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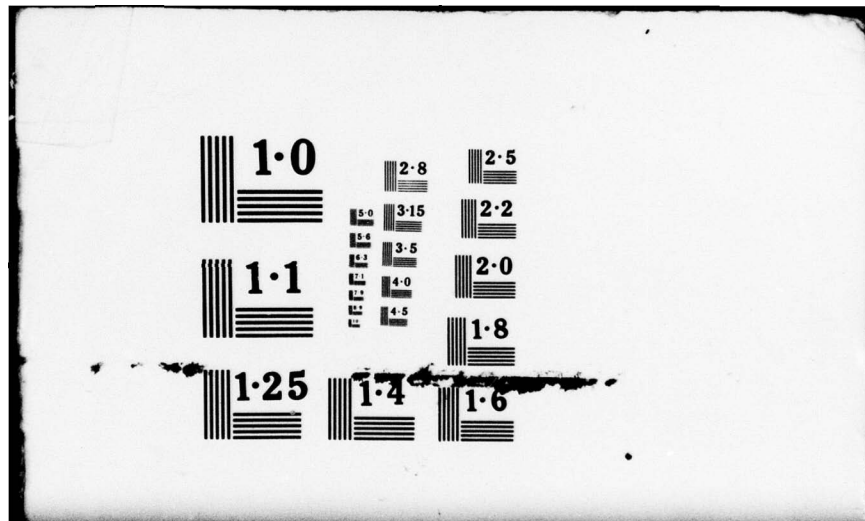
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TENNESSEE RIVER BASIN

Name Of Dam: HUNGRY MOTHER STATE PARK DAM

Location: SMYTH COUNTY, VIRGINIA

Inventory Number: VA 17309

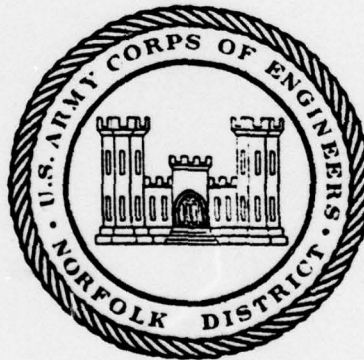
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LEVEL II

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

BY

GILBERT ASSOCIATES, INC.

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REVISION NO. 1 TO PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

HUNGRY MOTHER

The cover color is revised to white. The actual cover will not be changed. Each recipient of a copy of this report should notate the existing cover. In addition, add to Section 7, the following paragraphs:

7.1.1 Using the Corps of Engineers screening criteria for initial review of spillway adequacy, it has been determined that the embankment would be overtopped for all storms exceeding approximately 35% of the PMF. 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 a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

7.2.7 In accordance with paragraph 7.1.1, 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 determine by more sophisticated methods and procedures the adequacy of the spillway. Even though the seriously inadequate spillway would produce a dam failure primarily from hydrologic reasons, remedial measures in structural or geotechnical areas may be needed to remove the dam from an unsafe classification. Within 6 months of the date of notification to the governor, the professional consultant's report of appropriate remedial mitigating measures should have been completed and the owner should have an agreement with the Commonwealth of Virginia to a reasonable time frame in which all remedial measures will be complete. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

On

NATIONAL DAM SAFETY PROGRAM
PHASE I INSPECTION REPORT

REVISION NO. 2 TO HUNGRY MOTHER DAM

Delete recommendation No. 1 in brief assessment of dam.

Delete paragraph 7.2.2.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER VA 17309	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Inspection Report National Dam Safety Program Hungry Mother State Park Dam Smyth County, Virginia		5. TYPE OF REPORT & PERIOD COVERED 9 Final rept.
7. AUTHOR(s) Gilbert Associates-Thomas Roberts 12 Thomas E. Roberts		8. CONTRACT OR GRANT NUMBER(s) 15 DACW 65-78-D-0014
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 12 54p.
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Engineering District, Norfolk 803 Front Street Norfolk, VA 23510		12. REPORT DATE 11 August 1978
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 6 National Dam Safety Program. Hungry Mother State Park Dam (VA17309), Tennessee River Basin, Smyth County, Virginia. Phase I Inspection Report.		13. NUMBER OF PAGES 36
16. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) Approved for public release; distribution unlimited.		15. SECURITY CLASS. (of this report) Unclassified
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
18. SUPPLEMENTARY NOTES Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dams - VA National Dam Safety Program Phase I Dam Safety Dam Inspection		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) (See reverse side)		

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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.

LEVEL II

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Hungry Mother State Park Dam
State: Virginia
County: Smyth
USGS Quadrangle Sheet: Marion, Virginia
Stream: Hungry Mother Creek

The Hungry Mother Dam is an earth embankment about 640 feet long and 45 feet high. A stone masonry chute type spillway cuts through the right abutment and a reinforced concrete conduit on the left end of the embankment serves as the outlet.

The visual inspection of the dam revealed no visible signs of distress or failure; however, the inadequacy of the dam's spillway to pass the recommended design flood could result in a significant hazard and requires immediate action by the owner. (See Appendix V Conditions.)

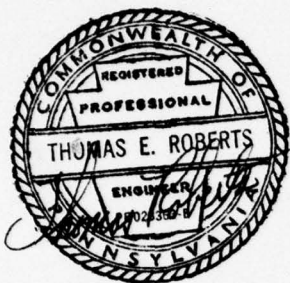
The spillway will pass only 35 percent of the PMF flood which, according to the U.S. Corps of Engineer's guideline (Engineer Technical Letter No. 1110-2-234) requires that it be rated as seriously inadequate. The PMF flood will overtop the dam by 3.3 feet.

The following recommendations are presented for the owner's consideration and implementation:

- (1) Immediately undertake the design of an enlarged spillway, the work to begin within 90 days.
- (2) Develop, within 30 days, a detailed emergency warning system to notify the downstream area of impending danger, and determine those areas subject to inundation from a dam break flood wave.
- (3) Obtain the services of a qualified consultant to evaluate the stability of the embankment through a subsurface investigation program. This work should be completed within 90 days.
- (4) Undertake, within 180 days, the repair of miscellaneous items including the sluice gate, the spillway erosion, and removal of brush from the upstream slopes.
- (5) Maintain a file of all available documents pertinent to the design, construction and operation of the dam, and institute a periodic inspection program.

Until such time as the above recommendations can be implemented, during periods of heavy rainfall the owner should provide round-the-clock surveillance of the dam and prepare to implement the emergency warning procedures recommended in paragraph (2) above.

Prepared by:



APPROVED: Original signed by:

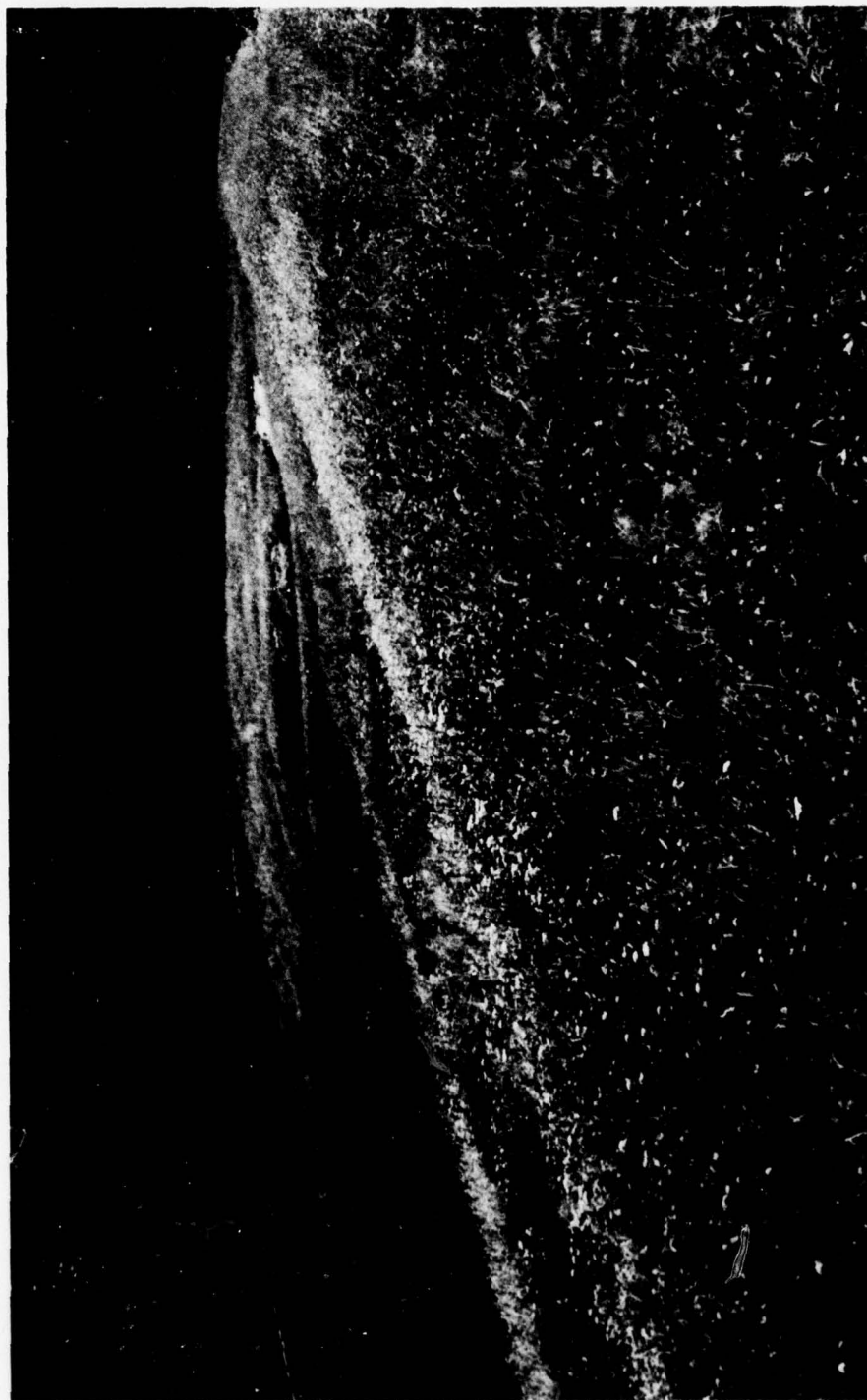
Douglas L. Haller

Douglas L. Haller
Colonel, Corps of Engineers
District Engineer

Date: 21 AUG 1978

Original signed by
Submitted By: JAMES A. WALSH

Original signed by
Recommended By: ZANE M. GOODWIN



June 1978

HUNGRY MOTHER STATE PARK DAM
OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: Hungry Mother State Park Dam I.D.#: VA 17309

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 U.S. Corps of Engineers to initiate a national program of safety inspections of non-Federal dams throughout the United States. The Norfolk District of the U.S. Corps of Engineers has been assigned the responsibility of the inspection of dams in the Commonwealth of Virginia. Gilbert Associates, Inc. has entered into a contract with the Norfolk District to inspect this dam, Gilbert Work Order 06-7250-002.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 1 of Appendix IV) and contract requirements between Gilbert Associates, Inc. and the Corps of Engineers. The objectives are to expeditiously identify whether this dam apparently poses an immediate threat to human life or property, and to recommend future studies and any obvious remedial actions that may be indicated by the inspection.

1.2 Project Description

1.2.1 Dam and Appurtenances: Hungry Mother State Park Dam is a zoned earthfill structure about 640 feet long and 45 feet high. The top of the dam is 20 feet wide and is at elevation 2208.0 feet m.s.l. The downstream slope is at 2-1/2 horizontal to 1 vertical with two 8-foot wide benches at intermediate elevations of 2,188 and 2,200 feet. The upstream slope is at 3 horizontal to 1 vertical from the toe up to elevation 2,195 feet and then changes to 2-1/2 horizontal to 1 vertical up to the top. The entire upstream slope was covered with a layer of hand placed riprap. The lower upstream slope consists of single flat stones, the upper portion has 18 inches of stone over a 9-inch gravel layer.

The outlet works consist of a gate tower located at the upstream toe of the dam that is connected to an outlet tunnel. The tunnel is a reinforced concrete box culvert 5 feet wide, 5-1/2 feet high, 287 feet long, with walls 2 feet thick. Six cutoff collars were placed along the tunnel at varying spacing toward the upstream end. The tunnel was constructed in the old creek bed of Hungry Mother Creek and, according to the drawings, was founded on bedrock.

The gate tower has a 5-foot 5-inch by 6-foot 6-inch opening at its base and two 3-foot by 3-foot sluice gates which regulate the outflow. According to the owner's representative, one of the gates is inoperable.

The service and emergency spillway is a stone-masonry channel with vertical walls along most of its length. The spillway crest width at elevation 2,200 feet m.s.l. is 145 feet; thereafter, the channel quickly narrows to 75 feet wide and drops at a slope of about 8 percent.

1.2.2 Location: Hungry Mother State Park Dam is located on U.S. Route 16, approximately 3 miles north of Marion, Virginia.

1.2.3 Size Classification: Based upon the height of 45 feet and the storage volume of 2,500 acre feet, the dam is classified as an intermediate size structure in accordance with Section 2.1.1 of Reference 1 of Appendix IV.

1.2.4 Hazard Classification: This dam is located above the town of Marion, Virginia; both the possible loss of life and possible excessive economic loss require that the dam be considered a high hazard based on Section 2.1.1 of Reference 1 of Appendix IV. The hazard classification used to categorize dams is a function of location only and is unrelated to the stability or probability of failure.

1.2.5 Ownership: State Park Commission, Commonwealth of Virginia.

1.2.6 Purpose: Recreation

1.2.7 Design and Construction History: The dam was designed and constructed under the supervision of the State Commission on Conservation and Development, Commonwealth of Virginia. It was constructed by the Civilian Conservation Corps. Construction was completed in 1934. The spillway channel was redesigned and lowered in about 1937.

1.2.8 Normal Operational Procedures: According to a representative of the owner, normally the dam is unattended. The two gate valves in the principal spillway are kept closed, with all overflow occurring at the service spillway. Each year the reservoir is lowered about 6 feet to allow for clearing of the shoreline.

1.3 Pertinent Data

1.3.1 Drainage Area: 12.9 square miles

1.3.2 Discharge at Dam Site: Maximum flood at dam site: maximum unknown. Recent observations by the owner's representative estimate a maximum head of 3 feet over the spillway, which is equivalent to approximately 2,300 c.f.s.

Spillway with 500-year design flood*..... 3,600 c.f.s.
(reservoir at 2,204 feet)

Spillway with pool level at top of dam10,200 c.f.s.

Outlet with one gate open 260 c.f.s.

Outlet with both gates open 450 c.f.s.

*As shown on plans

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in Table 1.1.

Table 1.1 DAM AND RESERVOIR DATA

Item	Elevation Feet m.s.l.	Area acres	Reservoir Capacity		Length miles
			Acre feet	Watershed inches	
Top of Dam	2208.0	167.0	2,500	3.63	14.1
Maximum Pool, Design Surcharge	2204.0	-	1,944	2.83	-
Spillway Crest	2200.0	124.0	1,350	1.96	13.6
Streambed at Centerline of Dam	2164 ₊	-	-	-	-
Maximum Tailwater	Unknown				

SECTION 2 - ENGINEERING DATA

2.1 Design: The construction of the dam was performed by the Civilian Conservation Corps under the supervision of the State Commission on Conservation and Development, Commonwealth of Virginia. Plans of the dam and appurtenant structures are located at the:

Virginia Division of State Parks
1201 State Office Building
Capital Square
Richmond, Virginia 23219

The drawings indicate that the embankment is made up of four zones: a central core of impervious material, an upstream zone of slightly less impervious material, a downstream zone of pervious material, and a zone of "very free draining material" at the toe. Two concrete cutoff walls are placed at the base of trenches cut through the overburden to the bedrock. One wall is placed in the upstream zone, the other at the center of the central core.

A series of gravel underdrains was constructed under the downstream embankment zones. The drains are perpendicular to the axis of the dam and drain into two collector drains near the toe. Each collector drain empties into Hungry Mother Creek.

2.2 Construction: There are no construction records available; however, soon after the dam was finished an investigation was begun by the Tennessee Valley Authority (TVA) to determine horizontal and vertical movement of the dam crest and the amount of leakage through the foundation of the dam. The investigation found no movement of the dam and gained no valuable information from the piezometers. The survey monuments and piezometers are still in place and in good condition.

