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NATIONAL DAM SAFETY PROGRAM. UPPER RAGGED MOUNTAIN NUMBER 1, IN--ETC(U)
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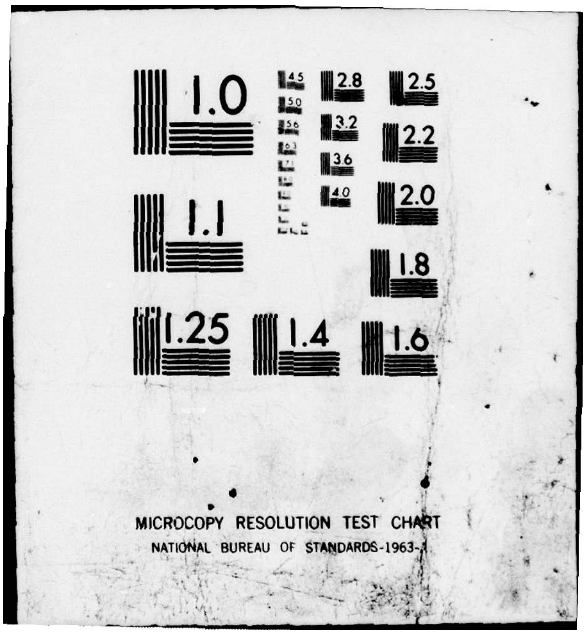
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Upper Ragged Mountain Number 1, Inventory Number: VA-00356. James River Basin. Albermarle County, State of Virginia. Phase I Inspection Report.

Michael Baker, III

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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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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 aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CONTENTS

NAME OF DAM: UPPER RAGGED MOUNTAIN NO. 1

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Upper Ragged Mountain No. 1
State: Virginia
County: Albemarle
Stream: Moores Creek
Date of Inspection: 16 November 1978

BRIEF ASSESSMENT OF DAM

Upper Ragged Mountain Dam No. 1, an earthfill dam with a stone core wall, is approximately 47 feet high and 470 feet long. The dam is located about 0.4 mile upstream of a lower dam. Visual inspection and analyses indicate deficiencies requiring immediate attention.

Using the Corps of Engineers screening criteria for initial review of spillway adequacy, it has been determined that the dam would be overtopped for all floods exceeding approximately 10 percent of the Probable Maximum Flood. The spillway is therefore adjudged as seriously inadequate. A portion of the core wall is exposed on the downstream right embankment due either to past sliding of the embankment or overtopping of the dam. Since the spillway capacity is unusually small, the consequences of dam overtopping and failure could cause a catastrophic event and possible overtopping or failure of the lower dam immediately downstream. The dam is classified as unsafe, emergency. The owner was instructed to lower the upper pool.

The following items should be completed before the dam is returned to service:

1) Further investigation of spillway adequacy including the possibility of enlarging the spillway.

2) Stability analyses of the embankments including soil testing, piezometers and observation wells, and a detailed assessment of the steepness of the submerged downstream slope especially under rapid drawdown conditions and the lower reservoir.

3) The effects of a sudden drawdown condition on the lower reservoir.

4) Investigation of alternate means to empty the reservoir under emergency conditions.

5) Better vehicle access to the dam.

6) A flood warning system for downstream residents.

MICHAEL BAKER, JR., INC.

Michael Baker, III, P.E.
Chairman of the Board and
Chief Executive Officer

COMMONWEALTH OF VIRGINIA
MICHAEL
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CERTIFIED PROFESSIONAL ENGINEER

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Date: APR 3 1979

NAME OF DAM: UPPER RAGGED MOUNTAIN NO. 1

OVERALL VIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: UPPER RAGGED MOUNTAIN NO. 1 ID# VA 00356

SECTION 1 - PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

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

1.2 Description of Project

1.2.1 Description of Dam and Appurtenances: Upper Ragged Mountain Dam No. 1 is an earthen structure about 470 feet long and 47 feet high. The top of dam is 12 feet wide and has a minimum elevation of 659.9 feet* above Mean Sea Level (M.S.L.). Side slopes of the dam, extending from a stone core wall about 4 feet wide, are approximately three horizontal to one vertical (3:1) on the upstream side and 2.5:1 on the downstream side.

The open channel spillway (see Photo 2) has stone lined walls and bottom, and is located on the right abutment area. The spillway is approximately 9 feet wide at the bottom with near vertical side walls. It has a level section about 30 feet long, elevation 657.0 feet M.S.L., with an approach channel slope of 12.5% and a discharge channel with a slope averaging nearly 20%. The exit channel is cut in soil and soft rock, and curves to the left as it exits into a lower reservoir immediately downstream of the dam. Total length of the spillway is approximately 160 feet.

*All elevations are based on assumed normal pool elevation of 657.0 feet M.S.L. as shown on the U.S.G.S. 7.5 minute topographic quadrangle, Charlottesville West, Virginia.

The gate house is located in the reservoir 120 feet from the crest of the embankment at about the midpoint of the dam (see Photo 1). The gate house, which is constructed of stone to the maximum water level and wood frame above water level, has two water chambers with five valves on the downstream chamber and 10 valves on the upstream chamber. Access to the gate house is by a steel bridge with a wooded timber walkway that begins at the top of the dam.

1.2.2 Location: Upper Ragged Mountain Dam No. 1 is located approximately two miles west of the City of Charlottesville, Virginia. Upper Ragged Mountain Dam No. 1 is located immediately upstream of a lower reservoir. The pool level from the lower reservoir is the tail-water for Upper Ragged Mountain Dam No. 1. The lower reservoir submerges about 27 feet of the 47 foot total height of Upper Ragged Mountain Dam No. 1.

1.2.3 Size Classification: The maximum height of Upper Ragged Mountain Dam No. 1 is 47 feet. The reservoir volume to the top of dam is 757 acre-feet. Therefore, the dam is in the "intermediate" size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

1.2.4 Hazard Classification: A summer camp, for handicapped children, is located approximately 0.8 mile downstream of the upper dam and only 0.4 mile downstream of the lower dam. Lives could be lost if failure were to occur at a time when this camp was inhabited. Several homes, located further downstream in the City of Charlottesville, may also be affected in the event of a failure. Also, the failure of Upper Ragged Mountain Dam No. 1 could cause overtopping or possible failure of the lower dam downstream thereby increasing the hazard. It is for these reasons that Upper Ragged Mountain Dam No. 1 is classified in the "high" hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: The dam is owned by the Rivanna Water and Sewer Authority, Charlottesville, Virginia.

1.2.6 Purpose of Dam: The dam is used for water supply by the City of Charlottesville, Virginia.

1.2.7 Design and Construction History: No design or construction history was available except a general report on the development of the Charlottesville water system (see Appendix V). According to this report, the dam was designed in 1884 by Mr. E. W. Dowditch and constructed in 1885.

1.2.8 Normal Operating Procedures: According to the owner, the valves in the gate house are no longer operated due to their age and condition. A 10 inch diameter water pipe (broken and no longer in service) from the gate house passes through the dam and is routed in the vicinity of the original streambed (submerged by the lower reservoir impoundment) to the lower dam. The owner has indicated that he believes the water from Upper Ragged Mountain Reservoir No. 1 primarily outlets from flow through the broken 10 inch diameter pipe. The water impounded by Upper Ragged Mountain Dam No. 1 does not flow over the spillway during normal runoff periods. Overflow from the supply line from Sugar Hollow Reservoir is diverted by pipe into Upper Ragged Mountain Reservoir about 500 feet northwest of the left abutment.

1.3 Pertinent Data

1.3.1 Drainage Area: The drainage area of Upper Ragged Mountain Dam No. 1 is approximately 1.28 square miles including 0.84 square mile upstream of the Interstate Route 64 culvert.

1.3.2 Discharge at Dam Site: The maximum flow through the spillway at the dam site is not known.

Open-Channel Spillway:
Pool level at top of dam . . . . 140 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.(a)	Area acres	Reservoir Capacity Acre-feet	Reservoir Capacity Watershed inches(b)	Length feet
Top of dam	659.9	35	757	11.1	3500
Open channel spillway crest	657.0	32	660	9.7	3200
Streambed at centerline of dam (c)	613±	-	-	-	-

(a) All elevations are based on an assumed normal pool elevation of 657.0 feet M.S.L. as shown on the U.S.G.S. 7.5 minute topographic quadrangle, Charlottesville West, Virginia.
(b) Based on 1.28 square miles of watershed.
(c) Estimated from soundings.

