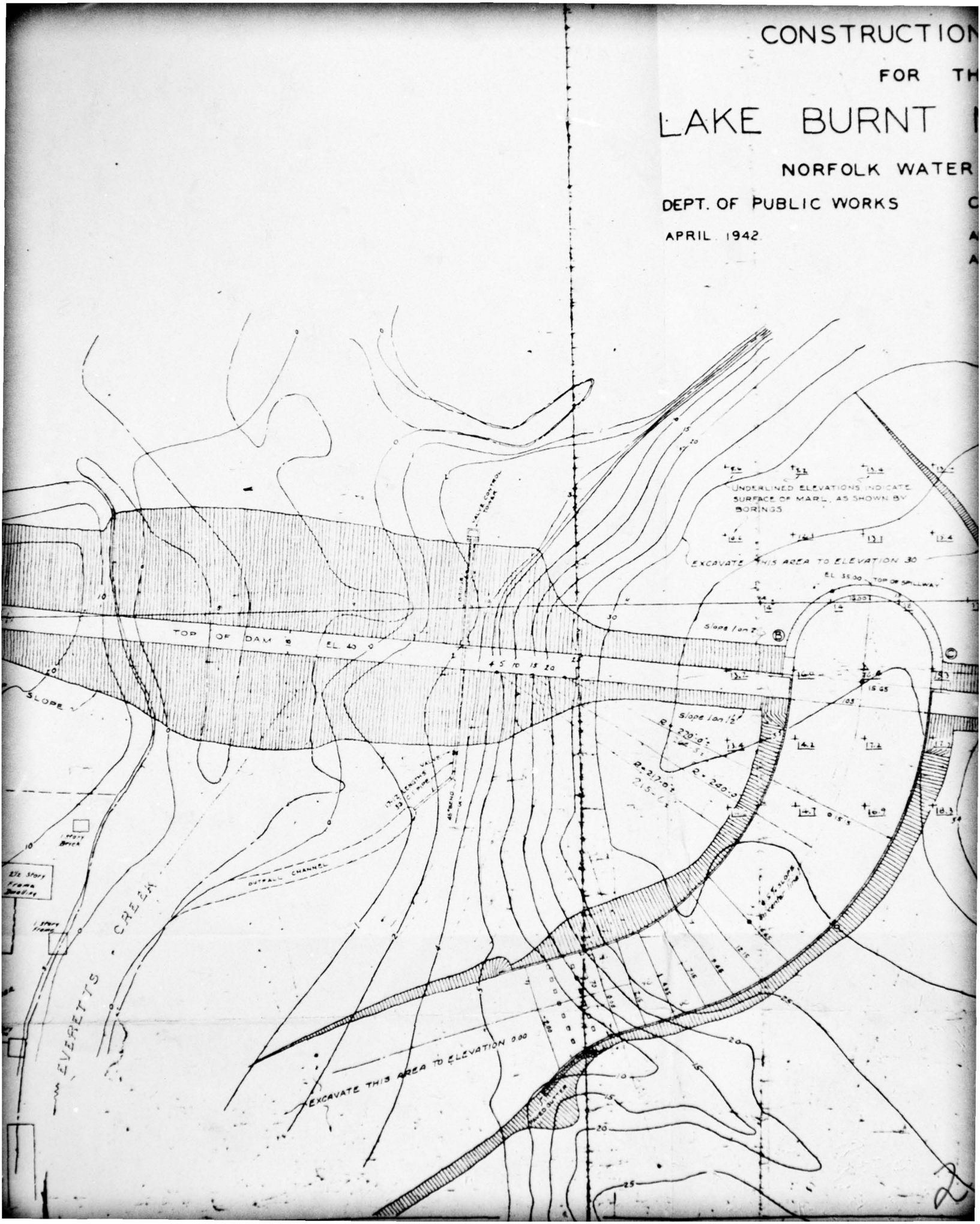
N3645—W7637.5/7.5

1965

PHOTOREVISED 1972

VICINITY MAP
BURNT MILLS DAM
LAKE BURNT MILLS

Slope 1on2
TOE OF SLOPE
SURVEY LINE
AND LINE OF TEST BORINGS
Slope 1on1½
TOE OF SLOPE
OLD 30 COUNTY ROAD
VA ROUTE 603
W.T.JOYNER & H.D.GRIFFIN
W.K.WAGNER
VERETTS BRIDGE


CONSTRUCTION
FOR TH
LAKE BURNT
NORFOLK WATER
DEPT. OF PUBLIC WORKS
APRIL 1942
UNDERLINED ELEVATIONS INDICATE SURFACE OF MARL, AS SHOWN BY BORINGS
EXCAVATE THIS AREA TO ELEVATION 30
EL 35.00 TOP OF SPILLWAY
TOP OF DAM EL 40.0
Slope 1 on 2
Slope 1 on 1½
SLOPE
EVERETTS CREEK
OUTFALL CHANNEL
EXCAVATE THIS AREA TO ELEVATION 0.00
2

TION PLANS

THE

T MILLS DAM

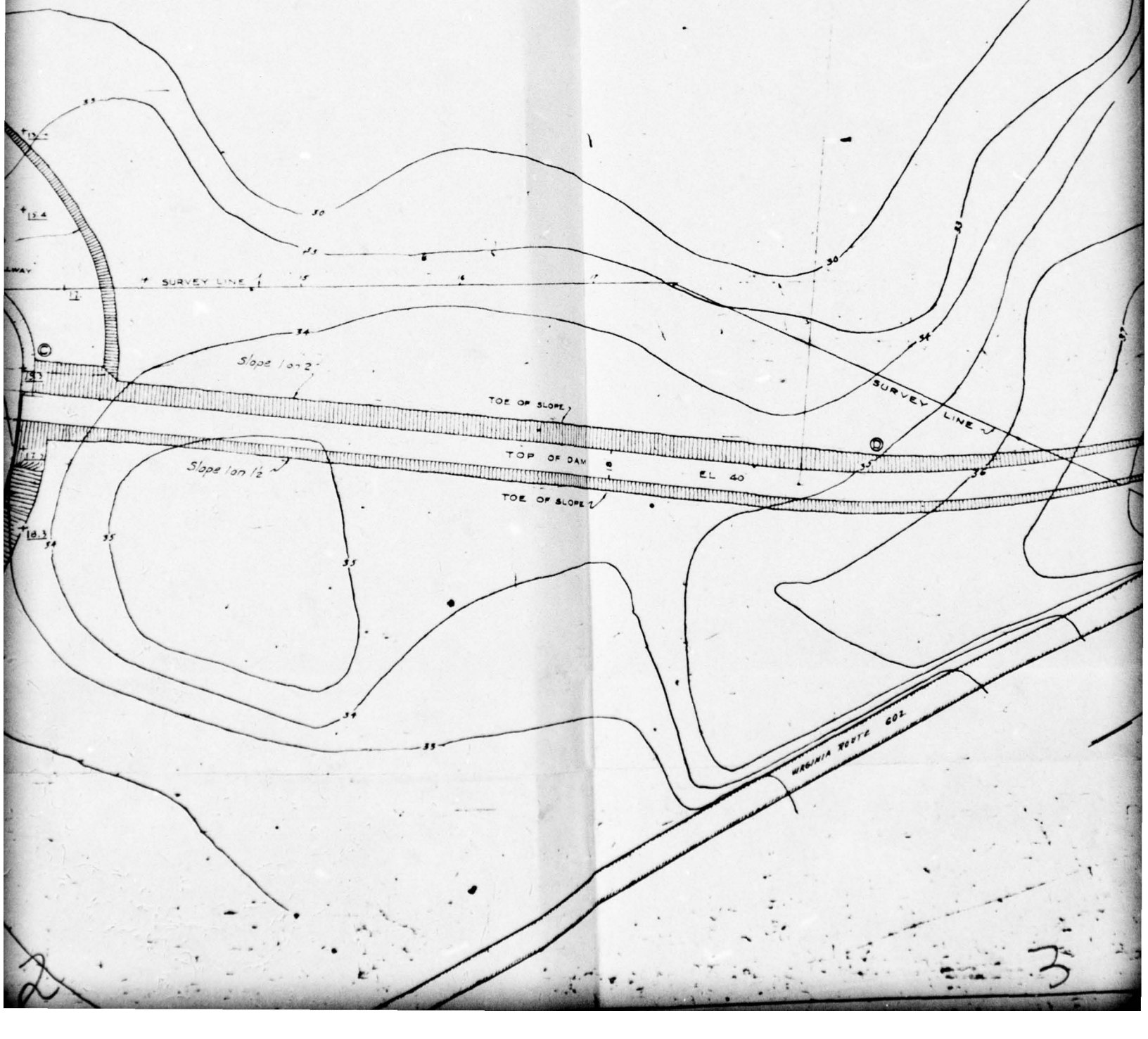
ATER SUPPLY

CITY OF NORFOLK, VIRGINIA.

APPROVED:

APPROVED: DIRECTOR OF PUBLIC WORKS

PRINCIPAL ASST ENGINEER




2

3

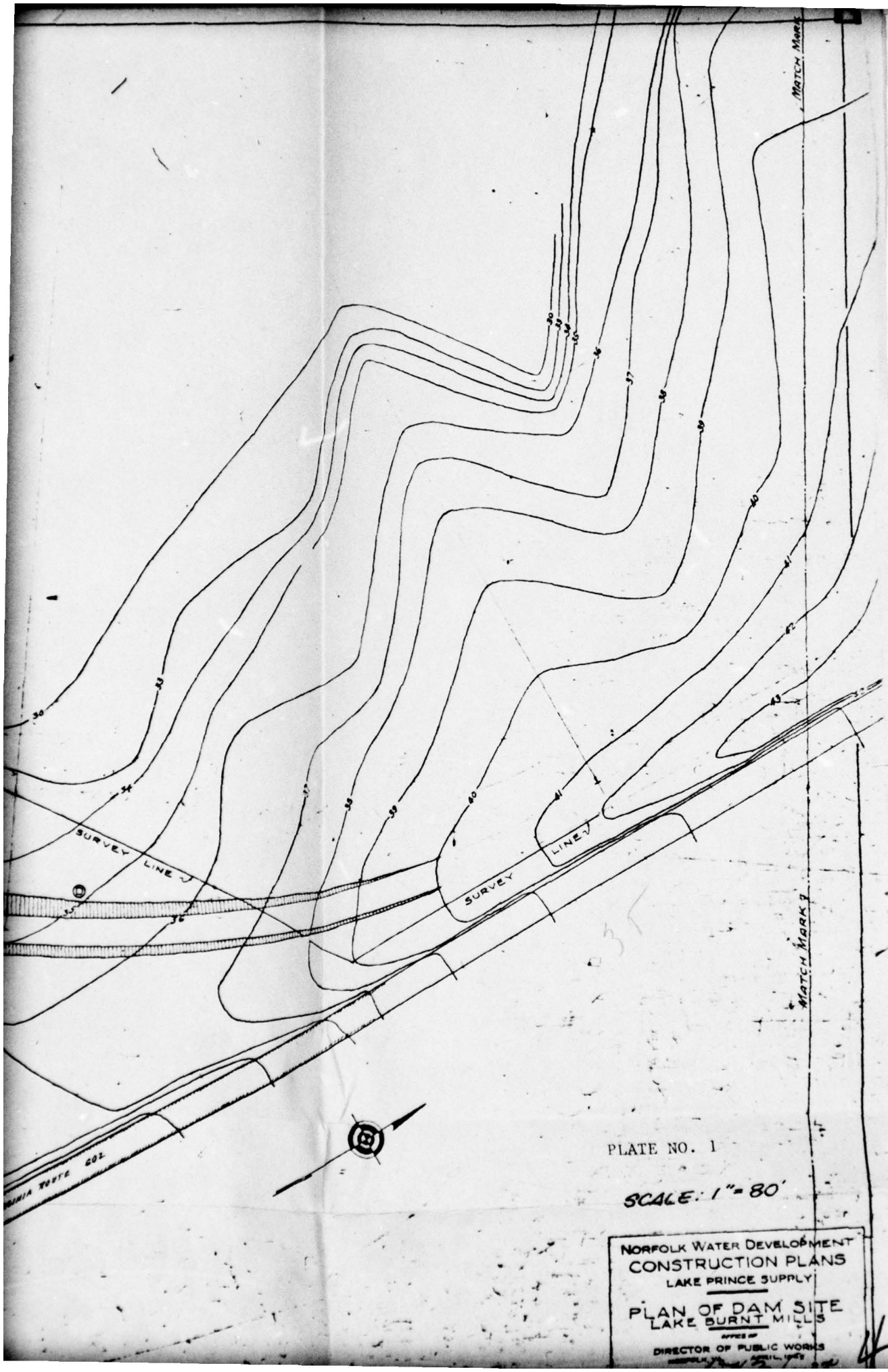


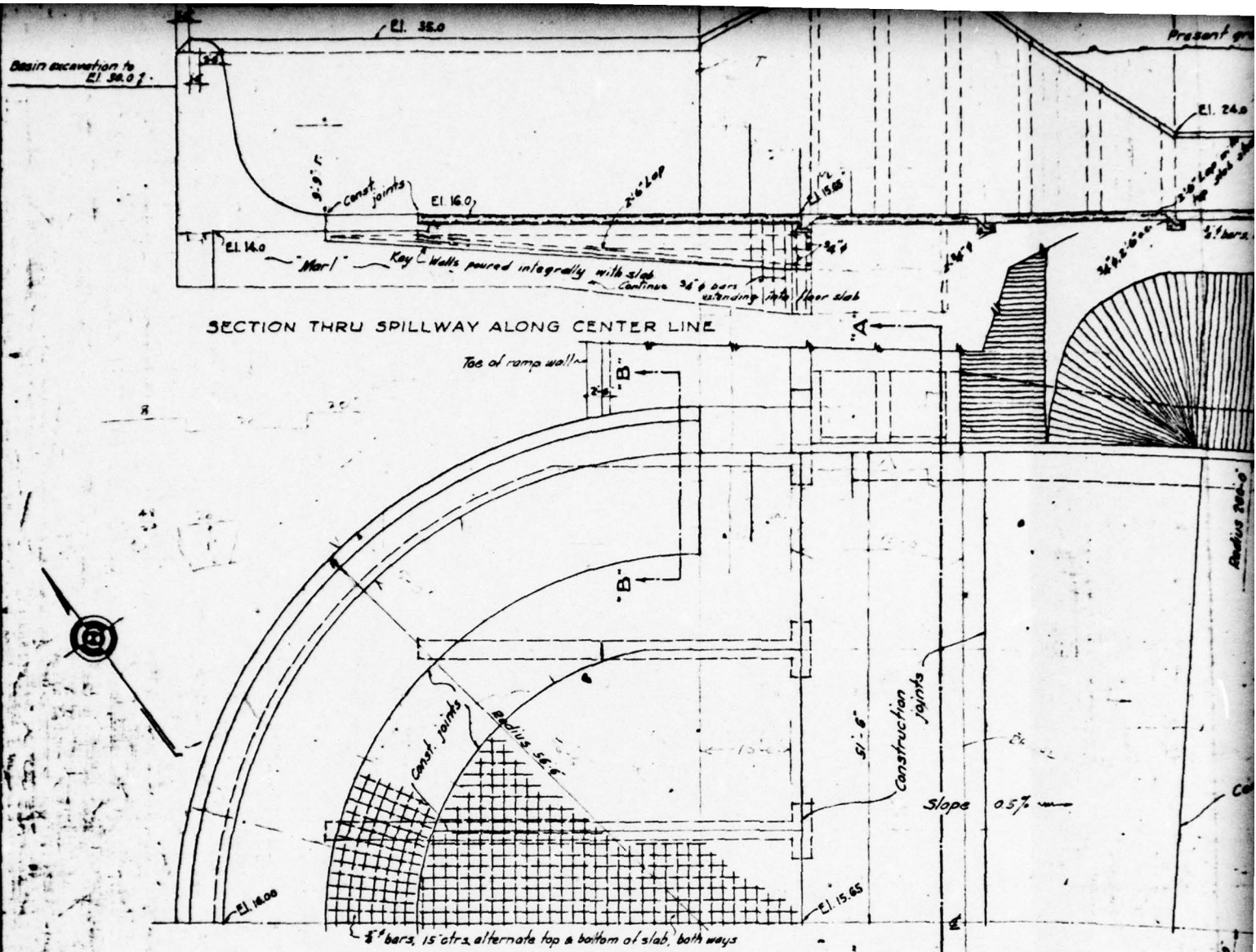

PLATE NO. 1

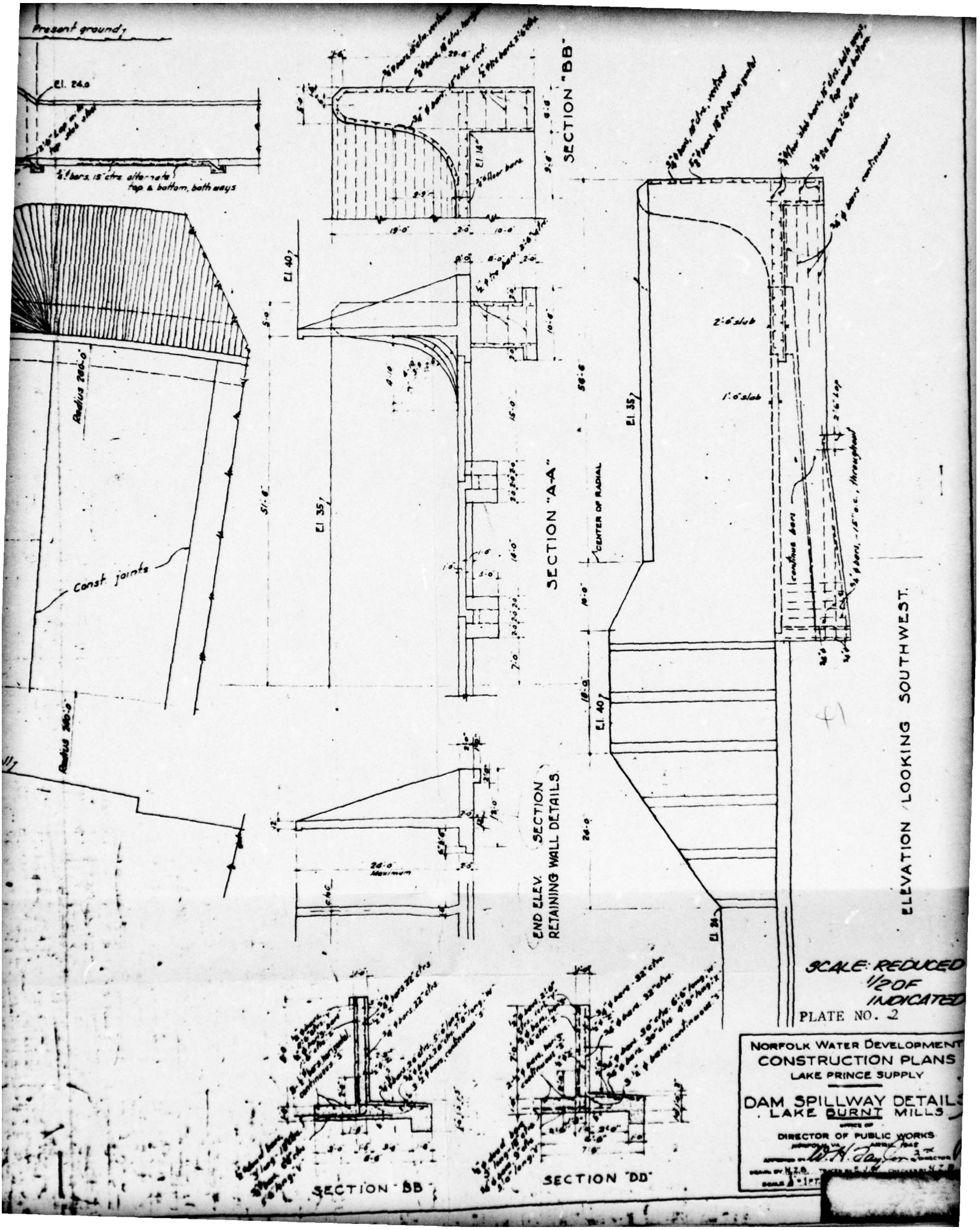
SCALE: 1" = 80'

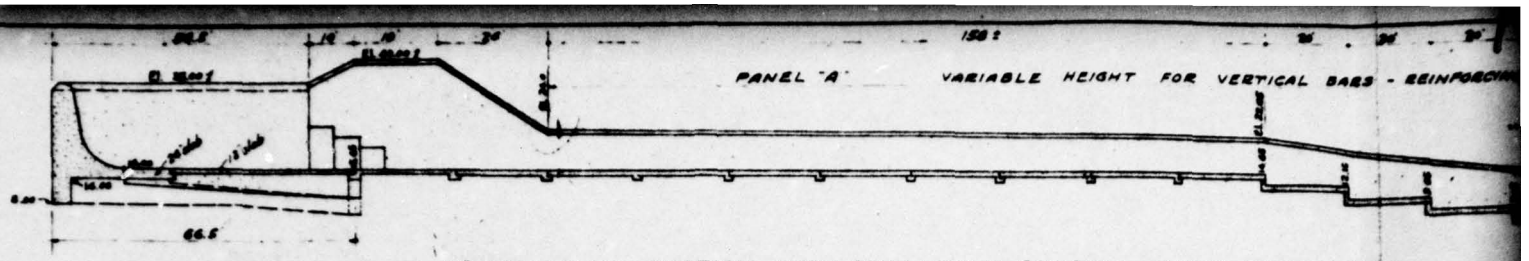
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
LAKE PRINCE SUPPLY