2.3 Operation: The normal operation of the dam is to leave the outlet structure closed, allowing all overflow to leave via the spillway channel; hence normal water level is at the spillway crest elevation of 2,200 feet m.s.l. No records of reservoir level or controlled releases are kept.

2.4 Evaluation: Plans are available from the Park Commission. Good quality tracings are available for both the original plan sections and details of the embankment and appurtenant structures and also for the spillway redesign. The record drawings appear to coincide with actual structures and conditions based upon the visual inspection. The engineering data are sufficient for a Phase I evaluation.

SECTION 3 - VISUAL INSPECTION

3.1 **Findings:** The downstream slopes were generally uniform and were covered with protective vegetation. Larger brush, including trees with 2-inch to 4-inch diameter trunks were present at the toe of the slope. A series of 4-inch by 4-inch concrete monuments, spaced at approximately 50 feet apart along the dam centerline, apparently served as monitoring points for horizontal and vertical movement. Also located downstream of the embankment, in the vicinity of the toe, were a series of 55-gallon drums with a 2-inch vertical steel pipe centered within the drum, and backfilled with earth. The pipes apparently served as piezometers.

A small bench (about 5 feet wide) has formed in the riprap on the upstream slope at the waterline indicating some breakdown of the riprap. This was not serious but should be repaired as a maintenance item.

Seepage occurs at the right abutment, approximately 190 feet from the crest along the south spillway retaining wall. Flow was estimated to be 5 g.p.m. or less. This flow probably comes from beneath the emergency spillway, exiting through the natural ground.

There is also a small amount (approximately 5 g.p.m.) of water flowing from behind the north wing wall of the outlet structure endwall. This flow apparently is the result of the existing "blind drains," which are indicated on the construction drawings. Lastly, the middle area of the downstream toe was swampy, but no appreciable flow could be observed. It could not be determined whether the water in this swampy area was from seepage or the area was just poorly drained.

The outlet is a vertical reinforced concrete gate tower, supporting two valves. The right valve is inoperative, and the left valve is used infrequently. The discharge barrel is a reinforced concrete rectangular tunnel approximately 287 feet long, with a 5-foot wide by 5-foot 6-inch high cross-sectional area. Visual inspection of the tunnel indicated that some leakage was occurring from within (approximately 4 g.p.m.) probably at the gate face areas, and from seepage through the walls. Small areas of concrete erosion have taken place on the roof at the junction of the gate and the concrete tunnel.

The spillway channel retaining walls consist of hand-placed field stone, laid in a concrete mortar base. The south retaining wall has begun to deteriorate such that the top stones have come loose. The walls appeared to be in good condition near the base.

The shorelines of the reservoir area are tree covered such that little of the banks are visible. No apparent slope failures were observed.

The downstream channel was relatively stable, in that the channel coming from the spillway was wide and contained a large amount of large rocks. Some bank erosion on the right bank had occurred recently for approximately 30 feet downstream of the spillway.

3.2 Evaluation: The visual inspections revealed no visible signs of major distress or failure in the dam and its appurtenances. However, minor repairs on the spillway and retaining walls and maintenance of the embankment slopes and riprap are required.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: The only operational procedure is an annual 6-foot lowering of the reservoir to allow clearing of the shoreline. At all other times the reservoir is maintained at the level of the spillway crest.

4.2 Maintenance of Dam: Given the age of the spillway, it is in fairly good condition, but several minor conditions have not been tended to. The rock walls have started to weather along the top with three areas showing cracks and loose stones. On the dam itself, some minor erosion has developed at the end of the spillway and the riprap of the dam is showing signs of deterioration. Grass on the slopes is mowed regularly but some brush has been allowed to grow on the upstream slope.

4.3 Maintenance of Operating Facilities: The only controls are the sluice gates located in the gate tower. One of these controls is inoperable according to the owner's representative.

4.4 Description of Any Warning System In Effect: None

4.5 Evaluation: Although the maintenance program has kept up the appearance of the dam, it has not kept up with some of the deteriorating conditions which should be attended to. Specifically, the spillway retaining walls are in need of repair, the one gate valve in the gate tower should be repaired, the downstream side slopes immediately after the spillway should be dressed to protect against erosion, and the riprap should be cleared of brush and then reinforced.

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: There are no hydraulic or hydrologic data available except for a 500-year flood reservoir level of 2,204 feet shown on the plans. Calculations performed for this Report did not agree with this given level but instead found a 100-year flood level of 2,204.6 feet.

5.2 Hydrologic Records: None

5.3 Flood Experience: There are no gages on the dam or records of previous floods, but a recent storm (1977) which is regarded as the largest to occur in a number of years, developed about 3 feet of head over the spillway according to the owner's representative. There were no high water marks or any other visual indications of hydraulic performance.

5.4 Flood Potential: The PMF, one-half the PMF, and the 100-year floods were determined for this site by a method developed by the Soil Conservation Service using regional precipitation values. The results of these studies are given in Table 5.1. These analyses pertain to present hydrologic conditions and do not consider future uncertain conditions, such as urbanization or other changes in the watershed.

5.5 Reservoir Regulation: None.

5.6 Overtopping: A U.S. Army Corps of Engineers computer program HEC-1 was used to determine flood levels in the reservoir for the three guideline flood hydrographs (PMF, one-half PMF, and 100 years). The reservoir levels and discharge rates are given in Table 5-1.

The hydrographs were developed and routed by using the HEC-1 computer program (Reference 2 of Appendix IV) and appropriate precipitation, unit hydrograph, and storage volume versus outflow data as input. The triangular unit hydrograph was developed from the drainage area and estimated time to peak (Reference 3 of Appendix IV). Probable maximum precipitation and 100-year precipitation data were obtained from U.S. Weather Bureau publications (References 4 and 5 of Appendix IV). Information from design drawings was used to compute the storage-outflow relation with the spillway functioning as a broad-crested weir. Losses were estimated at an initial loss of 1.0 inch and a constant loss rate of 0.3 inch/hour.

The results indicate that the spillway can pass only a flood of up to 35 percent of the PMF before the dam will be overtopped. The PMF will overtop the dam by 3.3 feet for a period of seven hours. The one-half PMF will overtop the dam by 1.2 feet for three hours. The overtopping of the dam will probably lead to its failure. For the one-half PMF, the velocity at the crest is only 4.9 f.p.s. which would possibly be tolerated for a while, but on the downstream slope the velocities would exceed 10 f.p.s. which will quickly erode the slope.

TABLE 5-1 - RESERVOIR PERFORMANCE

Item	Flood		
	One Percent (a)	1/2 PMF	PMF (b)
Peak Discharge, c.f.s.:			
Inflow -	6070	16,300	32,500
Outflow -	4580	15,700	31,000
Peak Elevation, feet m.s.l.	2204.6	2,209.2	2,211.3
Ungated Spillway:			
Depth of Flow, feet (c)	3.1	6.1	7.5
Average Velocity, f.p.s.	9.9	14.1	15.6
Non-overflow Sections:			
Depth of Flow, feet (c)		0.8	2.1
Average Velocity, f.p.s.		4.9	8.2
Duration, Hours		3.0	7.0
Tailwater Elevation, feet m.s.l.	-	-	-

Notes:

- (a) The 1 percent exceedance frequency flood has one chance in 100 of being exceeded in any given year.
- (b) The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.
- (c) Critical depth.

5.7 Reservoir Emptying Potential: The pool can be lowered by the use of sluice gates located in the base of the gate tower. With the reservoir at the normal pool level, one gate alone should be able to pass about 260 c.f.s. and two gates, if both were operable, about 450 c.f.s.

A volume-elevation curve was not available for the reservoir, so in order to estimate the hydraulic head on the outlet, the head was assumed to vary as the cube root of the storage volume, being equal to the head at normal pool elevation for a full reservoir and equal to zero for an empty reservoir.

If an average inflow rate of 17 c.f.s. (1.3 c.f.s.m.) is assumed and only one gate were operable, it would take up to four days to empty the reservoir. With two gates open the reservoir could be emptied in only two days.

5.8 Evaluation: The most serious finding concerning the hydraulic design of the dam is that the spillway is too small to pass the recommended design flood (PMF).