SECTION 2 - ENGINEERING DATA

2.1 Design: There were no design drawings or calculations available for review. Data contained in this report was obtained during the visual inspection of 16 November 1978, and hydrologic and hydraulic calculations were computed as part of this report. A report entitled "Engineering in the Development of a Municipal Water Supply, Charlottsville, Virginia" was obtained from the water authority and is included as Appendix V.

2.2 Construction: Upper Ragged Mountain Dam No. 1 was constructed in 1885. The contractor is not known.

2.3 Operation: Operation and maintenance of Upper Ragged Mountain Dam No. 1 is the responsibility of the Rivanna Water and Sewer Authority, Charlottesville, Virginia for water supply to the City of Charlottesville. It is believed that water normally leaves the upper reservoir through a broken 10 inch water pipe (see paragraph 1.2.8). The water is drawn from the lower reservoir through water supply pipes to the City. No records of operation are available.

2.4 Evaluation

2.4.1 Design: There were no design or as-built drawings available to adequately assess the structural stability of the dam.

2.4.2 Construction: No as-built construction plans, material tests, or boring logs were available to adequately assess the condition of the dam. The assessment made in this report was based solely on the visual inspection of 16 November 1978.

2.4.3 Operation: The information available regarding the operation of the water supply system was provided by Mr. E. K. Potter of the Rivanna Water and Sewer Authority.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

3.1.1 General: The dam and its appurtenant structures were found to be in poor overall condition at the time of inspection. Pool elevations at the time of inspection were 653.9 feet M.S.L. and 637.0 feet M.S.L. for the upper and lower pools, respectively. Some of the problems noted should receive immediate remedial treatment. Others can be corrected as part of the maintenance program. Noteworthy deficiencies observed are described briefly in the following paragraphs. The complete visual inspection check list is given in Appendix III.

3.1.2 Dam: The embankment was in poor condition with several deficiencies that require attention. Sounding of the submerged portion of the downstream slope at the only location measured (see Plate 2) indicated a very steep condition (1H:2V). There is clear seepage (3 to 4 g.p.m.) on the downstream slope at the right abutment causing erosion and sloughing in a 20 by 30 foot area. Minor seepage occurs on the shore at the left abutment. A 50 to 100 foot fill separation occurs along the downstream face of the stone core wall near the right embankment. The separation, which formed an irregular "trench" approximately 4 feet deep and 3 feet wide, is caused by either slumping and/or erosion near a low point in the dam crest profile. Most of the dam is covered by thick vegetation. Several animal burrows were observed on the dam. Evidence of beaver activity was observed at the dam and along the edges of the reservoir. Wood debris is scattered on both upstream and downstream shorelines.

3.1.3 Open Channel Spillway: The stone masonry lined approach channel is in good condition. Some debris (branches and small logs) were piled along the spillway banks after removal from the channel by water authority personnel. This debris is a result of the beaver activity. The discharge channel is deeply incised in soil to weathered quartz monzonite. The discharge channel is uneven, and there are accumulations of wood debris and boulders in the lower portions. The cut slopes are steep and partially eroded. There is undercutting of the roots of two large trees.

3.1.4 Appurtenant Structures: The stone masonry walls of the intake tower and wooden frame gate house are in reasonably good condition considering their age. The emergency valves in the gate house were not checked. The lower reservoir on the downstream side covers the outlet structure thus preventing observations. The wooden timber span over the open channel spillway is rotten and in poor condition.

3.1.5 Reservoir Area: The reservoir area had no serious shoreline or gully erosion, but there are some fallen trees and scattered debris.

3.2 Evaluation

3.2.1 Dam: The physical condition of the embankment was poor with several significant deficiencies which require immediate correction. The separation of the embankment from the stone core wall on the right side should be further investigated with test borings and piezometers. This condition could be especially hazardous if overtopping were to occur. It is recommended that the excessive growth of vegetation on the slopes be cut to provide visibility and access. The animal burrows should be excavated and filled with compacted fill. The owner should consider some means of removing the beavers to prevent them from obstructing the spillway with debris. The wood debris on the upstream and downstream shorelines should be removed.

3.2.2 Open-Channel Spillway: The discharge channel needs some remedial attention to prevent serious erosion and future blockage. The steep slopes should be cut at a flatter ratio and seeded to provide greater stability and to prevent erosion. The undercut trees on the slopes should be removed. Dumped stone should be placed in the uneven portion of the channel to provide a uniform bottom. The wood debris should be removed. Stone riprap should be placed in the curved channel to prevent further erosion.

3.2.3 <u>Appurtenant Structures</u>: Periodic maintenance should be continued on the intake tower and gate house to prevent further deterioration. The wooden span over the emergency spillway should be repaired or removed.

3.2.4 <u>Reservoir Area</u>: The reservoir area is in good condition, but the fallen trees and large debris should be removed from the shoreline. A staff gage should be installed to monitor reservoir levels above normal pool.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: Operational procedures are generally discussed in paragraphs 1.2.8 and 2.3. The normal reservoir elevation of 657.0 feet M.S.L. is maintained by the open-channel spillway crest. Water supply to the lower reservoir is believed to outlet through the broken 10 inch water pipe.

4.2 Maintenance of Dam: Maintenance of the dam is provided by personnel from the Rivanna Water and Sewer Authority.

4.3 Maintenance of Operating Facilities: Valves in the gate house are old and no longer used for water supply.

4.4 Warning System: At the present time, there is no warning system or evacuation plan in operation. In addition to the resident caretaker who lives near the dam at the lower reservoir, Upper Ragged Mountain Dam No. 1 is visited by maintenance personnel from the Rivanna Water and Sewer Authority. These personnel should be instructed to watch for distressed conditions.

It is recommended that a formal emergency procedure be prepared and prominently displayed, and furnished to all operating personnel. This should include:

1) How to operate the dam during an emergency.

2) Who to notify, including public officials, in case evacuation from the downstream area is necessary.

3) Procedures for evaluating inflow during periods of emergency operations.

4.5 Evaluation: Observation of the dam during periods of high runoff is hindered by its inaccessibility. Access to the dam is either by boat from the lower dam (approximately 0.4 mile) or by foot around the southern edge of the lower reservoir (approximately 0.5 mile).

An annual maintenance and inspection program should be implemented with minor yearly maintenance scheduled at these times.

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: No design data (other than a storage capacity curve provided by the Rivanna Water and Sewer Authority) was available for this report.

5.2 Hydrologic Records: No hydrologic records were available.

5.3 Flood Experience: No flood experience records or high water marks were available.

5.4 Flood Potential: Performance of the reservoir by routing the Probable Maximum Flood (PMF), the 1/2 PMF, and the 100-year flood is shown in Table 5.1.

All data, except the previously mentioned storage capacity curve, were determined from measurements and data recorded during the field inspection. Outlet discharge capacity; reservoir area and storage capacity above normal pool; and hydrograph peak inflow, outflow, and maximum stage were computed as part of this report.

The total drainage area of Upper Ragged Mountain Dam No. 1 is 1.28 square miles of which 0.84 square mile is upstream of the Interstate Route 64 culvert. The floods were routed through this culvert and combined with the remaining 0.44 square mile of watershed to produce the inflow hydrograph for the dam. The floods were then routed through the reservoir and pertinent information is shown in Table 5.1. All flood routings for the reservoir begin with the water level at normal pool (elevation 657.0 feet M.S.L.).

5.5 Reservoir Regulation: Pertinent dam and reservoir data are shown in Table 1.1, paragraph 1.3.3.

Flow from the reservoir under normal conditions is believed to outlet through a broken 10 inch water pipe. During periods of excessive runoff, water will begin flowing through an open channel spillway in the right abutment when the reservoir level rises above the spillway crest elevation of 657.0 feet M.S.L.

The spillway is approximately 9 feet wide at its base and 10 feet wide at the top. If the spillway is not sufficient to carry the runoff, the reservoir level would continue to rise until water would begin flowing over the minimum top of dam elevation of 659.9 M.S.L. feet, about 100 feet to the left of the spillway.