PLAN OF DAM SITE
LAKE BURNT MILLS

OFFICE OF
DIRECTOR OF PUBLIC WORKS
NORFOLK, VA. APRIL, 1962

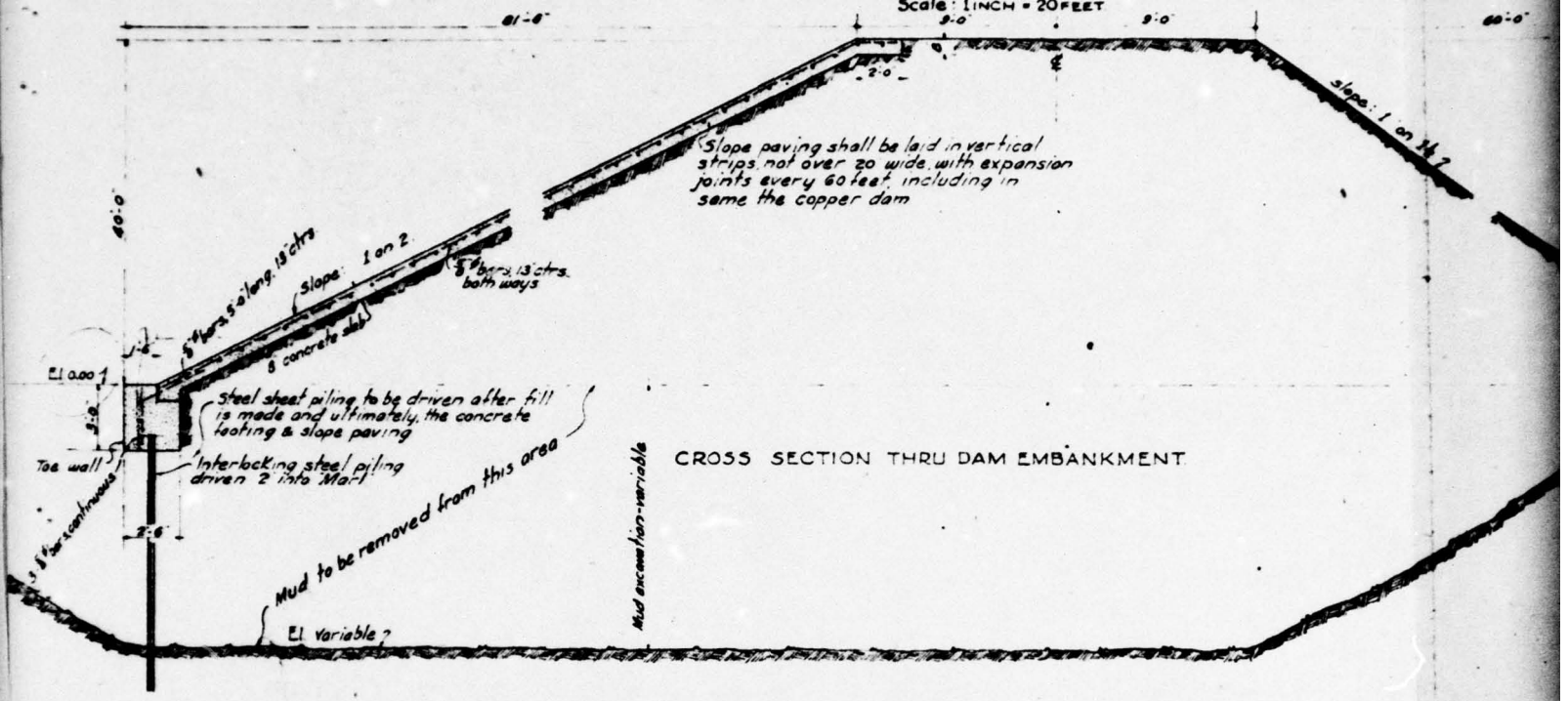

El. 36.0
Present gr
Basin excavation to El. 30.0 ±
El. 24.0
Const. joints
El. 16.0
El. 15.65
2'-6" Lap
El. 14.0
"Marl"
Key
Walls poured integrally with slab
Continue 36" ϕ bars extending into floor slab
SECTION THRU SPILLWAY ALONG CENTER LINE
Toe of ramp wall
"A"
"B"
Radius 266'-0"
Const. joints
Radius 56'-6"
51'-6"
Construction joints
Slope 0.5% ←
El. 16.00
El. 15.65
8" bars, 15" ctrs, alternate top & bottom of slab, both ways
HALF PLAN OF SPILLWAY AT ELEVATIONS INDICATED
Toe of retaining wall
Slope
El. 4.0
6'-6"
10'-6"
36" ϕ bars, 15" ctrs and 24" ϕ bars both continuous throughout entire spillway
El. 8.0
El. 10.0
6'-0"
20'-0"
36" ϕ bars, 30" o.c.
36" ϕ bars
52'-0"
El. 11.0
10'-0"
El. 14.0
Slope 5% ←
HALF PLAN OF SPILLWAY INDICATING EXCAVATIONS INTO "MARL"


Present ground
El. 24.0
Radius 266.0
Const. joints
SECTION "BB"
SECTION "A-A"
El 40
El 35
El 14
CENTER OF RADIAL
2'-6" slab
1'-0" slab
ELEVATION LOOKING SOUTHWEST
END ELEV.
SECTION
RETAINING WALL DETAILS
SECTION "BB"
SECTION "DD"
SCALE: REDUCED 1/2 OF INDICATED
PLATE NO. 2
NORFOLK WATER DEVELOPMENT
CONSTRUCTION PLANS
LAKE PRINCE SUPPLY
DAM SPILLWAY DETAILS
LAKE BURNT MILLS
DIRECTOR OF PUBLIC WORKS

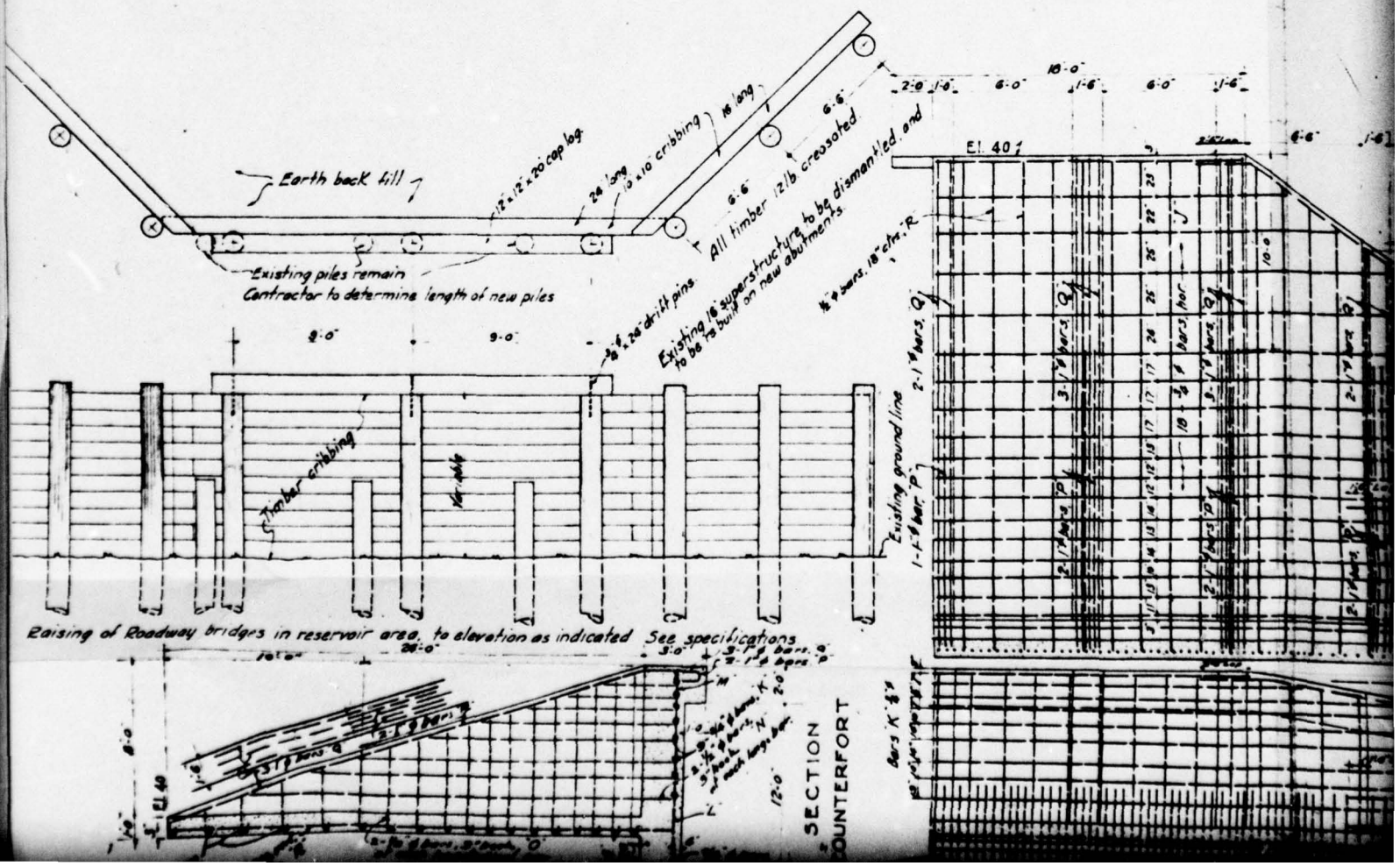



LONGITUDINAL SECTION THRU SPILLWAY & OUTFALL ALONG CENTER LINE

Scale: 1 INCH = 20 FEET

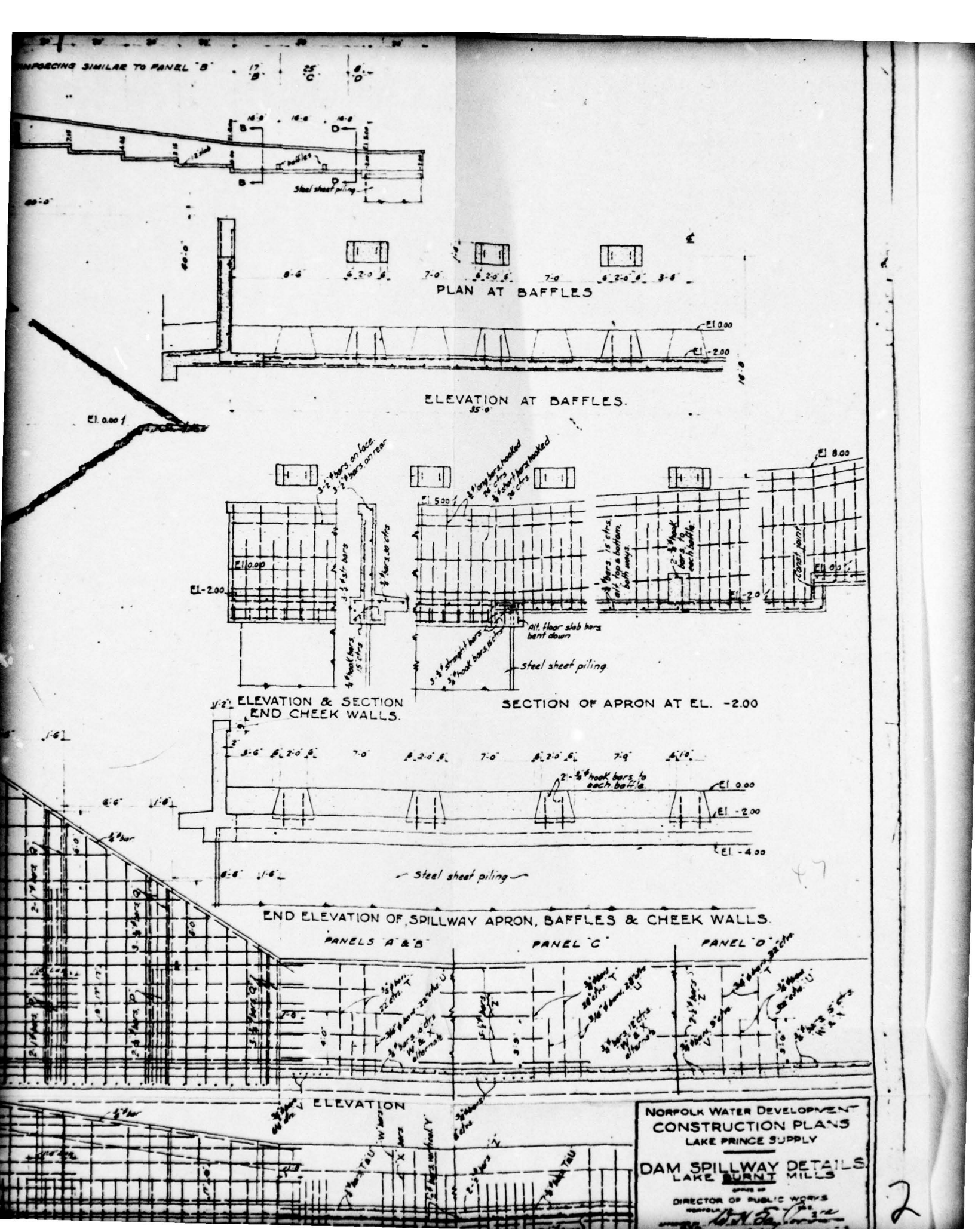



CROSS SECTION THRU DAM EMBANKMENT




Raising of Roadway bridges in reservoir area, to elevation as indicated See specifications