The screening criteria for assessing the adequacy of the spillway design flood contained in the U.S. Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams allow essentially no risk of loss of life from dam failure by overtopping. Experience indicates that very few existing non-Federal dams were designed with such conservative criteria. Therefore, the Phase I inspection findings will indicate noncompliance with the spillway design flood screening criteria for most non-Federal dams. In accordance with the Corps of Engineers' Engineer Technical Letter No. 1110-2-234, general criteria are needed for determining that the spillway capacity at a specific dam is seriously inadequate. The spillway is considered "seriously inadequate" if all three of the following conditions exist:

- a. There is high hazard to loss of life from large flows downstream of the dam.
- b. Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.
- c. The spillway is not capable of passing one-half the PMF without overtopping the dam and causing failure.

The spillway capacity was calculated at approximately 35 percent of the PMF. Based upon the Recommended Guidelines (Reference 1 of Appendix IV), the spillway is considered inadequate and according to the general criteria of the Corps of Engineers' Engineer Technical Letter No. 1110-2-234 above, it is considered seriously inadequate.

SECTION 6 - DAM STABILITY

6.1 Stability Analysis: There is no stability analysis available for the dam nor any information on the properties of the embankment materials. There was no evidence at the site of any settling, cracking, or sloughing of the slopes, and the only seepage observed was at the right abutment in a natural slope, not in the embankment.

6.2 Foundation and Abutments: Some seepage was observed on the right abutment at an elevation below the spillway channel. The seepage appeared to be leakage from the spillway chute rather than flow through the embankment. Bedrock outcrops show the foundation rocks to be composed of shale and therefore not susceptible to solutioning.

6.3 Evaluation: Based upon the dam's performance for over 40 years, it would seem that the embankment is stable, at least under normal conditions. The slopes used on the embankment are typical for embankment dams, and the cutoff walls and underdrain system indicate that a great deal of care was taken in the design to insure a stable embankment.

Nevertheless, due to unknown foundation and embankment material information, some uncertainties with respect to the long-term stability exist. Therefore, it is recommended that a static stability analysis of the dam be performed.

The dam is located within Zone 2 on Algermissen's Seismic Risk Map of the United States (1969 edition) and there are uncertainties with respect to the static stability of the dam, as set forth in paragraph 6.1. Therefore, in accordance with paragraph 3.6.4 of Reference 1 of Appendix IV, additional assessments should be made based on the results of the studies outlined in paragraph 7.2.4.

SECTION 7 - DAM ASSESSMENT/RECOMMENDATIONS REMEDIAL MEASURES

The assessment, recommendations, and remedial measures contained in this Report are based on the provisions of Appendix V, Conditions.

7.1 Dam Assessment: The visual inspection did not reveal any structural defects; however, the hydrologic analysis revealed that the spillway capacity is seriously inadequate under the recommended Corps of Engineers' guidelines. The lack of an engineering analysis of the embankment makes it difficult to make conclusions regarding the stability of the embankment, although from all indications the embankment was carefully designed. The other repair items listed below are not as serious as the spillway situation but should be attended to.

7.2 Recommendations/Remedial Measures

7.2.1 Flood Impact Study: It is recommended that the owner enlist the services of a qualified consultant to analyze the downstream area and to define the area affected by a flood wave resulting from a dam failure. The analysis should determine the effects of a failure at the following pool levels: normal, 1 percent storm, one-half PMF and PMF. Emphasis should be placed on the estimated property damage and potential loss of life. The recommended analysis should be completed within 120 days after receipt of this Report.

7.2.2 Increase Spillway Capacity: The owner should obtain the services of a qualified consultant to immediately begin the planning of an enlarged spillway. This work should be started within 90 days.

7.2.3 Warning System: A detailed emergency warning system should be developed as soon as possible to notify the downstream inhabitants of an impending dam failure. In order for the warning system to be effectively applied, a study of the downstream area should be made so that the areas subject to flooding as a result of a dam break can be identified.

7.2.4 Stability Analysis: It is recommended that the owner enlist the services of a qualified consultant to undertake a stability analysis of the embankment in accordance with Corps of Engineers' guidelines (Reference 1 of Appendix IV). This should be completed within 90 days after receipt of this Report.

7.2.5 Miscellaneous Repairs: The following miscellaneous repairs should be carried out within the next 180 days.

- a. Repair of the broken sluice gate.

- b. Clearing of brush from the upstream and downstream slopes.
- c. Correction of bank erosion at the end of the spillway chute.

7.2.6 Design Documents: A complete set of available design documents should be maintained by the owner. These files should include available design drawings, calculations, pertinent correspondence and maintenance records. It is further suggested that the owner implement a periodic inspection program to monitor the conditions of the spillway, embankment, reservoir, and operating equipment.

APPENDIX I
MAPS AND DRAWINGS

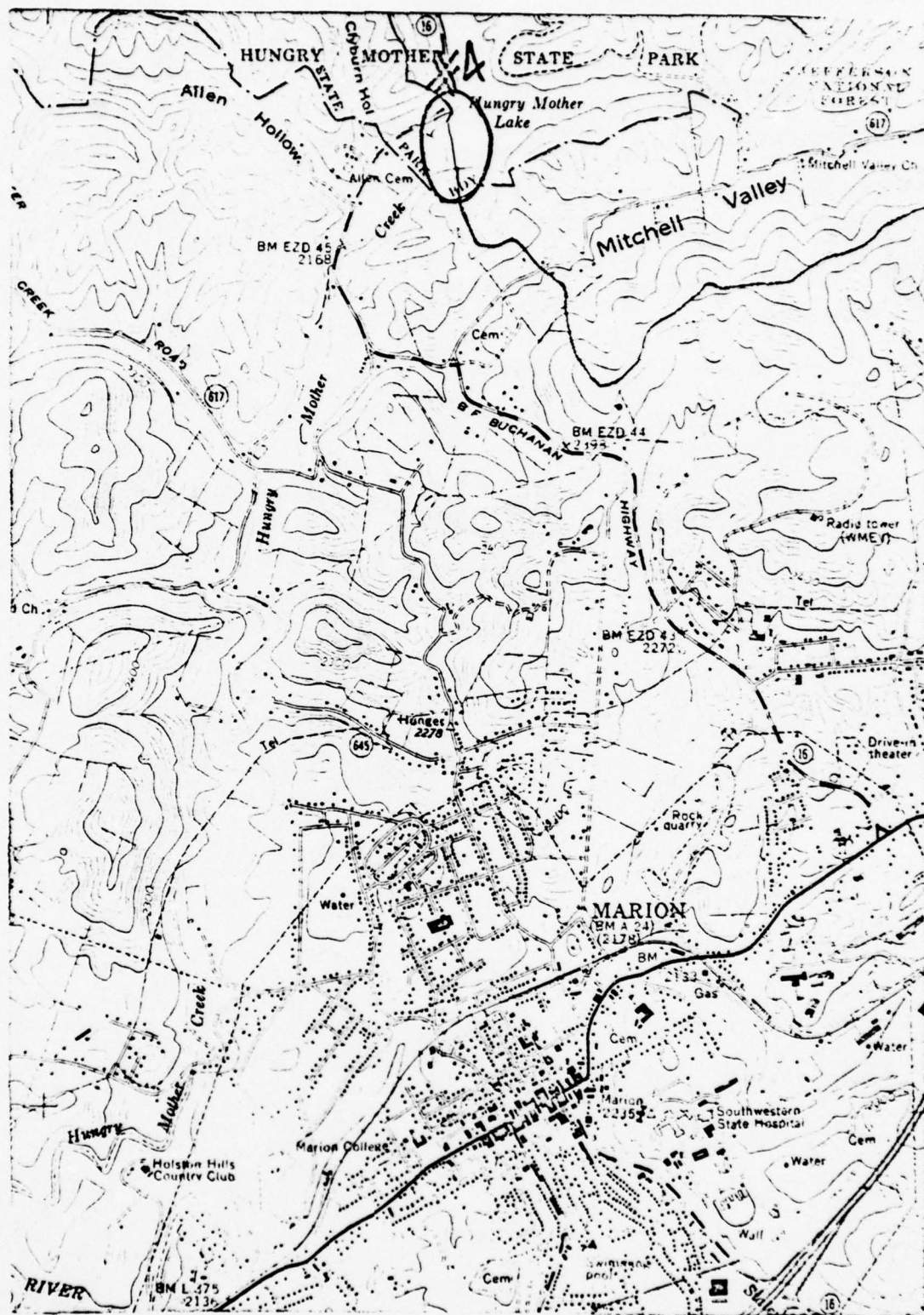
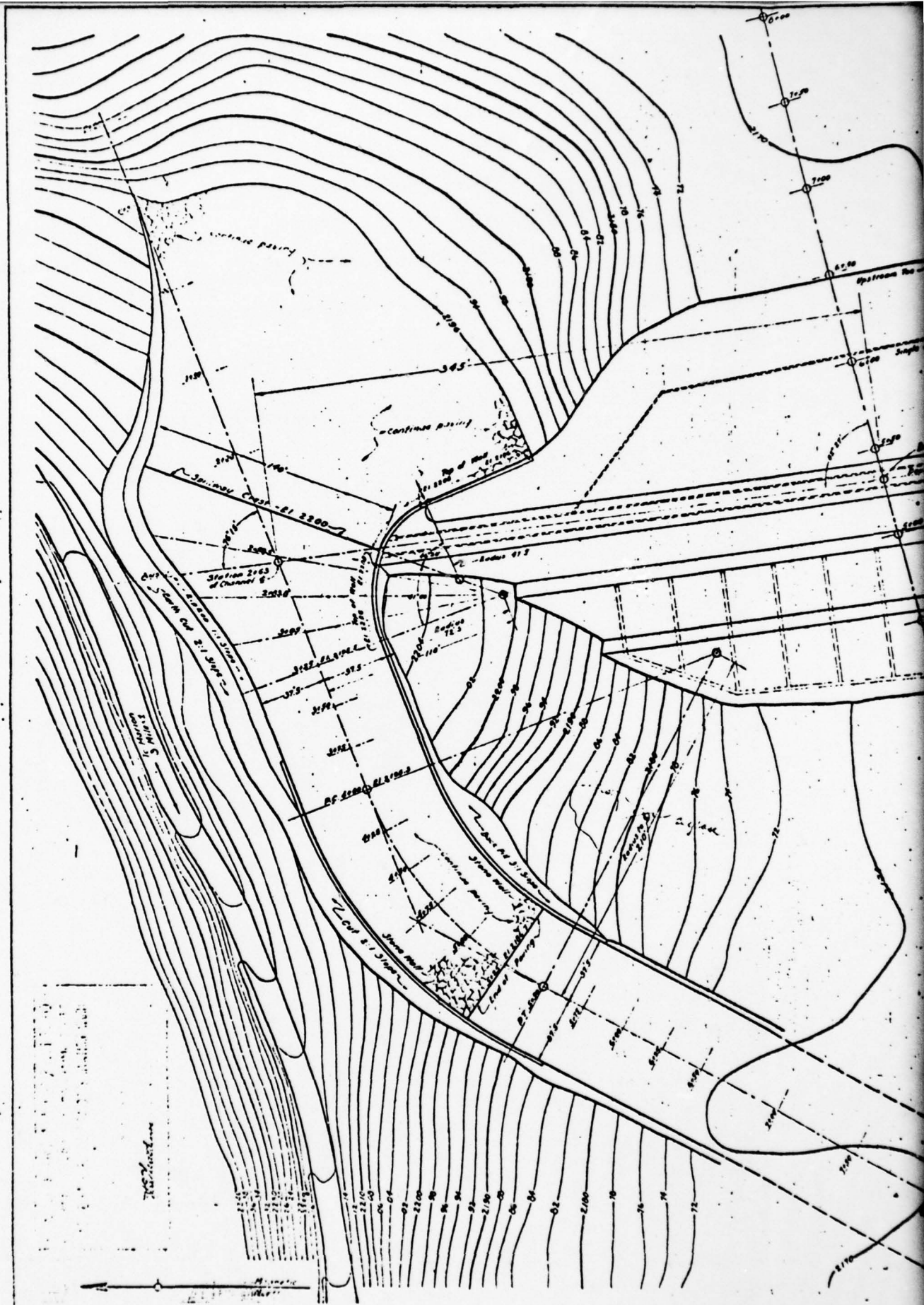