5.6 Overtopping Potential: The probable rise in reservoir and other pertinent information on reservoir performance for the various hydrographs are shown in the following table:

TABLE 5.1 RESERVOIR PERFORMANCE

Item	Normal	Hydrographs: 100 Year	Hydrographs: 1/2 PMF	Hydrographs: PMF
Peak flow, c.f.s.				
Inflow	-	1852	2573	4652
Outflow	-	275	1651	3425
Peak elev., ft. M.S.L.(a)	657.0	660.7	661.8	662.5
Open-channel spillway (elev. 657.0 feet M.S.L.)				
Depth of flow, ft.	-	2.4	3.1	3.6
Avg. velocity, f.p.s.	-	8.6	9.9	10.6
Non-overflow section (elev. 659.9 ft. M.S.L.)				
Depth of flow, ft.(b)	-	0.8/0.5	1.9/1.1	2.6/1.8
Duration of overtopping, hrs.	-	2.5	6.7	8.8
Average velocity, f.p.s.	-	1.0	2.6	3.6
Tailwater elev., ft. M.S.L.(c)	637	-	-	-

(a) All elevations are based on an assumed pool elevation of 657.0 feet M.S.L. as shown on the U.S.G.S. 7.5 minute topographic quadrangle, Charlottesville West, Virginia.
(b) Maximum depth/average depth.
(c) Tailwater is pool level of lower reservoir.

5.7 Reservoir Emptying Potential: At the present time, the reservoir can be emptied in a controlled manner by opening one of the valves in the gate house.

5.8 Evaluation: Upper Ragged Mountain Dam No. 1, classified as an "intermediate" size-"high" hazard dam, must pass a spillway design flood essentially equal to the PMF. The PMF was routed through the dam and reservoir as described in paragraph 5.4 and determined to overtop the dam embankment by 2.6 feet. The 1/2 PMF was then routed and also determined to overtop the dam by 1.9 feet. The discharge capacity is sufficient to pass only about 10 percent of the PMF.

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

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: No information describing the foundation of the dam is available. At the time of construction 93 years ago in 1885, the requirements were less demanding. The bedrock foundation is apparently hard quartz monzonite with quartz veins and some quartzite of Precambrian Lovingston Formation with a steep dip based on the observed exposures and the rock core samples found on the upstream slope. The soil is probably silty sand with rock fragments as observed in the abutment areas. The soil strata appears to be thicker on the left side than on the right side where there is more bedrock exposed on the ridge.

Apparently the stone core wall of the dam extends for its entire depth of 47 feet based on a report of the local water supply system.

6.2 Stability Analysis

6.2.1 Visual Observations: The steep slope (1H:2V), which was measured by soundings only at one location at the downstream toe of the embankment, represents an undesirable condition. There is clear seepage (3 to 4 g.p.m.) on the downstream slope at the right abutment where erosion and sloughing have occurred. Minor seepage also occurs on the shore at the left abutment. Either slumping and/or erosion has exposed a portion of the stone core wall on the right side at the crest. The profile run of elevations along the crest of the dam (see Plate 3) shows a low area in the vicinity of the slump. Thick vegetation on the slopes of the dam hindered a thorough inspection of the surface conditions (see Photos 3, 4, and 5).

6.2.2 Design Data: No stability analyses were available.

6.2.3 Operating Records: Inspection reports were not available.

6.2.4 Post-Construction Changes: Apparently there have not been significant alterations to the dam since it was constructed.

6.2.5 Seismic Stability: Upper Ragged Mountain No. 1 Dam is in Seismic Zone 2 and is considered to have no hazard from earthquakes according to the Recommended Guidelines for Safety Inspection of Dams, provided static stability conditions are satisfactory and conventional safety margins exist.

6.3 Evaluation: Since stability analyses were not available, a detailed stability assessment cannot be made. The clear seepage on the right side is in line with the low point of the dam (see Plate 3) where the earth has slumped or eroded from the downstream face of the stone core wall. The deficient conditions in this area may be related to an old slide. It is recommended that further field inspection be done in the right abutment area after the thick vegetation has been removed so that detailed remedial measures can be planned. It is suggested that test borings be drilled in the suspected slide area and piezometers be installed. The record of the boring or borings that had been drilled in the dam and any related data should be obtained if possible. A slope stability analysis should be performed on those sections of the embankment with the very steep toe using test results from the boring samples.

Further investigation of embankment stability may be affected by other possible remedial measures such as spillway enlargement or deliberate embankment breaching.

Until further investigations can be conducted and remedial measures recommended and completed, the seepage areas should be monitored to watch for unstable conditions, especially when the reservoir is at higher pool levels.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: Several conditions discovered during the field investigation and office analysis, indicate deficiencies requiring immediate attention. The most urgent of these items is the inability of the open channel spillway to pass the 1/2 PMF. Using the Corps of Engineers screening criteria for initial review of spillway adequacy, it has been determined that the dam would be overtopped by all floods exceeding approximately 10 percent of the PMF. The spillway is therefore adjudged as seriously inadequate. Since the spillway capacity is unusually small, and the consequences of a dam overtopping and failure could cause a catastrophic event; the dam is classified as unsafe, emergency.

The right abutment of the dam is a critical area. Clear seepage was discovered during the field inspection at the junction of the embankment and right abutment. This clear seepage is accompanied by some minor sloughing of the soil in this area. Also in this area, and located about 50 to 100 feet from the spillway is an exposed section of the stone core wall at the top of the dam on the downstream embankment. This exposed core wall may have been the result of one or both of the following conditions:

1) The embankment on the downstream side of the dam slid away from the core wall. (This is a likely possibility since the lower portion of the embankment is submerged by the lower reservoir. Also the clear seepage and sloughing at the right abutment indicate an unstable condition in the area near the exposed core wall and could possibly be related.)

2) Due to the unusually small size of the spillway, the embankment could have been overtopped at one time. Soil on the downstream side as well as on top of the core wall may have eroded away. The top of dam in this area is approximately 1 foot lower than the rest of the dam (see Plate 3). An erosion gully in this area extends down the embankment to a soil pile, which probably resulted from the transportation of eroded soil.

Whatever may be the case, the condition is not recent. There are no signs of recent erosion or sliding, and the area is heavily covered with brush and vines. Both the upstream and downstream faces of the dam are heavily vegetated which made visual inspection difficult and could obscure other possible problems.

The steepness of the submerged toe represents an undesirable condition, especially during periods of lower tailwater.

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 owners should engage the services of a professional consultant to determine by more sophisticated methods and procedures the adequacy of the spillway and the stability of the embankment. Within six months of the date of notification to the Governor, appropriate recommendations by the professional consultant for remedial mitigating measures should have been completed, and the owner should have an agreement with the Commonwealth of Virginia for a reasonable time frame in which all remedial measures will be completed. 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 including frequent measurements of both Upper Ragged Mountain Reservoir No. 1 and the lower reservoir pool elevations. It may be necessary to improve the condition of the jeep trail or build a new road to make the upper dam more accessible.

The inspection revealed certain items of rehabilitation or other work which should be implemented immediately by the owner. These are:

1) Install piezometers or observation wells to determine the elevation of the seepage line through the embankment.

2) Investigate the steepness of the submerged downstream toe for the entire embankment.

The recommendations of the consultant should consider the requirements for increased spillway capacity; raising the top of dam to a uniform elevation; repairs needed to stabilize the embankment at the exposed core wall area, the clear seepage area at the right abutment, and any areas with an excessively steep toe; and suggested alternate methods of emptying the reservoir during emergency conditions. Also, the consultant should consider the effects of a sudden drawdown condition on the stability of the lower reservoir. It is recommended that the owner also consider, because of the magnitude and cost of these repairs, a more realistic alternative (depending on the need of the reservoir storage for water supply) may be to have the consultant investigate breaching the dam. It is strongly recommended that this alternative be given full consideration due to the age of the structure, lack of design and construction information, and the remedial measures previously noted.

The following items can be accomplished as part of the Rivanna Water and Sewer Authority's maintenance program:

1) Cut and clear all brush and vines from the embankments.

2) Excavate, refill, and reseed the rodent holes.

3) Repair the spillway exit channel by filling scour holes and lining undercut banks with riprap.

4) Remove several large undercut trees on the spillway banks to prevent them from falling and blocking the spillway channel.

5) Clear all debris from the normal reservoir level including the lower reservoir on the downstream embankment.