COUNTERFORT




NORFOLK WATER DEVELOPMENT

CONSTRUCTION PLANS

LAKE PRINCE SUPPLY

# DAM SPILLWAY DETAILS

LAKE BURNT MILLS

DIRECTOR OF PUBLIC WORKS

NORFOLK

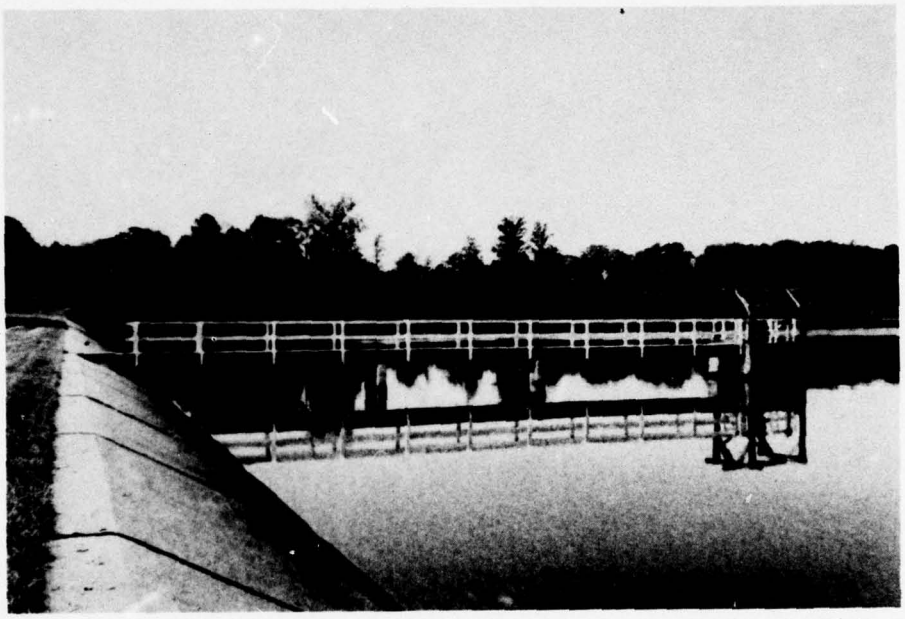
47

2

# APPENDIX II

## PHOTOGRAPHS

LAKE BURNT MILLS DAM



PHOTOGRAPH NO. 1
Intake Structure



PHOTOGRAPH NO. 2
Upstream Face of Dam

LAKE BURNT MILLS DAM

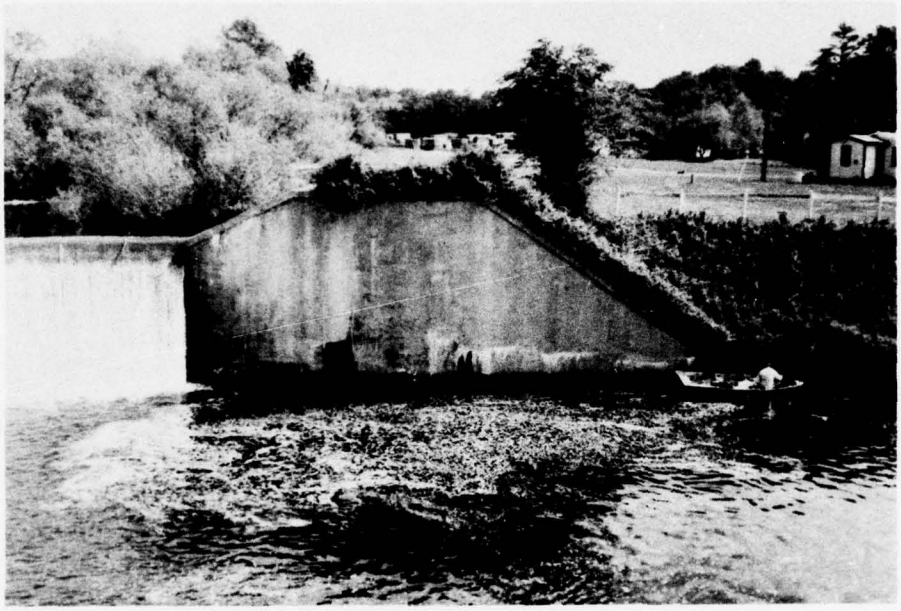


PHOTOGRAPH NO. 3
Face of Dam



PHOTOGRAPH NO. 4
Spillway
Front View

LAKE BURNT MILLS DAM



PHOTOGRAPH NO. 5
Spillway Abutment



PHOTOGRAPH NO. 6
Downstream

# APPENDIX III

# FIELD OBSERVATIONS

**Check List**
**Visual Inspection**
**Phase I**

Name Burnt Mills Dam County City of Suffolk (formerly Nansemond County) State Virginia Coordinates Lat. 3650.4 Long. 7637.7

Date(s) Inspection 5/7/79 Weather Broken Clouds Temperature 65° F

Pool Elevation at Time of Inspection 35 M.S.L. Tailwater at Time of Inspection 19 M.S.L.

Inspection Personnel:

Robert Gay, P.E. - SWCB

Taddeus Ward - City of Norfolk

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

Craig Ziesemer - City of Norfolk

Mike Cowell - Law Engineering
Soil and Geology

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

## CONCRETE SPILLWAY

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SURFACE CRAKCS CONCRETE SURFACES | Surface has hairline cracks around spillway. | Program is anticipated of surface treatment by gunite process. |
| STRUCTURAL CRACKING | No obvious structural failure. | |
| VERTICAL AND HORIZONTAL ALIGHMENT | No visible misalignment. | |
| MONOLITH JOINTS | No obvious leakage at spillway. | |
| CONSTRUCTION JOINTS | Abutment walls have stains. | Needs repair |
| | | |

## EMBANKMENT

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SURFACE CRACKS | No obvious cracking. | |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE | Tailwater was 3 feet ± deep at the toe of the dam. | |
| SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES | None obvious. | |
| VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST | No misalignment of the top of the dam. | |
| RIPRAP FAILURES | Riprap 3 feet above water downstream side of the dam. | |

## EMBANKMENT

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONSTRUCTION MATERIAL | | |
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | Right abutment - No evidence of cracking or erosion. | |
| ANY NOTICABLE SEEPATE | No visible seepage. | |
| STAFF GAGE AND RECORDER | None. | |
| DRAINS | None observed. | |
| FOUNDATION | | |
| | Right of emergency spillway - concrete slab on upstream slope settled 2-3 inches. | |

# OUTLET WORKS

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT | No obvious failures. | |
| INTAKE STRUCTURE | No obvious failures. | |
| OUTLET STRUCTURE | Not visible. | |
| OUTLET CHANNEL | Not visible. | |
| EMERGENCY GATE | ----- | |

## UNGATED SPILLWAY

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONCRETE WEIR | No obvious structural cracks. | |
| APPROACH CHANNEL | Forested. | |
| DISCHARGE CHANNEL | Water dowsntream is brackish. | |
| BRIDGE AND PIERS | No obvious structural failures. | |

# INSTRUMENTATION

| VISUAL EXAMINATION | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| MONUMENTATION/SURVEYS | None | |
| OBSERVATION WELLS | None | |
| WIERS | None | |
| PIEZOMETERS | None | |
| OTHER | | |

## RESERVOIR

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SLOPES | Flat, forested. | |
| SEDIMENTATION | Unknown. | |
| | | |
| | | |
| | | |

## DOWNSTREAM CHANNEL

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONDITION (OBSTRUCTIONS, DEBRIS, ETC.) | | |
| SLOPES | Flat. | |
| APPROXIMATE NO. OF HOMES AND POPULATION | 16 homes, estimated population of 60 people | |
| | | |
| | | |

# CHECK LIST
## ENGINEERING DATA
## DESIGN, CONSTRUCTION, OPERATION

| ITEM | REMARKS |
|---|---|
| PLAN OF DAM | See Appendix I |
| REGIONAL VICINITY MAP | See Appendix I |
| CONSTRUCTION HISTORY | Not known. |
| TYPICAL SECTIONS OF DAM | See Appendix I |
| HYDROLOGIC/HYDRAULIC DATA | |
| OUTLETS - PLAN and - DETAILS | |
| - CONSTRAINTS and - DISCHARGE RATINGS | |
| RAINFALL/RESERVOIR RECORDS | |

| ITEM | REMARKS |
|---|---|
| DESIGN REPORTS | None. |
| GEOLOGY REPORTS | None. |
| DESIGN COMPUTATIONS<br>HYDROLOGY & HYDRAULICS<br>DAM STABILITY<br>SEEPAGE STUDIES | Brief - See Appendix IV. |
| MATERIALS INVESTIGATIONS<br>BORING RECORDS<br>LABORATORY<br>FIELD | None available<br>See Plan |
| POST-CONSTRUCTION SURVEYS OF DAM | None. |
| BORROW SOURCES | Unknown |

| ITEM | REMARKS |
|---|---|
| MONITORING SYSTEMS | None. |
| MODIFICATIONS | None |
| HIGH POOL RECORDS | 0.6 feet over spillway |
| POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS | None |
| PRIOR ACCIDENTS OF FAILURE OF DAM DESCRIPTION REPORTS | None |
| MAINTENANCE OPERATION RECORDS | Pool elevation is recorded |

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

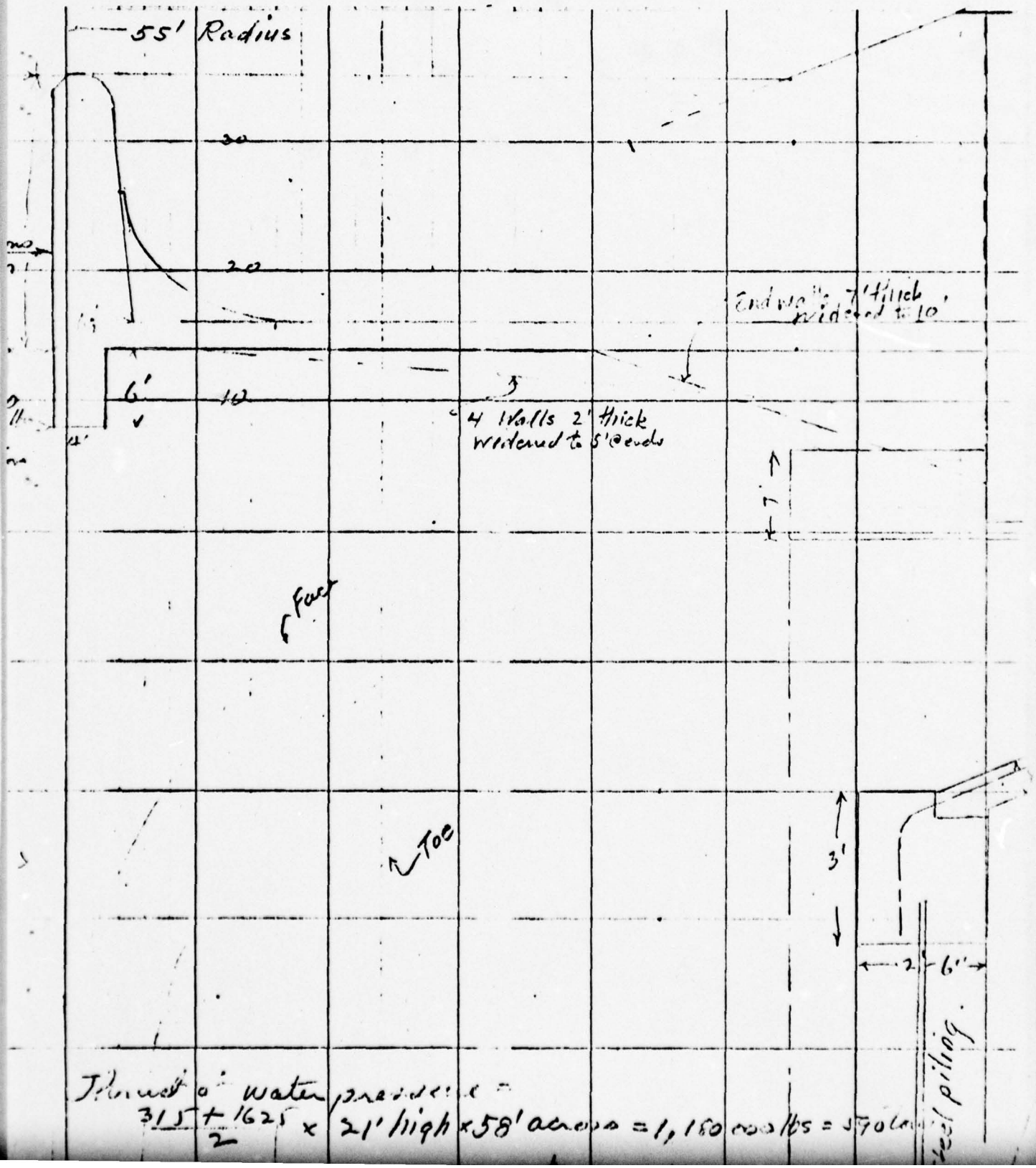
# APPENDIX IV

# DESIGN NOTES AND CALCULATIONS

City of Norfolk, Department of Public Works

Subject SPILLWAY – Date March 1952 Sheet No.