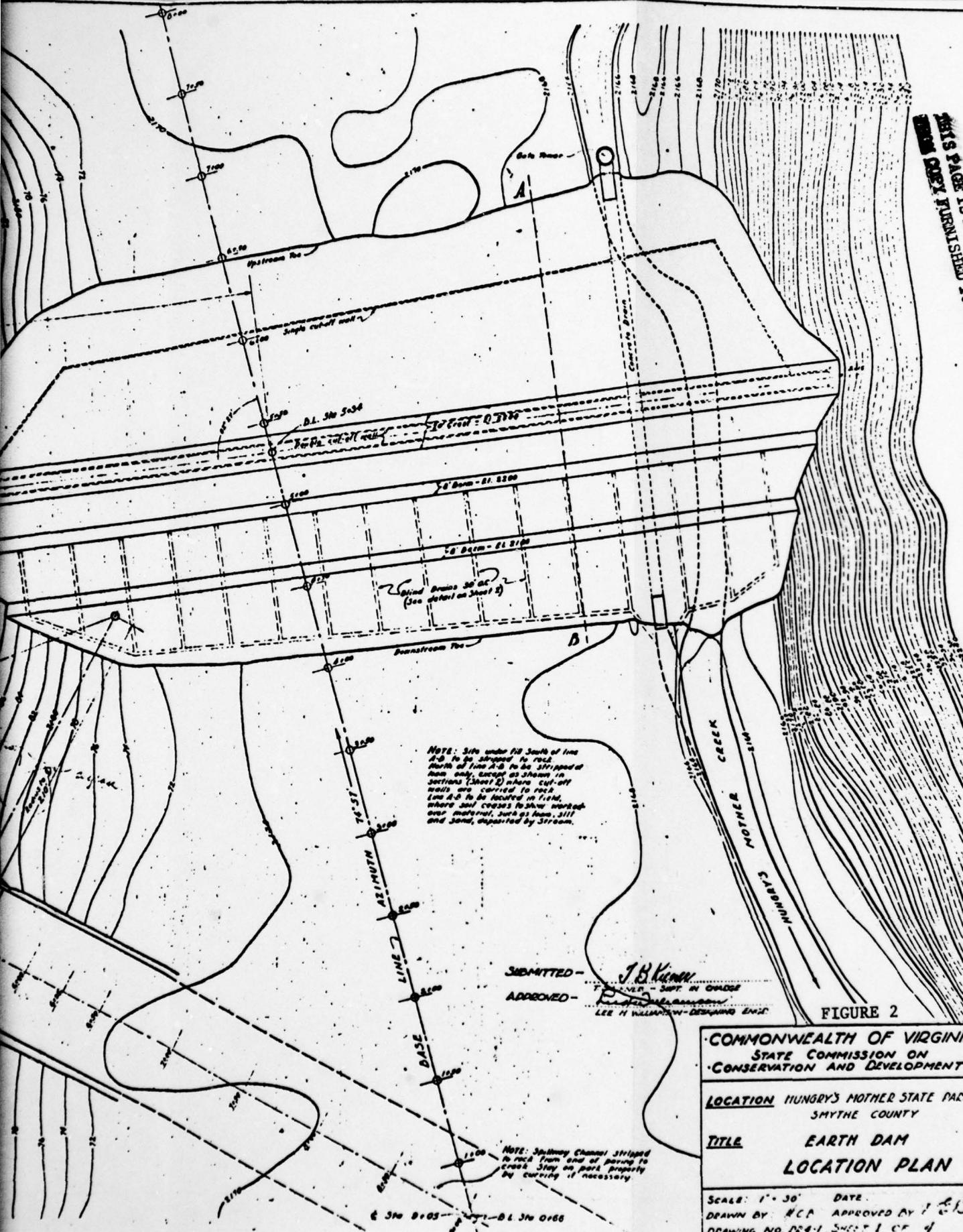
FIGURE 1
VICINITY MAP

HUNGRY MOTHER STATE PARK

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NOTE: Site under fill South of line A-B to be stripped to rock. North of line A-B to be stripped of top only, except as shown in sections (Sheet 2) where cut-off walls are carried to rock. Line A-B to be located in field, where soil covers to show worked over material, hard as shown, silt and sand, deposited by stream.