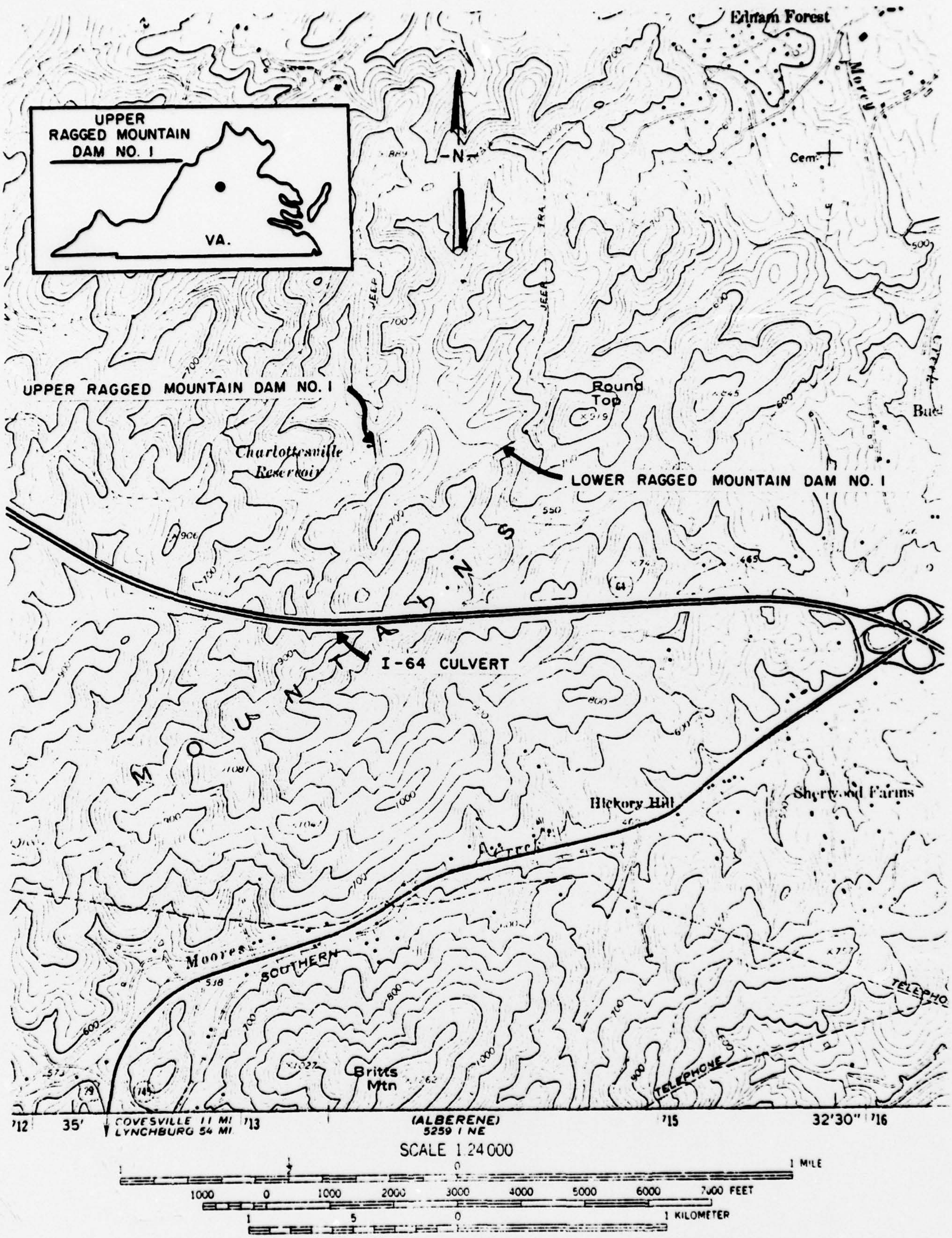
6) Monitor the clear seeps near the abutments.

APPENDIX I

PLATES

CONTENTS

NAME OF DAM: UPPER RAGGED MOUNTAIN NO. 1



<u>LOCATION PLAN</u>

UPPER RAGGED MOUNTAIN DAM NO. 1

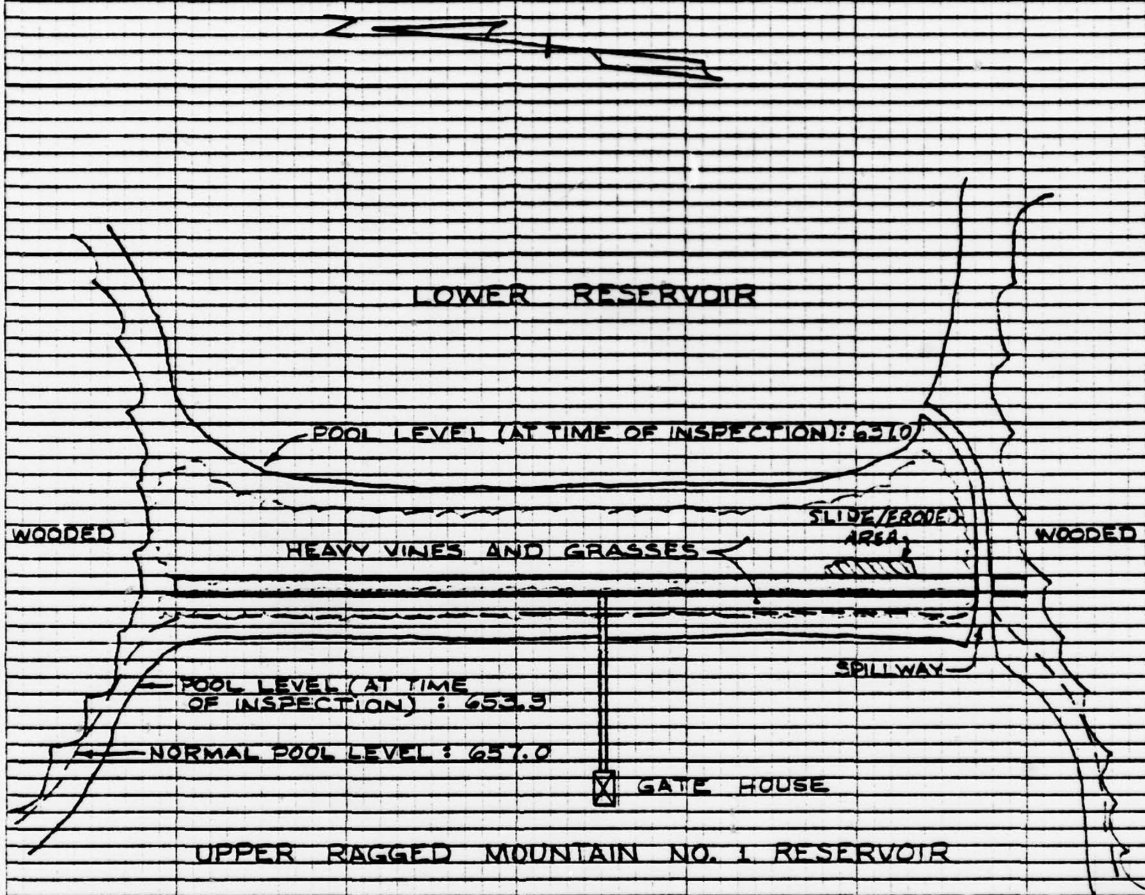


PLATE 1
UPPER RAGGED MTN. DAM NO. 1
PLAN OF DAM
MICHAEL BAKER, JR., INC.
SCALE: 1" = 100'

NOTE: DATA OBTAINED DURING FIELD INSPECTION BY MICHAEL BAKER, JR., INC.