Burnt Mills Dam Prepared by RZ



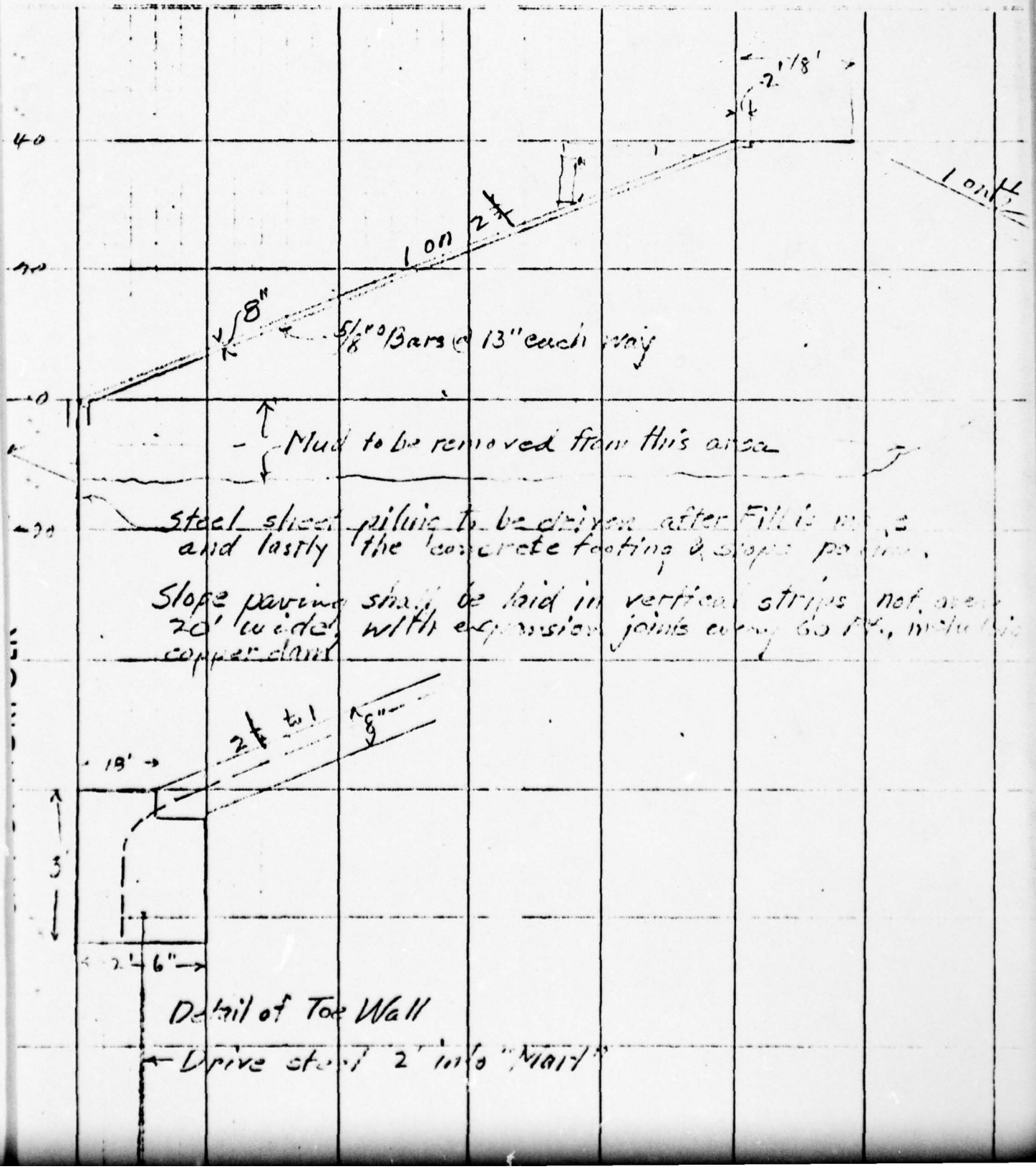

Thrust of water pressure =

$\frac{315 + 1625}{2} \times 21' \text{ high} \times 58' \text{ across} = 1,160,000 \text{ lbs} = 580 \text{ tons}$

City of Norfolk, Department of Public Works

Subject Burnt Mills dam Date 4-1 Sheet No.

Prepared by DLE



City of Norfolk, Department of Public Works

Subject Burnt Mills Dam Date 12-23-41 Sheet No.

Cost of Pumping to Lake Prince Prepared by W.Z.G.

if the tunnel were abandoned.

A pump placed below the proposed dam site could discharge thru 7000' of 30" pipe to the head of a gully leading to L. Prince, at Elev. 60

Friction for 15 MGD rate = 7 × 1.95 = 13.6'

Static lift = 25 to 60' (Reservoir prior empty.)

Assume 40' average. or 53.6' total

$$KW = \frac{10400\ GPM \times 8\tfrac{1}{3} \times 53.6}{4423.6 \times .80\%\ efficiency} = 133$$

Cost per year = $1.33 × 24 hrs × 365 = $11700

The above power would be wasted, since all the water would require repumping at the present pumping station.

A more economical handling would be to lay 2.1 mi. of 30" pipe to connect to the present line just east of the Lake House, so the gravity flow could draw water direct to Lake Prince.

Then friction in this 2.1 mi of pipe would be the only additional cost over present pumping.

$$\frac{10400\ GPM\ (=15\ MGD) \times 8\tfrac{1}{3} lbs \times 21.5\ friction}{4423.6 \times 80\%\ efficiency} = 53\ Kw.$$

53 × 24 hrs × 365 days = 462000 KW hrs = $4620.

or 85 cents per M.G.

City of Norfolk, Department of Public Works

Project Burnt Mills Dam Date 12-23-41 Sheet No.

Cost of Pumping to Lake Price Prepared by W Z Le

if the tunnel were abandoned.

2 pumps placed below the present dam site could discharge thru 7000' of 30" pipe to the head of a gully leading to L. Price, at Elev. 60

Friction for 15 MGD rate = 7 × 1.95 = 13.6'

Static lift = 25 to 60' (Reservoir prior conf.)

Assume 40' average. or 53.6' total

$$KW = \frac{10400\ GPM \times 8\frac{1}{3} \times 53.6}{4423 \times .80\%\ efficiency} = 133$$

Cost per year = 133 × 24 hrs × 365 = $11700

The above power would be wasted, since all the water would receive repumping at the present pumping station.

A more economical handling would be to lay 2.1 mi. of 30" pipe to connect to the present line at east of the dam. However, so this pumping could also work without, to keep the Elev. Friction in this 2.1 mi of pipe would be the only additional cost over present pumping.

$$\frac{10400\ GPM\ (=15\ MGD) \times 8\frac{1}{3}\text{'s} \times 21.5\ friction}{4423 \times 80\%\ efficiency} = 53\ KW.$$

53 × 24 hrs × 365 days = 462000 KW hrs = $4620.

City of Norfolk, Department of Public Works

Project Burnt Mills Dam Date 12-23-41 Sheet No.

Cost of Pumping to Lake Prince Prepared by W Z Lee

if the tunnel were abandoned.

2 pumps placed below the present dam site could discharge thru 7000' of 30" pipe to the head of a gully leading to L. Prince, at Elev. 60

Friction for 15 MGD rate = 7 × 1.95 = 13.6'

Static lift = 25 to 60' (Records prior to 1941)

Assume 40' average, or 53.6' total

$$KW = \frac{10400\ GPM \times 8\frac{1}{3} \times 53.6}{4423 \times .80\%\ efficiency} = 133$$

Cost per year = $1.33 × 24 hrs × 365 = $11700

The above power would be wasted since all the water would receive repumping at the present pumping station.

A more economical handling would be to lay 2.1 mi. of 30" pipe to connect to the present line at end of 7000 ft. pipe, so the pumps could discharge water direct to Lake Prince. Then friction in this 2.1 mile of pipe would be the only additional cost over present pumping.

$$10400\ GPM\ (=15\ MGD) \times 8\frac{1}{3}\ lbs \times 21.5\ friction = 53\ K.W.$$
$$4423 \times 80\%\ efficiency$$

53 × 24 hrs × 365 days = 462000 KW hrs = $ 4620.

# City of Norfolk, Department of Public Works

Project Burnt Mills Dam Date 12-23-41 Sheet No.

Cost of Pumping to Lake Prince Prepared by JTZ

if the tunnel were abandoned.

2 pumps placed below the present dam site could discharge thru 7000' of 30" pipe to the head of a gully leading to L. Prince, at Elev. 60

Friction for 15 MGD rate = 7 × 1.95 = 13.6'

Static lift = 25 to 60' (Reservoir prior emptying)

Assume 40' average or 53.6' total

$$KW = \frac{10400\ GPM \times 8\frac{1}{3} \times 53.6}{4423.6 \times .80\%\ efficiency} = 133$$

Cost per year = $1.33 × 24 hrs × 365 = $11700

The above power would be wasted, since all the water would return to the present pumping station.

A more economical handling would be to lay 2.1 mi. of 30" pipe to connect to the present line at end of Pin Point, so the pumps could discharge water direct to Lake Prince. The friction in this 2.1 mi. of pipe would be the only additional cost over present pumping.

$$\frac{10400\ GPM\ (=15\ MGD) \times 8\frac{1}{3}\ lbs \times 21.5\ friction}{4423.6 \times 80\%\ efficiency} = 53\ KW.$$

53 × 24 hrs × 365 days = 462000 KWHrs = $4620.

City of Norfolk, Department of Public Works

ct. Burnt Mills Dam Date 12-23-41 Sheet No.

st of Pumping to Lake Prince Prepared by W Zee

f the tunnel were abandoned.

2 pumps placed below the present dam site could discharge thru 7000' of 30" pipe to the head of a gully leading to L. Prince, at Elev. 60

Friction for 15 MGD rate = 7 × 1.95 = 13.6'

Static lift = 25 to 60' (Reservoir min. or max. lift)

Assume 40' average or 53.6' total

$$KW = \frac{10400\ GPM \times 8\frac{1}{3} \times 53.6}{4423 \times .80\%\ efficiency} = 133$$

Cost per year = $1.33 × 24 hrs × 365 = $11700

The above power would be, would, since all the water would require repumping at the present pumping station.

A more economical handling would be to lay 2.1 mi. of 30" pipe to connect to the present line at end of Elm Ave. pumping station, so the 7 mgd pumps could pump water direct to Norfolk.

Then friction in this 2.1 mi of pipe would be the only additional cost over present pumping.

$$\frac{10400\ GPM\ (=15\ MGD) \times 8\frac{1}{3}\ lbs \times 21.5\ friction.}{4423 \times 80\%\ efficiency} = 53\ KW.$$

53 × 24 hrs × 365 days = 462000 KW hrs = $4620.

or 85 cents per M.G.

1

City of Norfolk, Department of Public Works

ct Burnt Mills Dam Date 12-23-41 Sheet No.

t of Pumping to Lake Price Prepared by W.T.L.

the tunnel were abandoned.

2 pumps placed below the foundation of dam site could discharge thru 7000' of 30" pipe to the head of a gully draining to L. Price, at Elev. 60

Friction for 15 MGD rate = 7 × 1.95 = 13.6'

Static lift = 25 to 60' (Record prior to 1941)

Assume 40' average or 53.6' total

$$KW = \frac{10400\ GPM \times 8\frac{1}{3} \times 53.6}{4423.6 \times .80\%\ efficiency} = 133$$

Cost per year = 133 × 2000 hrs × .01 = $2660

The above power would be used, would pump all the water would require pumping at the present pumping station.