SUBMITTED - J.B. K...
APPROVED - LEE H. WILLIAMS - DESIGNING ENGINEER

FIGURE 2

COMMONWEALTH OF VIRGINIA STATE COMMISSION ON CONSERVATION AND DEVELOPMENT	
LOCATION HUNGRY'S MOTHER STATE PARK SHYTHE COUNTY	
TITLE EARTH DAM LOCATION PLAN	
SCALE: 1" = 30'	DATE: 1-2-3
DRAWN BY: H.C.P. APPROVED BY: J.B. K...	
DRAWING NO. 224-1 SHEET 1 OF 4	

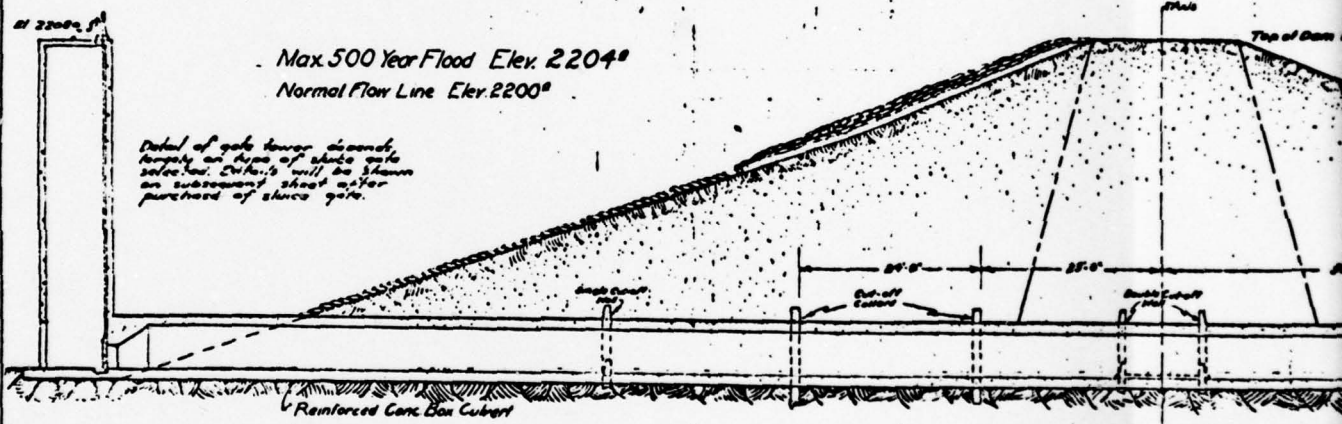
Normal Flow Line Elev. 2200'
Slope changes at this point. Elev. 2195'



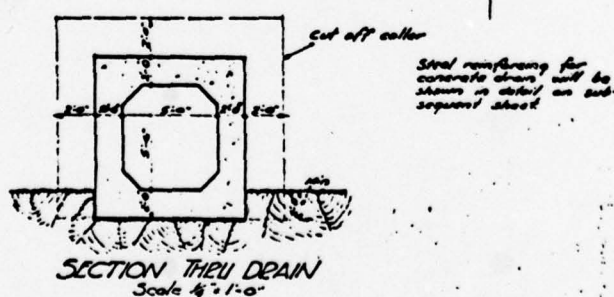
Note:-
To locate single cut-off wall
drop a perpendicular from
slope down 15' until it inter-
sects the ground surface
then go vertical until rock
is reached- as shown.

The working material to be
stripped to rock only where
shown on sheet '1'

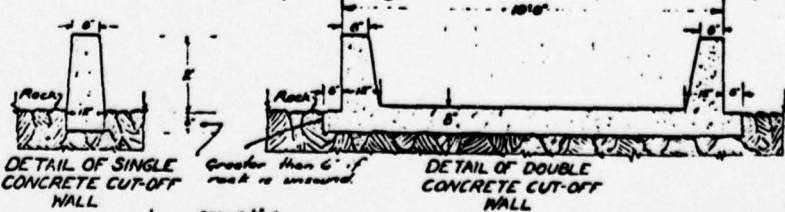
TYPICAL SECTION OF DAM
SCALE 1"=10'



SECTION AT DRAIN & GATE TOWER
SCALE 1"=10'

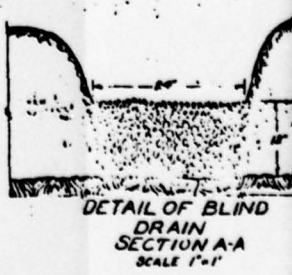


SECTION THRU DRAIN
Scale 1/4" = 1'-0"



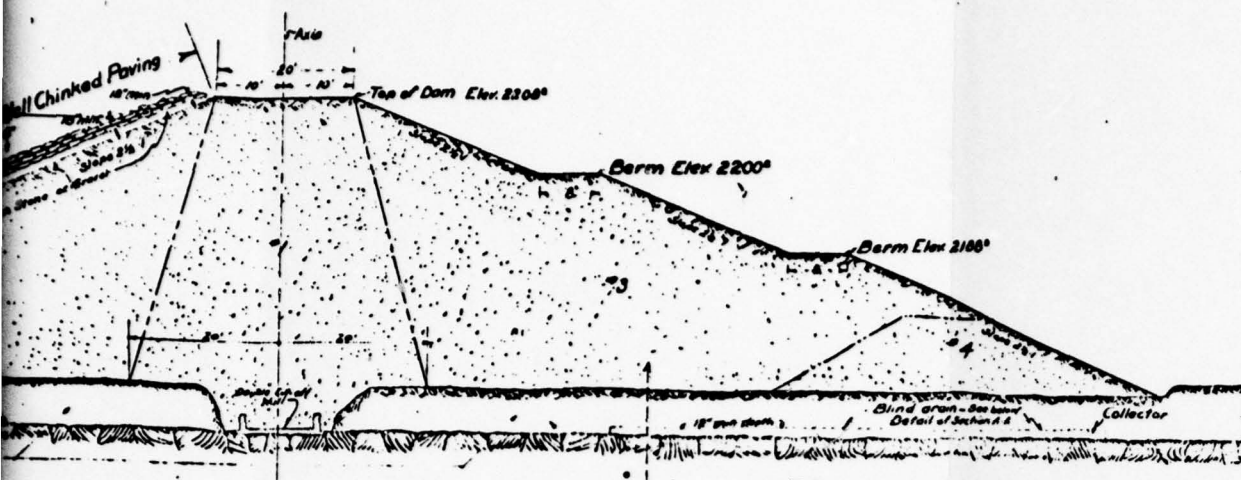
DETAIL OF SINGLE
CONCRETE CUT-OFF
WALL
SCALE 1/8" = 1'-0"

DETAIL OF DOUBLE
CONCRETE CUT-OFF
WALL



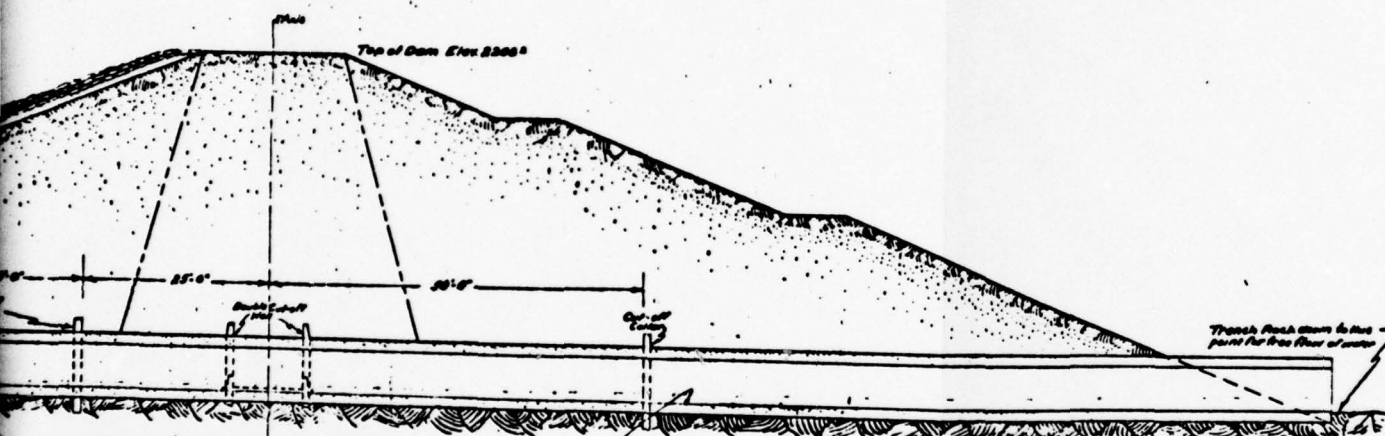
DETAIL OF BLIND
DRAIN
SECTION A-A
SCALE 1" = 1'-0"

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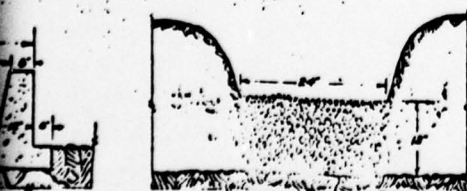
TYPICAL SECTION OF DAM
SCALE 1"=10'

- Notes -
- #1 This portion of fill to be most impervious material obtainable.
 - #2 This portion of fill to be of best impervious material after satisfying #1.
 - #3 This portion of fill to be as pervious a material as possible.
 - #4 This portion of fill to be a very free draining material.