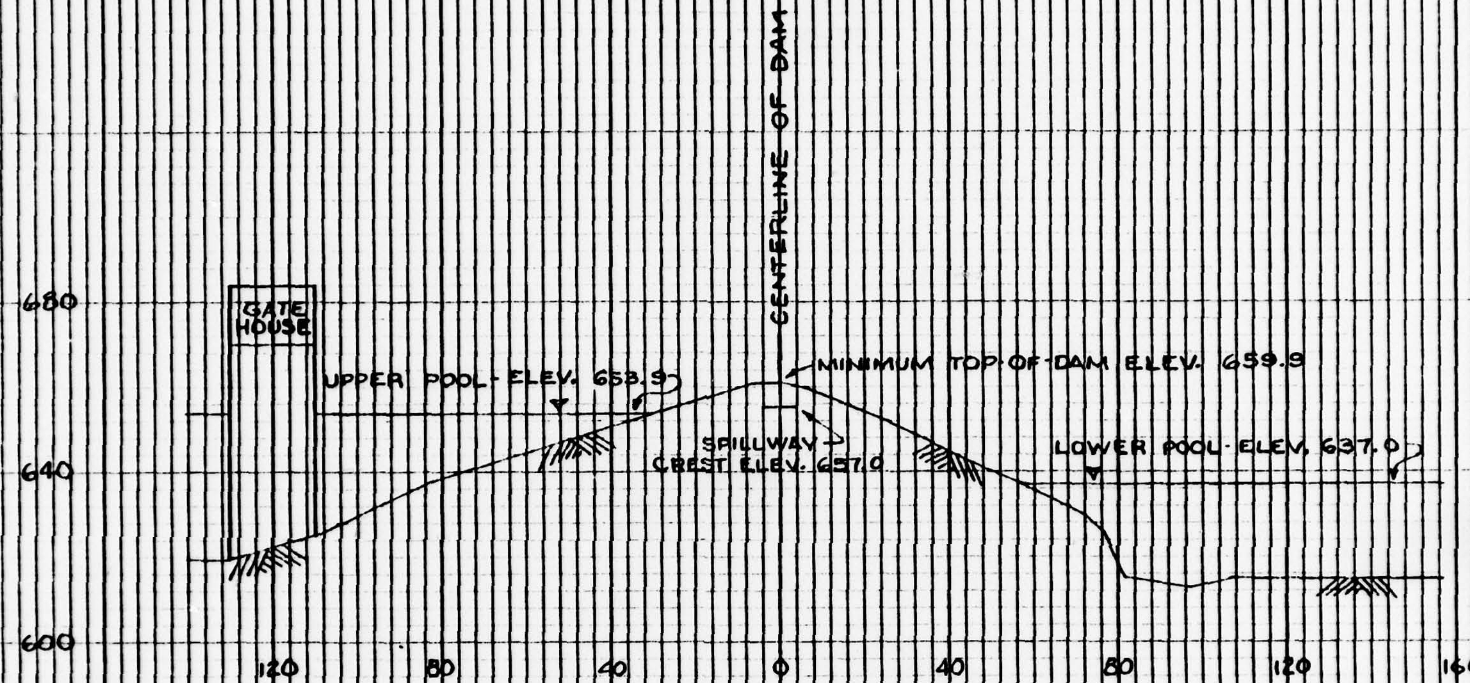
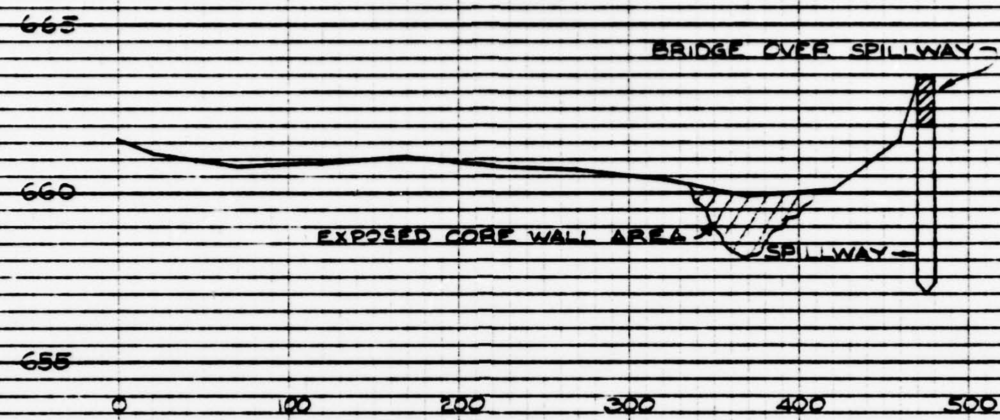


PLATE 2
UPPER RAGGED MTN. DAM NO. 1
SECTION OF DAM AT GATE HOUSE
MICHAEL BAKER, JR., INC.
SCALE: AS SHOWN

NOTE: DATA OBTAINED DURING FIELD INSPECTION BY MICHAEL BAKER, JR., INC.

TOP OF DAM PROFILE



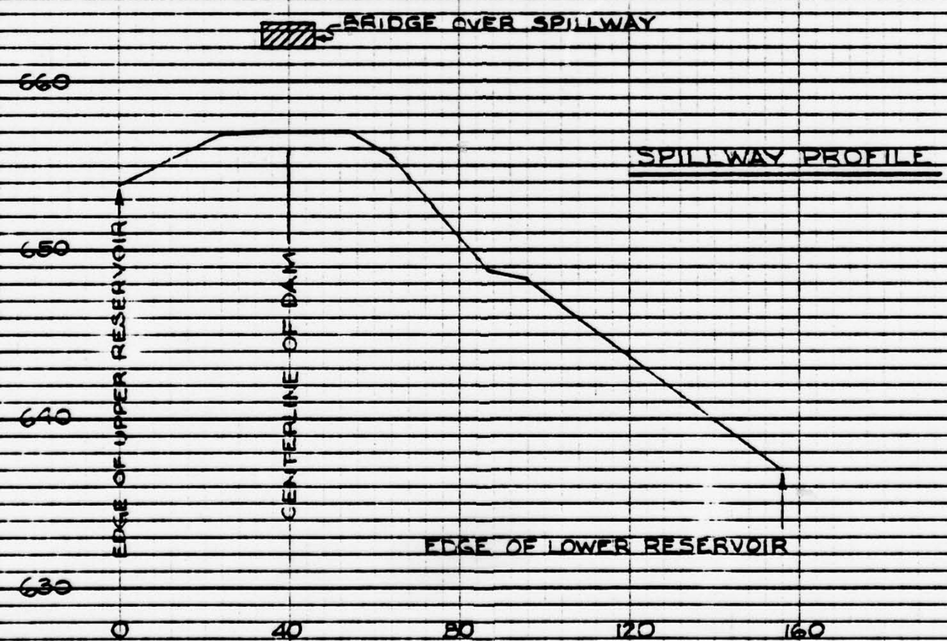


PLATE 3
UPPER RAGGED MTN. DAM NO. 1
MICHAEL BAKER, JR., INC.
SCALE: AS SHOWN

NOTE: DATA OBTAINED DURING FIELD INSPECTION BY MICHAEL BAKER, JR., INC.

APPENDIX II

PHOTOGRAPHS

CONTENTS

Note: Photographs were taken on 16 November 1978.

NAME OF DAM: UPPER RAGGED MOUNTAIN NO. 1

UPPER RAGGED MOUNTAIN DAM No. 1

Photo 1. Outlet Works Downstream Embankment and Edge of Downstream Reservoir

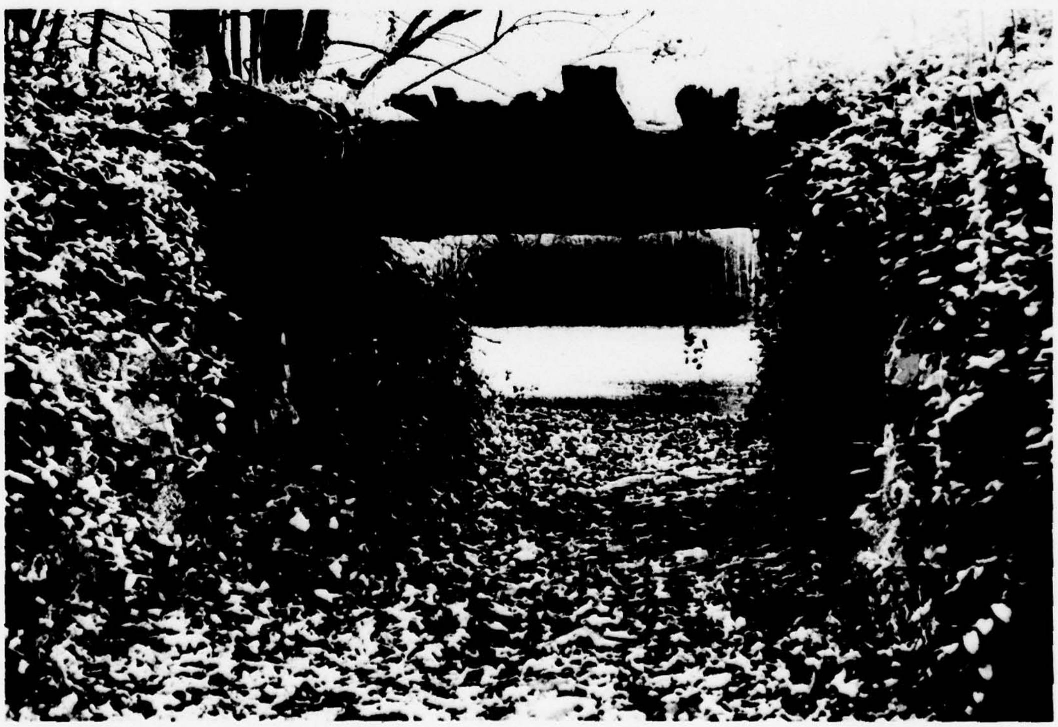


PHOTO 2. Looking Upstream at Spillway in Right Abutment of Dam

UPPER RAGGED MOUNTAIN DAM No. 1

PHOTO 3. Scarp (Four-foot Deep) at Top of Embankment Slide and Exposed Masonry Core Wall