A more economical handling would be to lay 2.1 mi. of 30" pipe to connect to the present line just east of the Lake House, so the pumps would draw water direct to disinfecting plant. Friction in this 2.1 mi of pipe would be the only additional cost over present pumping.

$$\frac{10400\ GPM\ (=15\ MGD) \times 8\frac{1}{3}\ lbs \times 21.5\ friction}{4423.6 \times 80\%\ efficiency} = 53\ H.P.$$

53 × 24 hrs × 365 days = 462000 KW hrs = $4620.

or 85 cents per M.G.

City of Norfolk, Department of Public Works

ct. Burnt Mills Dam Date 12-23-41 Sheet No.

t of Pumping to Lake Price Prepared by ALH

the tunnel were abandoned.

2 pumps placed below the foot of the dam site could discharge thru 7000' of 30" pipe to the head of a gully leading to L. Price, at Elev. 60

Friction for 15 MGD rate = 7 × 1.95 = 13.6'

Static lift = 25 to 60' (Reservoir prior emergency)

Assume 40' average or 53.6' total

$$KW = \frac{10400\ GPM \times 8\frac{1}{3} \times 53.6}{4423.6 \times .80\%\ efficiency} = 133$$

Cost per year = $1.33 × 2 yrs × 365 = $1170.

The above power would be wasted, since all the water would be receiving repumping at the present pumping station.

A more economical handling would be to lay 2.1 mi. of 30" pipe to connect to the present line at end of this line. However, so the pumps could discharge with direct to Lake Price. Then friction in this 2.1 mi of pipe would be the only additional cost over present pumping.

$$\frac{10400\ GPM\ (=15\ MGD) \times 8\frac{1}{3}\ lbs \times 21.5\ friction}{4423.6 \times 80\%\ efficiency} = 53\ KW.$$

53 × 24 hrs × 365 days = 462000 KWHRS = $4620.

or $5400 per M.G.

City of Norfolk, Department of Public Works

ct Burnt Mills Dam Date 12-23-41 Sheet No.

t of Pumping to Lake Prince Prepared by W Zee

the tunnel were abandoned.

If pumps placed below the foundation of dam site could discharge thru 7000' of 30" pipe to the head of a gully leading to L. Prince, at Elev. 60

Friction for 15 MGD rate = 7 × 1.95 = 13.6'

Static lift = 25 to 60' (Reservoir prior emptied)

Assume 40' average or 53.6' total

KW = 10400 GPM × 8 1/3 × 53.6
44236 × .80% efficiency = 133

Cost per year = 133 × 24 hrs × 365 = $1170.

The above power would be wasted, since all the water would require repumping at the present pumping station.

A more economical handling would be to lay 2.1 mi. of 30" pipe to connect to the present line at end of the dam / tunnel, so the pumps could draw water direct to Lake Prince.

Then friction in this 2.1 mi of pipe would be the only additional cost over present pumping.

10400 GPM (=15 MGD) × 8 1/3 lbs × 21.5 friction.
44236 × 80% efficiency = 53 Kw.

53 × 24 hrs × 365 days = 462000 KWHrs = $4620.
or 85 cents per M.G.

City of Norfolk, Department of Public Works

ct Burnt Mills Dam Date 12-23-41 Sheet No.

st of Pumping to Lake Price Prepared by W Z Lee

the tunnel were a bandoned.

If pumps placed below the present dam site could discharge thru 7000' of 30" pipe to the head of a gully leading to L. Price, at Elev. 60

Friction for 15 MGD rate = 7 × 1.95 = 13.6'

Static lift = 25 to 60' (Recommend minimum conditions)

Assume 40' average, or 53.6' total

$$KW = \frac{10400\ GPM \times 8\frac{1}{3} \times 53.6}{4423 \times .80\%\ efficiency} = 133$$

Cost per year = 133 × 24 hrs × 365 = $1170.

The above power would be wasted, since all the water would require repumping at the present pumping station.

A more economical handling would be to lay 2.1 mi. of 30" pipe to connect to the present line at end of the dam. Power, so the pumps could draw water direct to Norfolk. The friction in this 2.1 mi of pipe would be the only additional cost over present pumping.

$$\frac{10400\ GPM\ (=15\ MGD) \times 8\frac{1}{3}\ lbs \times 21.5\ friction.}{4423 \times 80\%\ efficiency} = 53\ K.W.$$

53 × 24 hrs × 365 days = 462000 KW hrs = $4620.

or 8.5 cents per M.G.

# City of Norfolk
Virginia

December 11, 1941

Mr. W. H. Taylor, III
Director of Public Works

Dear Sir:

The tabulated list below represents the results of analysis of several samples of water taken by Mr. N. Z. Ball and I on December 10, 1941 and analyzed in our laboratories on the same date. The results are chloride content in parts per million:

| | | |
|---|---|---|
| No. 1 | - Sample from Chowan River, Winton, North Carolina | 302.2 ppm |
| No. 2 | - " " Meherin " , Murfreesboro, North Carolina | 5.2 ppm |
| No. 3 | - " " The Nottaway River, Bridge on Route #258 | 78.0 ppm |
| No. 4 | - " " The Black Water River, Franklin, Virginia | 26.0 ppm |
| No. 5 | - " " " " " " , Burdette, " | 7.8 ppm |

The sample taken from the Black Water River at Franklin Virginia showed definite industrial pollution presumably from the Chesapeake-Camp Paper Company. This pollution exists to such an extent that the Chesapeake-Camp Company find it necessary to transport water from the Nottaway River for use in their boilers. The river water at this point showed a decided greenish-brown color and had a very definite sulphite odor. No evidence of this pollution was found in the sample taken at Burdette, Virginia.

Very truly yours
DIVISION OF WATER SUPPLY

R. W. FITZGERALD
Chief Chemist

of

December 15, 1941

Mr. Walter H. Taylor, III
Director of Public Works

Dear Sir:

With reference to the attached letter from Mr. R. W. Fitzgerald giving you the chloride content of water samples taken from the Chowan, Meherrin, Nottaway and Blackwater Rivers, I wish to say that these indicate that a large supply of potable water could be pumped from the Blackwater, except for the pollution at Franklin. It might be possible to utilize the natural flow of the Meherrin and Nottaway Rivers also if some form of collapsing, submerged weir could be built below the confluence to prevent salt water backing upstream from the Chowan.

However, the water at the highway bridge in Franklin, which is a short distance up stream from the paper mill, was practically black, with a strong odor of sulphite waste. This would indicate a very low flow in the river; and surface observation did not indicate any flow there or at Burdette. Thus it appears that the stream would be almost useless at times such as the present drought, unless the pollution at Franklin was stopped, or storage provided by building a dam at some point above Franklin.

If a dam were constructed just north of Zuni there would be no inundation of the Norfolk and Western Railway or State Highway No. 460. The flooded area would be very largely in waste area, which can probably be purchased at a low price.

At the site one mile north of Zuni the drainage area is approximately 430 sq. miles; and a reservoir of any capacity up to 40 billion gallons could be created, depending on the height of the dam.

If the flow line is made at elevation 30, and top of dam elevation 40, the dam would be some 4000' long and the storage would be 5370 MG or 12.5 MG per sq.mile of drainage area.

By taking the yield-curve and extrapolating to produce a curve for 2% water surface, it appears that, to obtain a yield of 50 MGD or 116,000 gals. daily per sq. mile, the storage should be 22 MG per sq. mile or 9460 MG total. This would require that water be stored to elevation 34 more or less.

The flooded area at elevation 30 would be 3.63 sq. mile or 2300 acres, and at elevation 34 maybe 5000 acres. This ought to cost not over $25. per acre. The dam would be little if any

higher than Lake Prince, but would require a large number of movable gates for passing flood water.

Yours very truly,

Principal Assistant Engineer.

NZB:H

ORTLAND CEMENT ASSOCIATION
INTER-OFFICE CORRESPONDENCE

Southeastern OFFICE

January 2, 1942

Our file 10-6

AIR MAIL

Mr. C. O. Haines
616 Westover Avenue
Norfolk, Virginia

In checking over the design computations and sketches for the Burnt Mills dam, it strikes me that the structure is not stable against sliding forces. Although the calculations indicate ample security against sliding, I question if they are made on proper assumptions. In addition, the item of uplift does not seem to have been taken into consideration and such forces may exist in considerable degree.

Before going into detail with my remarks, it should be stated that the design of dams presents many individual problems and on many questions a good deal of study and personal observation on the part of an expert is essential before a reasonably sure answer can be given. I am not an expert on this subject and my opinions may be highly debatable. Therefore, I am going to briefly outline my reactions for what they may be worth, with the thought that further study may be desirable by the designer on the items questioned.

The use of daps, or keys, on the underside of the abutment footings and floor is utilized in the design to build up sliding resistance. I doubt that it is safe to rely on such a method. I know many engineers would not allow any value to these shallow daps because the dirt is apt to shear and push out. If they were in rock, it would be a different matter, or if the dam base were set deep into the ground with a key wall at the heel, perhaps some allowance could be given to the key wall. Of course, there is no argument that under many conditions these daps would build up much resistance, but the danger lies in the one time they may offer little help, such as when the ground becomes saturated and weak.

I also question the wisdom of crediting the floor between abutments as having any value in resisting sliding. As a matter of fact, it may be more of a hindrance than a help. For instance, if the ground below becomes saturated, which no doubt it will at times, then the uplift pressure is apt to exceed the dead weight of the floor itself, in which case a negative result would be obtained and the floor would act as a boat and tend to lift the structure. A floor may be useful as a pavement to resist scour, but frequent weep holes for escape of ground water should be provided. I would prefer that it be made not integral with the dam.

Thus, eliminating the daps and the floor from consideration, it would be necessary to increase considerably the weight of the abutments to provide sufficient horizontal resistance.

In the calculations for water pressure against the dam, the pressure on the dam is calculated down to a depth of 24½ ft. below high water level. I think this should be down to 27 ft., the actual bottom of the dam, which would make the unit pressure at the bottom 1,685 lb. and the total pressure approximately 21,800 lb. per foot of dam. This would increase the reaction at the abutments to about 1,210,000 lb.

In order to resist sliding, it is customary to require that sufficient resisting capacity be developed by frictional resistance alone. On earth, a factor of safety of 2½ to 3 is usually required.

Assuming the coefficient of friction of .33 is correct and a factor of safety of 2½ is required, then the coefficient of friction to be used in calculations would be $\frac{.33}{2.5}$ or .13. This is low, as may be expected for clay foundations, and it means considerable weight must be developed in the abutments, many times more than now provided.

Regarding uplift, this force at the heel of the dam may equal the unit water pressure at the bottom of the dam, and perhaps a good percentage of this amount at the toe of the dam. All of this would depend on the nature of the ground material on which the dam sets. Someone with good experience and judgment on this matter should be consulted. The uplift forces would have to be subtracted from the weight of the structure when calculating frictional resistance against sliding. In other words, resistance to sliding must equal (W - uplift) x Coeff. of friction, where W = total weight of structure and uplift equals total of forces acting upward on dam and abutment.

The intensity of uplift may sometimes be lessened by providing a key wall at the heel of dam, making a longer path through which ground water must percolate and decreasing its pressure head by friction. Also such a key, if deep in the ground, may be assumed to offer some resistance to sliding by direct pressure against the ground. Again I think it would be wise to consult some better authority on these latter questions, particularly how much value may be allowed to such factors.

PORTLAND CEMENT ASSOCIATION

Mr. C. O. Haines 3. January 2, 1942

I am returning the calculation sheets as requested. Note some remarks I have made on them in blue pencil.

D. L. CHANEY

D.L.C.*LR
Enclosures

Copy sent J. E. Dunn

January 27, 1942.

Mr. D. L. Chaney,
Portland Cement Association,
Atlanta, Georgia.

Dear Sir:

Your letter of January 2nd addressed to Mr. C. O. Haines, regarding the proposed spillway for our Burnt Mills Dam, was handed to me at that time by Mr. Haines, but I regret to say that more pressing business pushed this matter entirely off the boards until now.

As to your deductions regarding this proposed spillway, while I cannot agree with all of them, I am confident that you would have thought differently if we had sent you more complete information.