SECTION AT DRAIN & GATE TOWER
SCALE 1"=10'

lay reveal on straight grade from tower to downstream outlet of maximum depth possible with slope of rock. Top to be level, must never be higher than surface of rock.



DETAIL OF BLIND DRAIN
SECTION A-A
SCALE 1"=1'

- Notes -
- Fine stone all around outside.
 - Coarse stone in interior.
 - Drain need not be on rock - depth to be determined in the field.

SUBMITTED -

J.B. Kline

APPROVED -

W. H. Williams

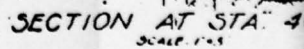
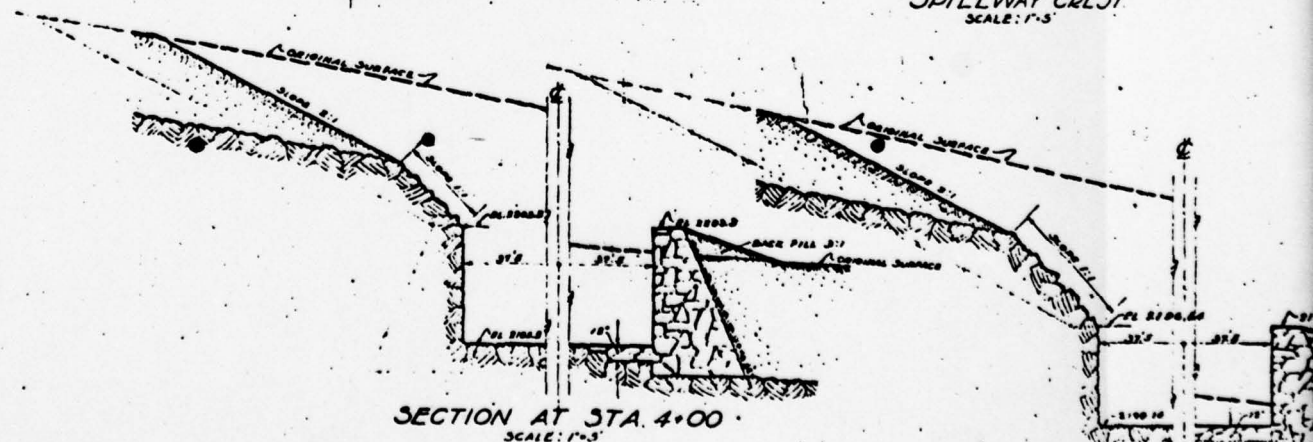
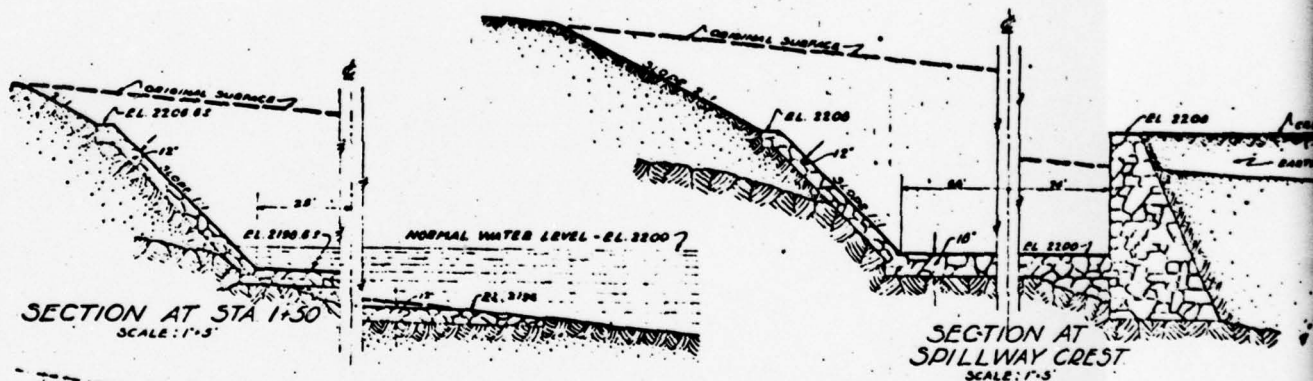
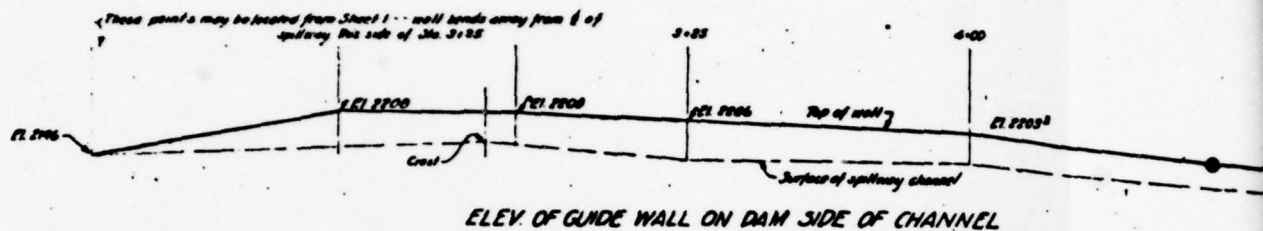
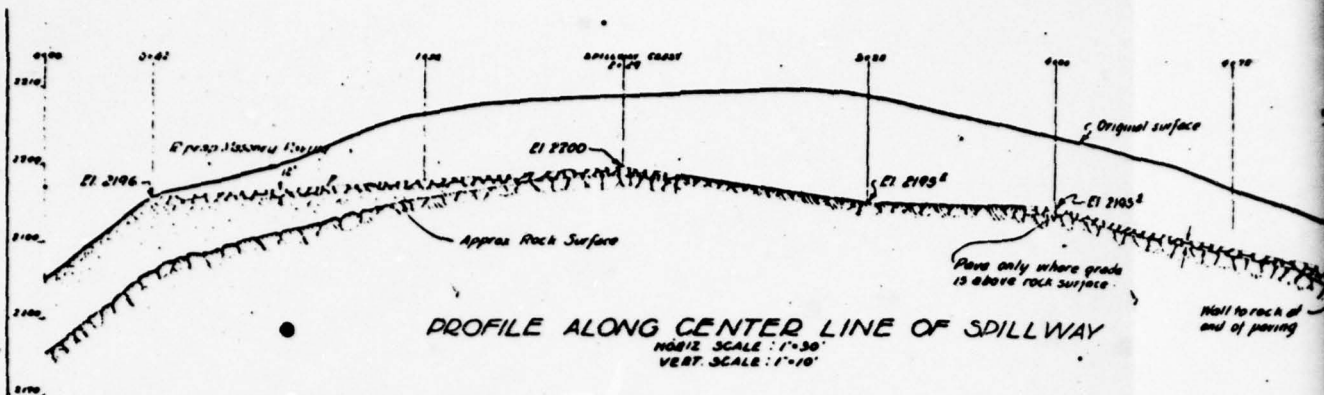
FIGURE 3