PHOTO 4. Clear Seepage Area at Downstream Right Abutment

UPPER RAGGED MOUNTAIN DAM No. 1

PHOTO 5. Excavated Trench in Clear Seepage Area at Right Abutment (Used to Determine Flow)

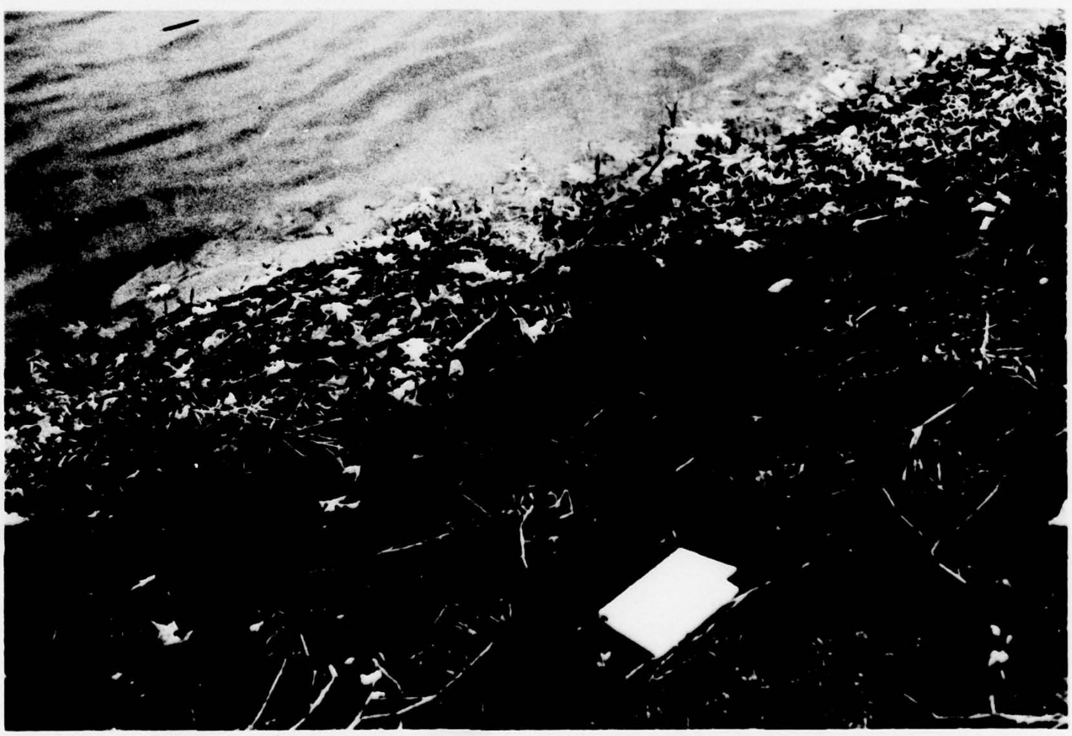


PHOTO 6. Eroded Animal Burrow at Downstream Edge of Reservoir

APPENDIX III

CHECK LIST - VISUAL INSPECTION

Check List
Visual Inspection
Phase 1

Name of Dam Upper Ragged Mountain No. 1 County Albemarle State Virginia Coordinates Lat. 3801.7

Long. 7834.0

Date Inspection 16 November 1978 Weather Overcast, Rainy Temperature 50°F.

Pool Elevation at Time of Inspection 653.9 ft.* M.S.L. Tailwater at Time of Inspection 637.0 ft.* M.S.L.

*All elevations are based on an assumed normal pool elevation of 657.0 feet M.S.L. as shown on the U.S.G.S. 7.5 minute topographic quadrangle, Charlottesville West, Virginia.

Inspection Personnel:

Michael Baker, Jr., Inc.:	Virginia Water Control Board:
T. W. Smith	Jack Hyden
W. L. Sheafer	
T. J. Dougan	

T. W. Smith Recorder

EMBANKMENT

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	The slopes of the dam are covered by thick vegetation (brush and vines) preventing thorough inspection. However, a scarp was observed and is described below.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	The lower part of the downstream slope was below the water level of Lower Ragged Mountain Dam No. 1; consequently, inspection of the toe of Upper Ragged Mountain No. 1 was not possible.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Observations were difficult because of the thick vegetation on the embankments. There is a scarp (approximately 4 ft. deep) adjacent to the stone core wall on the downstream slope and a low area (approximately 100 ft. long) in the crest near the right abutment. Possible causes are either erosion, settlement or slumping.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Some settlement or erosion of the fill over the top and immediately upstream of the stone core wall was observed. However, no unusual horizontal displacement was observed.	
RIPRAP FAILURES	There is no riprap on the embankment slopes.	
STONE MASONRY WALL	A section of the exposed core wall (approximately 4 ft. thick x 50 to 100 ft. long x 6 ft. high) covered by thick vegetation at the dam crest on the downstream side was observed. Reportedly, the dam is faced on the side with dry stone paving up to the maximum water level.	The growth should be removed.

EMBANKMENT

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
OTHER OBSERVATIONS	Several animal burrows (a few feet deep) were observed on the downstream slope on the left side. Wood debris has been deposited on the upstream and downstream shorelines.	The animal burrows should be excavated and filled with compacted backfill. The debris should be removed from the shorelines.
CONSTRUCTION MATERIALS AND FILL SLOPES	The soils observed on the surface slopes of the dam are comprised of clayey silt, sandy silt and silty sand, all with variable amounts of rock fragments. The soils near the upstream and downstream waterlines are wet and soft; elsewhere they are damp to moist. The slopes are covered with thick vegetation. Sounding of the submersed portion of the downstream slope revealed a very steep (1H:2V) condition at one section near the center of the dam.	It is recommended that the vegetation be removed or cut for access and inspection.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The abutment on the right side, adjacent to the open spillway, appears to be in brown, damp, sandy silt with rock fragments. Massive, very hard quartz monzonite with a vertical dip is exposed in a borrow area nearby. Brown, damp, silty sand with small rock fragments was observed in the low ridge at the left abutment. The abutment areas contained clear seepage noted below.	
ANY NOTICEABLE SEEPAGE	There is clear seepage in a 20 x 30 ft. area on the downstream slope at the right abutment near the spillway just above the lower lake level. The clear seepage emanates at 3 to 4 g.p.m. from very soft, saturated, silty sand with organic traces. The slope is eroded and slightly slumped. There is also minor clear seepage on the shore at the left abutment.	
STAFF GAGE AND RECORDER	None	Install staff gage to monitor reservoir levels.

EMBANKMENT

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SHORELINE AND DRAINS	No rock drains or stone riprap for slope protection were observed. The portion of the embankment that was visible did not appear to be significantly eroded on the shoreline. There was scattered wood debris on both the upstream and downstream shorelines.	The wood debris on the shorelines should be removed.
FOUNDATION	Information about the foundation is unavailable, including the horizontal and vertical measurements of the stone core wall. Segments of rock core samples were observed on the upstream shoreline of the dam. The core sample is comprised of very hard quartzite, quartz monzonite and quartz of the Precambrian Lovingston Formation. This composition is probably representative of the bedrock foundation.	If possible, the boring data should be obtained.

OUTLET WORKS

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Observation of the outlet conduit was not possible since the toe of the dam was inundated by the lower reservoir.	
INTAKE STRUCTURE	The intake tower consists of stone-masonry walls to maximum water level with the gate house of wood frame construction. Considering the age of the structure, it is in reasonably good condition.	
OUTLET STRUCTURE	Observation of the outlet structure was not possible since it was inundated by the lower reservoir.	
OUTLET CHANNEL	Observation of the outlet channel was not possible since the toe of the dam was inundated by the lower reservoir.	
EMERGENCY GATE	Gates in the gate house are no longer used.	
OTHER	The Water Authority Manager reports that a 10 inch water pipe connecting the upper and lower reservoirs is broken somewhere under the lower reservoir and is partially open, thus allowing flow from the upper reservoir to the lower reservoir.	