As to saturation of the material under the spillway, the first requisite for building a dam is that there shall be as little as possible of any such saturation. Complete saturation, such as you envisage might float the floor on the down stream side of the spillway, would be fatal to the dam as a whole. It is our intention to put either steel sheet piling or a concrete cut-off wall at the toe of the slope of the embankment, and would be continued under the front edge of the spillway weir. I think your suggestion of a key wall at the heel of the dam (in addition to the steel sheet piling) is good, as it would increase water tightness, and by adding proper reinforcing it would certainly resist the water pressure tending to produce sliding.

Furthermore, I believe you are not informed that the material on which this structure is proposed to be placed is something we consider to be better than ordinary clay. It is called "Marl", but I think it is actually nothing but ocean mud which has been compacted. It contains silt, sand and some shells; but it is so compact that water has been running over it, below the waste gates of an old dam upstream from our new dam site, for twenty (20) years to our knowledge without apparently having eroded any noticeable amount. At the site of the proposed spillway we have made borings which indicate that this structure can be built on the same kind of material. In fact, this material seems to underlie nearly all that region.

We believe this material to be almost absolutely impervious in its native state, and that this quality makes it unnecessary to consider the saturation under the spillway. Also, the material is very firm, and, therefore, we believe that the daps or keys on the under side of the floor and the abutment footings would offer a very considerable resistance against sliding. Perhaps we were too optimistic in our calculations of the resistance against sliding, but we are confronted with the problem of either building the spillway with the foundation at the depth indicated in order to get it on this so called "Marl" or to build it at a less depth with the foundation on ordinary sand clay soil.

As a further indication of the firmness of this "Marl", I wish to say that we made a load test on an area 2 feet square, and a load of 16 tons produced no measurable settlement after the initial settlement, which occurred when we began to apply the load.

It is our plan to build the semi-circular spillway, the floor within it and perhaps 50 feet down stream, and the contiguous portions of the sidewalls as a monolith: as few construction joints as possible and no expansion joints. Our present Lake Prince is wider, without expansion joints, and has given no trouble on that account. If built in this way, we still feel that the keys under the floor would create much resistance to sliding, at least up to the shearing resistance of the Marl.

As a further precaution against uplift under the slab, we intend to install porous drain tile, with outlets downstream, to remove any seepage which might possibly get under the cut-off wall.

If you can spare the time to think this matter over any further, we will be very glad to have your further comment.

Yours very truly,

Norman Z. Ball,
Principal Assistant Engineer.

NZB:P

City of Norfolk, Department of Public Works

Subject Dam at Burt Mills Date 12-27-41 Sheet No. 2

Prepared by J. W. Mc

Bottom ring - f = $\frac{1530 \times 55\frac{1}{2}}{12 \times 144}$ = 73.7 #/□"

If line of pressure is at edge $\frac{73.7 \times 2}{3}$ = 147 #/□"

Reaction at abutment - 18,730 × 55½ = 1,040,000 #

Load taken at abutment

By bearing on daps (12' wide)

3 + 2 + 2 = 7

7 × 12 = 84

Less lugs = 6

78 × 3,000 = 234,000

By friction

Wt. of 40' sect of wall - 872,000#

" " 20' " " " 17,000 × 20 = 340,000

.33 × 1,212,000 # = 404,000 #

Tot load taken by abutment = 638,000 #

1,040,000

638,000

402,000 # = Load to be transmitted to floor

Rock shear

$V_c = \frac{402,000}{60 \times 12 \times \frac{7}{8} \times 12}$ = 53.2 psi enough

Load taken by floor

By bearing on daps 3 + 2 + 2 = 7

7 × 48½ × 3,000 = 1,029,000 #

By friction

Wt. of ½ dam - 467,500

" " ½ of 2' floor - 175,000

" " ½ " 1' " - 148,500

.33 × 811,000 = 270,333

Resistance of Head on floor = 1,290,333 # ult.

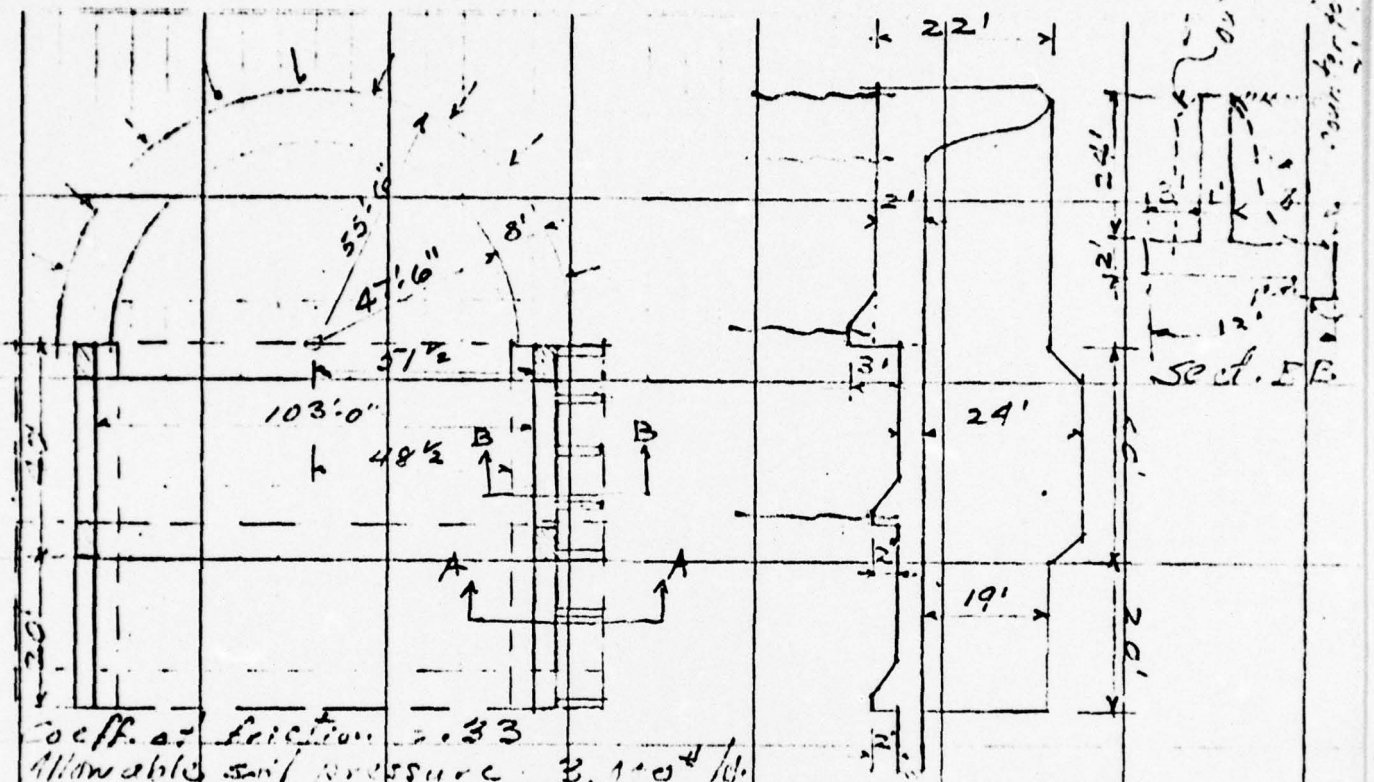
Factor of safety against sliding furnished by floor - 1,290,333 ÷ 402,000 = 3.21

Dapped by wall at bot

# City of Norfolk, Department of Public Works

Subject Dam at Burt's Mills Date 12-27-41 Sheet No. 1

Prepared by J. W. W.




Coeff. of friction = .33

Allowable soil pressure 3,100 #/sq. ft.

f'c = 2500

fc = 1,000 for all conc. except arch ring

fs = ½ x 2500 = 312 for web rings or [illegible]

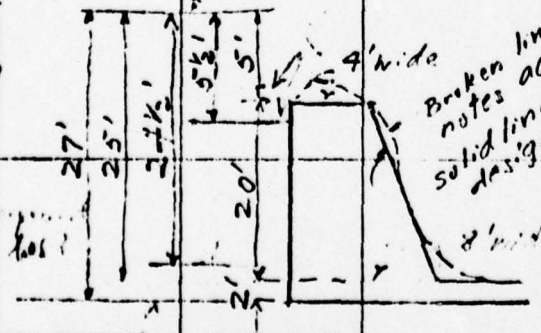
fs = 20,000

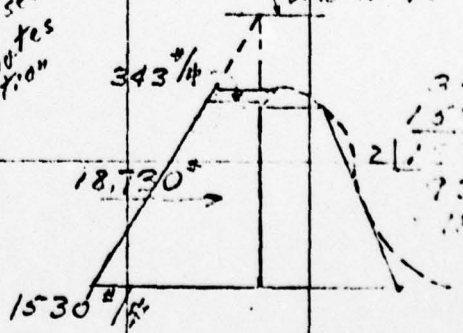
K = 164

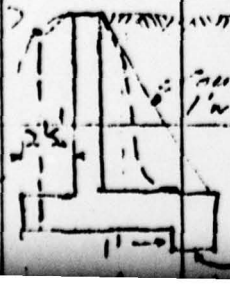
Vc = 50

V = 150

v = 125




Pressure on top ring = 62.4 x 5½ = 343 #/sq. ft.

Pressure on bottom ring = 62.4 x 24½ = 1530 #/sq. ft.

By test ink "Low Dams" p. 175

Top ring - $f = \frac{343 \times 55\frac{1}{2}}{4 \times 144} = 33.8$ #/sq. in.

City of Norfolk, Department of Public Works

Subject Burnt Mills Dam Date 12-4-41 Sheet No.

Spillway Capacity — Prepared by V.T.

Drainage Area taken at 25 Sq. Mi.

We should provide not less than 300 Sq. Ft. per Sq. Mi.

= 7500 Sq. Ft.

Crest of Spillway = El. 35

" " Dam = " 40

Weir Table for 5' depth & 5' approach head gives Q = 41.5 Cu. Ft.

For type K Weir multiply by 1.21 = 50.2 per Lin. Ft.

7500 ÷ 50 = 150' Length of Weir.

Lake Prince with 30.1 Sq. Mi. has 206' Weir.

$206 \times \frac{25}{30} = 172'$ Long

Use 170 Ft.

# APPENDIX V

## SPECIFICATIONS CITY OF NORFOLK
(Partial)

**Engineer** shall mean the person appointed by the City to have engineering charge of the work herein contemplated, or any other engineer whom he may from time to time designate to act in his place or stead, either directly or acting through properly authorized agents, such agents functioning severally within the scope of the particular duties entrusted to them.

**Contractor** shall mean the party of the first part above designated entering into this contract for the performance of the work required by it, and the legal representative of said party, or the agent appointed to act for said party in the performance of the work.

**Reservoir** shall mean the reservoir to be formed by the construction of the dam herein contemplated.
**Dam,** whenever used without qualifications, shall mean the proposed dam contemplated herein.

**Directed, Required, Permitted, Ordered, Designated, Prescribed,** or words of like import, wherever used in the specifications or upon the drawings, shall be understood as the direction, requirement, permission, order, designation or prescription of the Engineer, and similarly the words **Approved, Acceptable, Satisfactory,** or words of like import, shall mean approved by, or acceptable or satisfactory to, the Engineer, subject in each case to the final determination of the City, unless otherwise expressly stated.

## LOCATION AND GENERAL DESCRIPTION

**Location:**

4. The sites of the works contemplated hereunder are indicated on Drawing No. A-0. The dam is located in the valley of Exchange Creek, a tributary of the Western Branch of the Nansemond River, about one mile east of Ellis' Wharf, and about six miles northwesterly from the City of Suffolk, in the County of Nansemond, State of Virginia; the pump house is located just below the dam; and the road diversions are located in or near the area to be flooded by the dam; the exact locations to be more accurately fixed by stakes to be set by the Engineer on the ground.

**General Description:**

5. The works hereunder shall consist of an earth dam, a concrete spillway, an intake tower with outlet pipes under the dam, a pump house, a wharf, county road diversions, and appurtenances. The dam proper shall consist of an earthern embankment, approximately thirty feet in height above the marsh surface in the creek valley. It shall have a top width of fourteen feet and upstream and downstream slopes of one vertical to two and one-half horizontal. It shall have a cut-off wall along the toe of its upstream slope, this cut-off wall being of steel piling with a concrete facing for that portion of the length of the dam overlying the marsh, and being of concrete for the remainder of the length of the dam. The intake tower will be located above the dam on solid ground on the Northeast shore of the stream. From this tower two lines of cast iron pipe shall be laid under the dam to and beyond the pump house. Suction and discharge pipes shall also be laid in pump house, with discharge pipe connections extending through the wall to the main supply line. The pump house shall be located below the dam on solid ground on the northeast shore of stream. The wharf will be on the same shore, just below pump house. The road diversion work consists of the elevation or diversion of roads across the reservoir site, and the erection of bridges across the water ways on the following roads: "Phillips Road," "Two Bridges Road," "Three Bridges" and "The Ford," all of which roads are County Highways. Also one pile trestle across the reservoir on the Oliver Land Tract.

## ELEVATIONS

6. All elevations shown on the plans or mentioned in these specifications are elevations in feet or decimals thereof above or below approximate mean high water, the reference bench mark for which shall be furnished by the Engineer on the ground.

## TEST BORINGS

7. 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 at-

tached hereto, the approximate thickness of the mud and sand being also indicated on Section at Station 14, and on the cross section of the temporary channel on the same drawing.

8. 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 omissions in said information.

## ITEMS TO BE FURNISHED BY THE CITY

9. The City shall permit the Contractor to use, for the purposes of his work hereunder, such lands and rights-of-way as the Engineer may deem necessary for said purposes. The City shall deliver to the Contractor without charge on the wharf to be built by the Contractor hereunder, all of the following materials, which are to form part of the completed work:

Cast Iron Hub and Spigot Pipe with special castings for same

Cast Iron Flanged pipe and fittings

Manhole Frames and Covers

Gate Valves with Extension Stems and Post Indicator Floor Stands

Check Valves

Sluice Gates with Frames, Extension Stems and Bevel Gear Floor Stands

Lead, Yarn, Bolts, Clamps, Nuts and Gaskets for the above Piping

The City shall also deliver, as above, the two 36-inch blind flanges for temporary use in testing pipe lines.

10. The Contractor shall be responsible for all of said materials after they shall have once been delivered as above speci-

fied, and up to the time when they shall have been finally accepted as part of the completed work, and he shall make good any loss or damage in said materials no matter whether said loss or damage occurs as the result of acts or negligence on the part of himself or his agents or in any other manner.

11. He shall carefully inspect all of said materials as soon as they are delivered to him, and shall test all gate valves and sluice gates to see whether they are in good working order and are watertight when closed; and he shall promptly report to the Engineer any defects that he may discover, and the City shall make good such defects so reported. If any defect in any part of said material is thereafter discovered, before the final acceptance of the work contemplated under this contract, and such defect shall not have been so reported by him at the time of the above inspection and tests, it will be considered that said part of said material was not defective when delivered to the Contractor, and he shall be held responsible for said defect, and shall correct the same, and shall make good any loss or damage occasioned thereby.

## MATERIALS

12. All materials of every description furnished or built into the work by the Contractor shall be first class in every particular and in full accordance with the following specifications.

**Gravel or Broken Stone:**

13. Coarse aggregate for concrete shall be either crushed stone or gravel. The Contractor shall furnish samples of the stone or gravel he proposes to use, a sufficient time in advance of its use to enable the Engineer to make the necessary tests and analyses, and all such stone or gravel must be approved, both as regards its quality and the proportion which it shall bear to the other ingredients of the concrete mixture.

14. The aggregate shall be clean, hard, durable, and free from all matter which might impair the strength of the concrete in which it is to be used. Aggregate containing soft, flat or elongated particles will not be approved.

15. The stone or gravel to be used in the concrete shall contain no piece of stone or gravel larger than will pass through a screen of one-inch mesh, nor smaller than will be retained on a screen having one-quarter-inch mesh, except that in the con-

crete of the cut-off wall, and in the concrete in the walls in front of the steel sheet piling, stone or gravel may be used not larger than will pass through a screen of two-inch mesh, nor smaller than will be retained on a screen of one-quarter-inch mesh.

**Sand:**

16. Sand shall consist of hard, durable grains and shall be free from soft, decayed or friable material. It shall not contain more than 2% by weight of finely divided clay, loam, or other suspended matter when tested by washing in such a manner as to remove all such material without removing any of the fine sand. The grains shall have rough unpolished surfaces and shall be well graded in size from the finest to the coarsest. Not more than 8% by weight, including the suspended matter, shall pass the No. 100 sieve, and not more than 60% the No. 16 sieve. The voids in the dry sand when well shaken shall not exceed 40% of the total volume of the sand. Contractor shall furnish samples of the sand which he proposes to use a sufficient time in advance of its use to enable the Engineer to make the necessary test and analyses, and all such sand must be approved before it is used in the work.

**Cement:**

17. The cement used throughout the work shall be American Portland Cement, well seasoned, dry and free from lumps, and of a brand that has established itself for three years or more, and that has been used with satisfaction for that length of time, under climatic and other conditions similar to those to which the work herein contemplated will be subjected.

18. Cement shall conform in all respects to the Specifications for Portland Cement adopted by the American Society for Testing Materials in 1918, as approved by the American Society of Civil Engineers up to date.

19. The Contractor shall provide suitable watertight sheds for the storage of the cement and shall give the Engineer facilities for taking samples. All cement shall be subject to rejection at any time that it is found to be defective.

**Steel:**

20. The steel bars used to reinforce the concrete are shown on the plans as round bars; they may be either plain or deformed round bars; or square bars, provided that in case of the use of

square bars no reduction be made in effective area, and provided that the change be first approved by the Engineer. The minimum distance between bars and surface of concrete shall be one (1) inch. All bars shall conform in every respect to the Standard Specifications for either Billet-Steel of Rail-Steel Concrete Reinforcement Bars adopted August 25, 1913, and revised in 1914, by the American Society for Testing Materials.

21. Steel shall not be painted, but shall be thoroughly cleansed of dirt, grease or scale before being embedded in the concrete.

22. To reduce the number of laps, the length of the bars shall be as great as may be economically practicable. No welded steel will be permitted.

## WORKMANSHIP

23. All workmanship of every description supplied under this contract shall be first class in every respect and in full accordance with the following specifications.

## EXCAVATION

**Excavation below Elevation 0:**

24. Before depositing in place any material which will ultimately form a permanent 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 strata without disturbing said stratum. The prism of mud thus excavated shall extend from shore to shore and shall expose the top of the sand stratum for a width of about 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 mud after the base of the prism has been excavated to its full width and depth.

25. The average dimensions of this prism near the center of the dam are indicated approximately on the Section at Station 14 on Drawing No. A-1, but the City reserves the right to alter its dimensions in such manner as the Engineer may see fit, provided always that such alterations shall not affect the total yardage involved in the excavation, by more than thirty per cent.

26. The Contractor will 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 at sufficient height by raising them from time to time as the mud is deposited behind them. These dykes shall be located approximately as shown on Drawing No. A-1, so as to enclose an area above the dam and another area below the dam, and the Contractor shall deposit the mud as it is excavated on these two areas as directed.

**Excavation above Elevation 0:**

27. The surface of all excavation shall be cleared of all trees including stumps, or brush, and, wherever directed, the top soil shall be stripped to any approved depth not exceeding one foot; and the entire surface of the area to be covered by embankment, with the exception of the flat marsh area, shall be cleared of all trees, stumps, or brush, and a layer of soil to a depth of 6 inches shall be stripped therefrom. The trees, brush, and soil removed as above specified shall be deposited wherever directed, provided that the straight line distance from point of removal to point of deposit shall not exceed 300 feet. The volume of the earth material so removed shall, for purposes of payment, be classed as Excavation above Elevation 0.

28. The material excavated for the embankment and for the refilling beneath the same to replace the excavated mud, and for refilling the temporary channel to be hereinafter described, shall be taken from such places as the Engineer may direct, but not more than four hundred feet in a straight line from the nearest point of the embankment or channel, respectively.

29. The material for the fill under the embankment and the larger part of the material for all parts of the embankment above Elevation 0 and east of Station 12 shall be taken from borrow pits east of the stream, the remaining material for the embankment and the material for refilling the temporary channel shall be taken from points west of the stream.

30. The excavation for the intake tower, pump house, and pipe line, shall be such as will permit the installation of these structures in the best, safest and most expeditious manner, and the material so excavated shall be deposited wherever directed but not more than 100 feet in a straight line from the nearest

point of the structure for the installation of which the material was excavated.

31. The material excavated to permit the construction of the cutoff wall shall be deposited where directed, but said material need not be deposited more than 20 feet in a straight line from said wall. The material excavated to permit the construction of the spillway shall be deposited where directed, but not more than 250 feet in a straight line from the nearest part of the spillway.

32. In all cases the material specified as above in Articles 27 to 31, inclusive, shall be taken from points involving the least haul which shall, in the judgment of the Engineer, be consistent with the selection of proper material or with the safe and proper execution of the work in other respects.

## EMBANKMENT

33. No material shall be placed in the embankment, or in the re-fill under the same, or in the re-fill of the temporary channel, unless it shall have been first approved.

34. Unless otherwise directed, the soil containing the largest proportion of sand will be selected for the re-fill below Elevation 0, the remainder of the embankment being constructed of soils having less sand and more clay in their makeup. No soil having an objectionable amount of roots or other vegetable matter shall be used for any permanent part of the embankment or re-fills.

35. After the re-fill under the embankment shall have been placed to the satisfaction of the Engineer, 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.

36. The placing of earth in the embankment shall be done in such manner as will provide at all times the maximum drainage consistent with the foregoing specifications, 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.

37. Unless the earth is sufficiently moist when spread, each layer should be wet so as to facilitate the desired compact-

ing, and if required at any time the top of the embankment shall be wet just before a layer of earth is spread. The wetting shall be done in a manner which will avoid the formation of pools of water, and will secure the uniform moistening of all portions of the embankment.

38. Compacting shall be accomplished with approved rollers having grooved, banded or lugged rolls. The rear wheel or wheels of the roller shall be of such width and diameter and shall bear such a proportion of the total weight of the roller that it shall cause a calculated average pressure on the bank of at least 30 pounds per square inch over its entire bearing surface. The bearing surface considered shall be the width of the roller multiplied by one-half the arc bounding a segment of the average outside circumference of the roll, having a middle ordinate of one inch. The roller shall pass over every part of each layer that can be compacted by the roller as many times as may be necessary to compact it thoroughly unless it is satisfactorily compacted by the transportation of materials or by other means.

39. In order to allow for shrinkage, the Contractor shall build the embankment to such elevation as may be directed but not more than 2 feet above Elevation 30 at any point.

40. When the embankment has been so built, the Contractor shall then finish its top and slopes to smooth plane surfaces, the upstream slope being trimmed to prepare it to receive the reinforced concrete facing to be placed thereon as shown by the plans.

## STREAM CONTROL

41. It is the intention to complete as much as possible of the work herein contemplated before the months of high normal rainfall, but it is expressly stipulated and agreed that the Contractor shall take all the responsibility for the control of the normal and flood flows from the watershed tributary to the reservoir, along the lines laid down in these specifications, or in accordance with plans submitted by himself and approved, and that he shall indemnify and save harmless the City, its officers and agents, from all damages and costs which may result from failure to provide for said flows. He shall not be entitled to a second payment for work destroyed or damaged by floods and replaced, nor to any damages due to floods passing through or over the partially completed work or construction plant.

# APPENDIX VI

# REFERENCES

## LIST OF REFERENCES


1. Recommended Guidelines for Safety Inspection of Dams, Department of the Army, Office of the Chief of Engineers, Washington, D.C., 20314.

2. HEC-1 Flood Hydrograph Package, Hydrologic Engineering Center, U S Army Corps of Engineers, Davis, California, 1973.

3. U S Weather Bureau and U S Army Corps of Engineers, "Seasonal Variations of Probable Maximum Precipitation East of the 105th Median 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.