UNGATED SPILLWAY

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Not Applicable	
APPROACH CHANNEL	The stone masonry channel (with an old wooden span above at crest of the dam) constructed at the right abutment is 9 ft. wide x 30 ft long.	
DISCHARGE CHANNEL	A curved channel (160 ft.±) is cut in the soil and soft, decomposed, quartz monzonite with an invert 4 to 12 ft. wide down to the lower lake. The bottom is uneven with scourholes. There was an accumulation of tree branches, twigs and leaves at a low point in the curve above the boulders in the lower channel. The channel was dry.	It is recommended that the wood debris be removed to prevent blockage and that the deep holes be filled with rock.
BRIDGE AND PIERS	There are no piers; however, the wooden timbers over the spillway are rotted and in poor condition.	
SLOPES	The ratios of the cut slopes on both sides vary from 1:1 to vertical in brown silt, sand and rock fragments overlying soft, decomposed, quartz monzonite. The roots of the two large trees are partially eroded on the slopes. Vines and weeds had grown on portions of the slopes. There appeared to have been some sloughage of soil in the 25 ft. cut in the hill side at the channel curve.	Stone riprap should be placed on the banks in the vicinity of the slump and undercut trees to prevent further erosion. Steep slopes should be reduced and planted with grass. Some undercut trees should be removed to prevent channel blockage.

INSTRUMENTATION

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

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

RESERVOIR

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The slopes are gentle to steep in brown, sandy silt and silty sand with rock fragments. There are scattered exposures of hard quartz monzonite with a vertical dip. The water level was 3 ft. below the edge of woods exposing a shoreline with scattered fallen trees and branches.	
SEDIMENTATION	No measureable sedimentation was observed.	

DOWNSTREAM CHANNEL

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Observation was not possible since the downstream channel was inundated by lower reservoir.	
SLOPES	Observation was not possible since the downstream channel was inundated by lower reservoir.	
APPROXIMATE NO. OF HOMES AND POPULATION	Lower Ragged Mountain Dam No. 1 is located immediately downstream from Upper Ragged Mountain Dam No. 1. A few homes are located downstream of the two reservoirs at higher elevations. A summer camp is located approximately one mile downstream of the lower reservoir and is occupied on a seasonable basis.	

APPENDIX IV

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

ITEM	REMARKS
PLAN OF DAM	None were available. Sketch taken from field observations is included as Plate 1.
REGIONAL VICINITY MAP	Enclosed as the Location Plan.
CONSTRUCTION HISTORY	The dam was constructed in 1885.
TYPICAL SECTIONS OF DAM	None were available. Sketches taken from field measurements are included as Plates 2 and 3.
HYDROLOGIC/HYDRAULIC DATA	None were available.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	None were available.
RAINFALL/RESERVOIR RECORDS	None were available.

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

ITEM	REMARKS
DESIGN REPORTS	None were available.
GEOLOGY REPORTS	None were available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None were available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None were available. However, a boring or borings had apparently been drilled in recent years at the dam site since core samples were found on the shore. Further inquiries should be made to obtain recorded data.
POST-CONSTRUCTION SURVEYS OF DAM	None were available.
BORROW SOURCES	An apparent borrow area was observed near the right abutment.

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	None is known.
HIGH POOL RECORDS	None
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available, except a brief discussion of the dam in a paper entitled "Engineering in the Development of a Municipal Water Supply" for the City of Charlottesville.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None is known.
MAINTENANCE OPERATION RECORDS	None

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

ITEM	REMARKS
SPILLWAY PLAN	
SECTIONS DETAILS	None
OPERATING EQUIPMENT PLANS & DETAILS	None

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 1.28 sq.mi. (primarily wooded)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 657.0 ft. M.S.L.* (560 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 657.0 ft. M.S.L. (560 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: 659.9 ft. M.S.L.

ELEVATION TOP DAM: 659.9 ft. M.S.L.

CREST: Principal Spillway

a. Elevation 657.0 ft. M.S.L.
b. Type Ungated open-channel type with stone walls and bottom
c. Width 9 ft. bottom width
d. Length Total length 160 ft. including exit channel (30 ft. level section)
e. Location Spillover South end of dam outside right abutment
f. Number and Type of Gates None

OUTLET WORKS: Outlet is submerged by lower reservoir, no data available.

a. Type Unknown
b. Location Unknown
c. Entrance inverts Unknown
d. Exit inverts Unknown
e. Emergency draindown facilities All gates in gate house are no longer used and presumed not to work

HYDROMETEOROLOGICAL GAGES: None at dam site

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE Unknown

*All elevations are based on an assumed normal pool elevation of 657.0 feet M.S.L. as shown on the U.S.G.S. 7.5 minute topographic quadrangle, Charlottesville West, Virginia.

Name of Dam: UPPER RAGGED MOUNTAIN NO. 1

APPENDIX V

ENGINEERING IN THE DEVELOPMENT OF A MUNICIPAL WATER SUPPLY, CHARLOTTESVILLE, VIRGINIA

ENGINEERING IN THE DEVELOPMENT OF A MUNICIPAL WATER SUPPLY

The water supply of any community is of prime interest to its people and I trust that a few highlights about the water supply of my community particularly in an engineering way will be of some interest to you as engineers.

I have had occasion at various times to go back to the record in connection with the water system of the City of Charlottesville and have found the development since before the Civil War times most interesting. Information from the Civil War period to 1870 I have gotten from word of mouth, but from an authentic source. Dr. Francis P. Dunnington, for years professor of chemistry, at the University of Virginia and whose job it was to examine water from some of the old wells that were dug in Jefferson's day has supplied this early history.

No doubt most of you are familiar with the general location of things in Charlottesville but I will refresh your memory very briefly. The City is even now well scattered over an area of about four square miles; the University of Virginia and its lands are located in the western and high end of the City, while the main business and industrial section occupy the lower eastern end.

Before the Civil War all water was gotten from scattered springs and wells, carried in buckets by those not fortunate enough to have one of these luxuries close by. The town pump was located in the middle of Main Street at the top of Vinegar Hill. This well is now covered by the statue of Lewis and Clark, and serves as a very good foundation for the statue of those illustrious explorers. At this time there were various pumps and several springs scattered about the few buildings at the University of Virginia, the strongest spring perhaps being very near the present site of the McIntire Amphitheatre.

At about this time, during the 1850's, a small dam was built at the foot of Lewis (or Carney's) Mountain about a mile west of the University near the Chamberlain Place from which a 2½" pipe brought the water by way of the present gymnasium to a small open lake on the University grounds located north of the Rotunda and northeast of the present Chapel. From this lake a covered canal conveyed the water to a steam pump in the old annex (since removed) where it was lifted to a tank in the top of the Rotunda, thence by gravity to the University buildings and professor's homes. This water was used for all purposes except for drinking, drinking water still being carried from pumps and springs. The operator of the steam pump in the old annex was one Martin Tracy, an Irishman of some renown in those days. His automatic gauge consisted of a stick attached to a float - by looking out the window up to the Rotunda he could observe his stick and work his pump accordingly.

In 1868, Major Green Peyton assumed charge of the buildings and grounds at the University. It had been apparent for years that some further steps would have to be taken for a more abundant and pure supply of water. The wells were being closed from pollution and the water problem was indeed bad. Major Peyton in the spring of 1868 constructed a brick reservoir on the north side of Observatory Mountain which held perhaps one-half million gallons and from which a 4" cast iron pipe conveyed this water by gravity to the tank in top of the Rotunda.

At this time and during the several succeeding years the town had no such thing as a water system. The town authorities even then, however, sensed their responsibility to provide water for its citizens as is evidenced by this resolution of the Council in June 1871: "Be it ordained, by the Council that in consequence of the pump near the Farrish house having been used in part for a number of years as a public pump, the Council agrees to pay one-half the amount necessary to put it in good repair, provided the whole cost does not exceed $25.00." Shortly after this we find that the Council contracted for the use of another well in the vicinity of Court Square at a cost of $40.00.

Then in October, 1873, a committee from the Council recommended the employment of an engineer to devise a plan for the securing of a pure and abundant supply of water for the citizens of Charlottesville, and spoke of a public vote on the question of a bond issue. In April of the following year, an engineer was retained to locate a dam, pipe line, hydrants, etc., and to make an estimate of the cost.

Nothing came of the movement until August, 1884, when a report was submitted by another engineer, Mr. E.W. Dowditch, who made a similar report on the same project.

A contract was entered into with the University of Virginia wherein the University was to pay about one-sixth of the total cost of the project since the University was by this time as badly in need of water as was the town. This was really the first joint arrangement between University and Town officials in water matters and has continued to this time and no doubt will continue.

A dam was then built in the Ragged Mountains about three miles west of town, being an earth structure 45 feet in height, a top width of 12 feet and side slopes about 1½ to 1. It is faced on the inside with dry stone paving up to the maximum water level. This upper reservoir has a storage capacity of 182 million gallons and is supplied by a few small springs and a drainage area of about 300 acres. The pipe line connecting this reservoir with the town is a 10" cast iron pipe.

For a few years then Charlottesville enjoyed the luxury of an abundance of water and in October, 1888, the City fathers removed the charge of water for bath tubs which must have been a popular edict with the citizens. However, a dry season or two must have changed the complexion of things, for in 1892 the University of Virginia laid a 6" line to the reservoir which has been removed in recent years and in 1892 a small dam was built near Moore's Creek and Maury's Branch about two miles below the reservoir. The purpose of this small pond was to catch the leakage from the reservoir and other water from the drainage area in the intervening two miles. Two steam pumps were installed which operated intermittently until recent years when the present Moorman's River supply was put into service.

A slight diversion at this point would not be out of order. With the increased use of water during the 1880's and the adoption of more up-to-date and more numerous plumbing fixtures, the problem of sanitary conditions and disposal of sewage presented itself. The Council in 1893 carefully sought engineering advice and very wisely retained the services of a well known engineer, Mr. Rudolph Herring of New York. Mr. Herring's study and report was adopted and the sanitary system installed under his direction is still in useful service, with many later additions, of course.

A few of the many water rates in 1898 are very interesting. The following rates are annual:

Dwellings valued at less than $1000.00 For each $100 valuation add 15¢	$5.00
For Bricklaying 10¢ per 1000 brick	
Bottling Establishments	$25.00
Hotels (without water closets) Water closets in hotels and public places first seat $8.00, each additional seat	$40.00 $ 5.00

The minutes of the Council of that day reveal another quite interesting sidelight when they appropriated the sum of $75.00 to defray the expenses of the Superintendent of Water to the American Water Works Association meeting in Boston. The mayor vetoed this in no uncertain terms. His veto:

"Gentlemen of the Council:

I return without my signature the accompanying resolution appropriating $75.00 to defray the expenses of the Superintendent of Water to a meeting of the American Water Works Association to be held in Boston.

Our Superintendent of Water has no complex nor scientific work to perform that I have ever heard of.

His duties are plain and simple. Furthermore, as we have no Assistant Superintendent of Water the superintendent should be in place to do his work for which he receives a salary of $1000.00 and $144.00 for horse feed.

His services will never be more needed; certainly they are particularly required at this season of the year.

It is unnecessary to say that the principal is wrong and the precedent unwise, if not dangerous even if the treasury was in better shape than it is."

In the Mayor's message to the Council in 1904, we find that the growth of the community and increased water consumption caused that gentleman to make this remark. "The most important matter for the Council to consider is the water question. Its importance is so great that it cannot be magnified or exaggerated. I would suggest that you avail yourselves of the service of local or other expert service in solving this problem to the end of a wise issue of this important matter."

It was two years before public sentiment and engineering details could be worked out for the construction of what is now known as the lower reservoir or Mayo's Rock Dam. It is a concrete structure of the usual gravity section and is 60 ft. high. It is immediately below the old or upper reservoir, built in 1885. The lake formed by it goes back against the downstream toe of the old dam. The capacity of the new reservoir is 433 million gallons, making the total storage of the two reservoirs 615 million gallons. (Words underlined supplied by copyist)
The drainage area was increased to 1,216 acres or about two square miles. From this concrete dam an 18" cast iron pipe line led to the City. It might be well to mention here that in 1934 it became necessary to strengthen this dam by guniting the upstream face and placing an earth embankment on the downstream slope. Both front and back of the dam were spalling badly and the dam was in generally poor condition.

The system took care of itself very well for quite a few years. However, a combination of increased demand and dry seasons depleted these reservoirs to such a point that the growth of algae and other organisms resulted in a most unpalatable water. In 1920, the New York firm of Hazen, Whipple, and Fuller made a study of the situation, then in 1921, Williamson, Carroll, and Saunders of Charlottesville together with Fuller and McClintock made a most thorough and exhaustive study of available supplies. There were six sources investigated with completeness:

1. Moorman's River
2. Rivanna River
3. Buck Mountain Creek
4. Ivy Creek
5. Maury's and Moore's Creek
6. Mechum's River

The Moorman's River supply proved unquestionably superior. It is a typical mountain stream, rising on the east slopes of the Blue Ridge in what is now the Shenandoah National Park, and the water is of excellent quality. The drainage area is about 19 square miles, the greater part of which is heavily wooded. A small diversion or intake dam was built at the foot of the mountains and an 18" cast iron pipe about 13½ miles in length was installed which connected with the existing 18" line at the lower reservoir. The capacity of this 18" Moorman's River gravity line is approximately 3½ million gallons daily. Since the present City consumption (1936-37) is about 2½ million gallons daily, the excess is allowed to divert into the reservoirs, which float on the line so to speak, and serve as an emergency supply in unusually dry periods when Moorman's River does not suffice. This arrangement has been excellent and the quality and quantity of the water has met all expectations.

I will state briefly the reasons for rejecting the other five possible sources of supply:

1. Rivanna River - Excessive turbidity, expensive chemical treatment and pumping costs.
2. Buck Mountain Creek - Insufficient quantity and longer distance.
3. Ivy Creek - Insufficient quantity, excessive turbidity and pumping costs.
4. Maury's and Moore's Creek - Insufficient quantity and poor quality.
5. Moorman's River - Excessive turbidity and pumping costs.

Since completion of the Moorman's River project in 1925, the City has enjoyed perhaps the most quiet period of its water works history. The only close call was as a result of the unusual drought of 1930 when water supplies all over the country were being severly tested. The City, as a precautionary measure, installed a pump of 3 million gallons daily capacity on Mechum's River on the 18" Moorman's River pipe line. This pump has never been used, but is in place to serve should an emergency arise. When additional supply is needed, which at the present rate of growth of the community will not be so many years distant, the logical step will undoubtedly be a storage dam at Moorman's River showing further the wisdom of the Moorman's River Project.

The filtration plant was built in 1922 on Observatory Mountain and increased in capacity in 1936 by the addition of a 3/4 million gallon daily unit and can be further enlarged as occasion demands. This plant is of the slow sand type and is one of the few in the United States. The success in operating results of the Charlottesville filters is due in no small measure to the good quality of the raw water to be treated.

This brief history of the water system over a period of almost 100 years might lead the layman to believe that the City has continually been in search of a new supply, but one must remember that in this period only three major steps have been taken, (1) the upper reservoir in 1885; (2) the lower reservoir in 1906; and (3) the filter plant and Moorman's River project in the 1920's. The City fathers have proceeded with caution on these matters and from their sound judgment and foresight has resulted a water system of which the citizens of Charlottesville should feel justly proud.

THE END

APPENDIX VI

LETTER TO GOVERNOR

FACSIMILE HEADER SHEET
(ER 105-1-5)

FROM (Name)	OFFICE SYMBOL	TELEPHONE NO.	RELEASER'S SIGNATURE		
[illegible]	NADEN-DS	446-3706	[illegible]		
TO (Name)	OFFICE SYMBOL	TELEPHONE NO.	# PAGES	PRECEDENCE	DTG
[illegible]	NADEN-TF	8-796-7556	[illegible]	[illegible]	2/6/79

SUBJECT

ENG FORM 430, 1 FEB 73

NAOEN-DS 5 February 1979

Mr. R. V. Davis
Executive Secretary
P. O. Box 11143
Richmond, Virginia 23230

Dear Mr. Davis:

Upper Ragged Mountain Dam No. 1 is a 470 feet long and 47 feet high earthen structure built in 1885. The surface of the dam is covered with vines and small brush. Under the surface cover can be seen many erosion gullies. A slough has occurred on the downstream face and an active clear seep is located adjacent to the slough. The emergency spillway is unusually small (capacity 10% of PMF). It is very doubtful the dam can survive an overtopping. Downstream approximately 2500 feet from Upper Ragged Mountain Dam No. 1 is another earthfill dam which has been judged seriously inadequate, unsafe, non-emergency. Failure of Upper Ragged Mountain Dam No. 1 under any condition will result in overtopping of the lower dam most probably causing a failure of the lower dam. A camp for handicapped children is located within a mile downstream. A failure of the lower dam can cause a catastrophic event for the downstream inhabitants. Upper Ragged Mountain Dam No. 1 is therefore assessed as unsafe, emergency. The owner should immediately dewater and safely breach the dam. Until the emergency situation is alleviated, a detailed emergency operation plan and warning system for downstream residences should be immediately developed by the owner. During periods of anticipated heavy precipitation, the owner must provide around-the-clock surveillance of the dam. A Phase I Inspection Report is being completed and will follow.

Sincerely yours,

DOUGLAS L. HALLER
Colonel, Corps of Engineers
District Engineer

APPENDIX VII

REFERENCES

REFERENCES

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