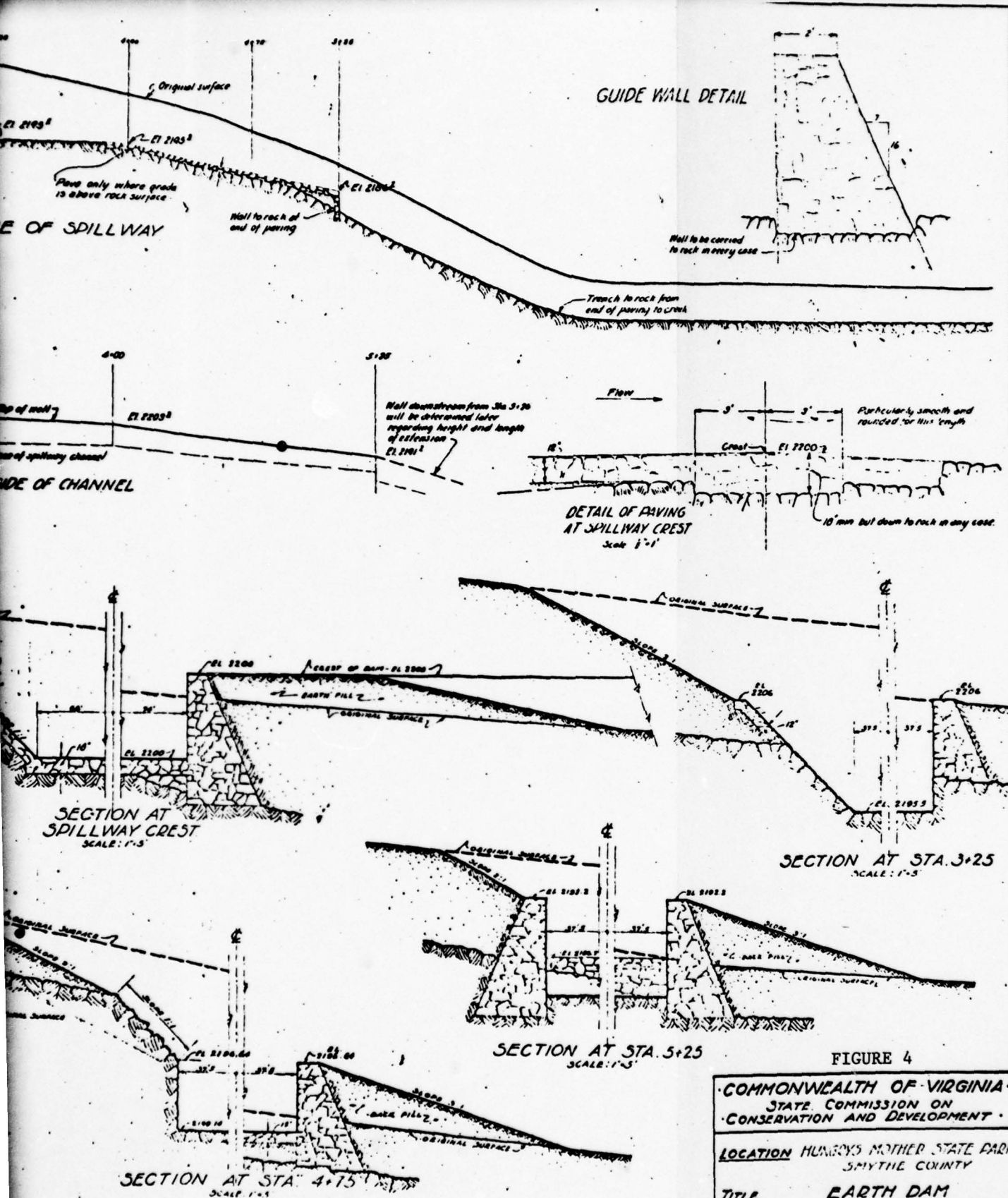
COMMONWEALTH OF VIRGINIA
STATE COMMISSION ON
CONSERVATION AND DEVELOPMENT

LOCATION HUNGRY'S MOTHER STATE PARK
SMYTH COUNTY

TITLE EARTH DAM
SECTIONS

SCALE: AS SHOWN DATE: JUNE 1954
DRAWN BY: A.B.H. APPROVED BY: W.E. Burson
DRAWING NO. 224-2 SHEET 2 OF 4





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FIGURE 4

COMMONWEALTH OF VIRGINIA
STATE COMMISSION ON
CONSERVATION AND DEVELOPMENT

LOCATION HUNGERFORD'S MOTHER STATE PARK
SPRYTHIE COUNTY

TITLE EARTH DAM
SPILLWAY SECTIONS

SCALE: AS SHOWN DATE: 12/1/53
DRAWN BY: A.C.A. APPROVED BY: J.B. Kenev
DRAWING NO. DPA-3 SHEET 3 OF 4

SUBMITTED -

J.B. Kenev

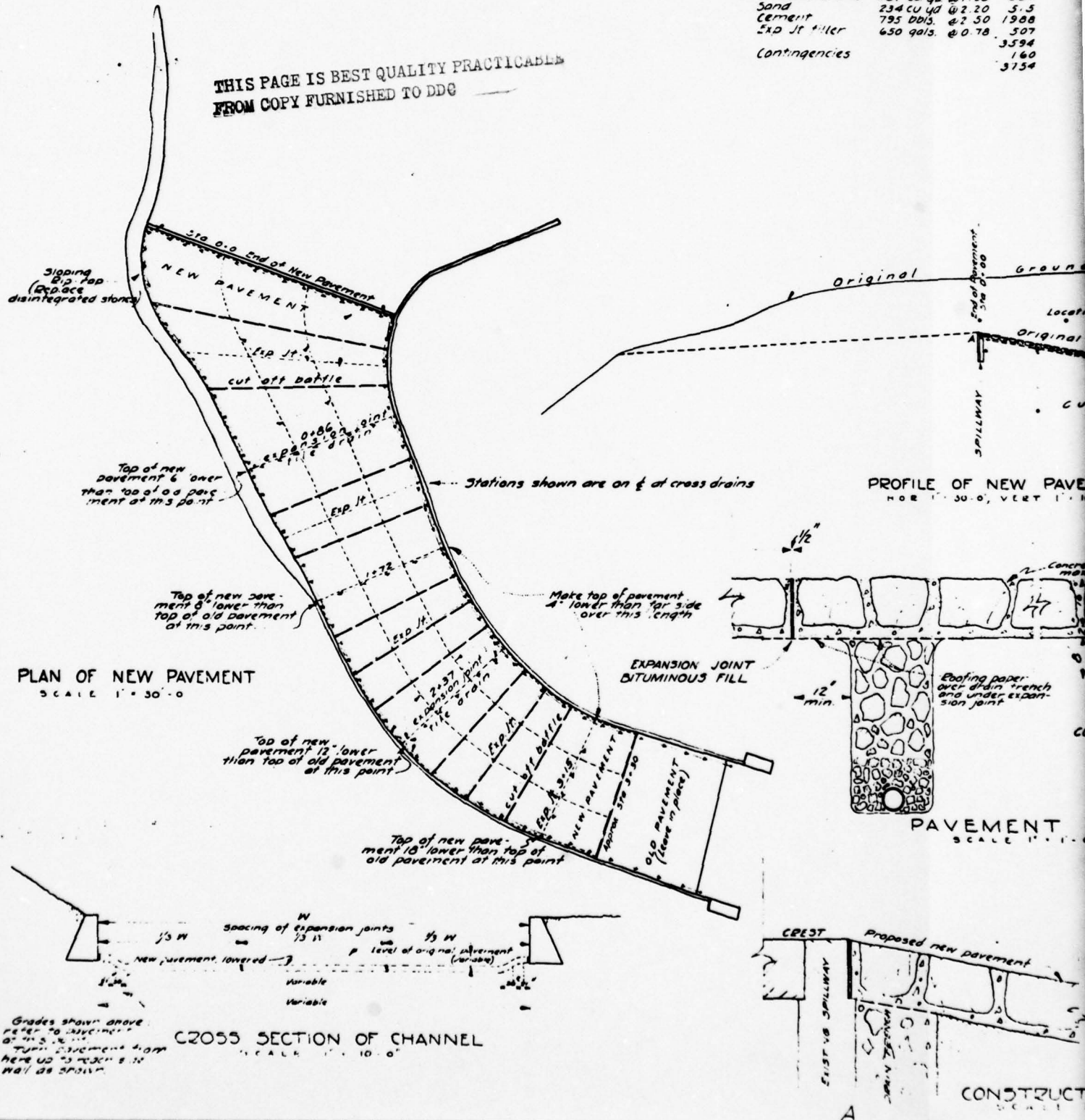
APPROVED -

FOR ENGINEER IN CHARGE
J.B. Kenev
SEE INSTRUCTIONS TO DRAWING ENGINEER

ESTIMATE

Job 124 Earth Excavation	1000 cu yd	
Job 128 Masonry	1000 cu yd	
concrete mortar	530 cu yd	
crushed stone	467 cu yd	@ 1.25 584
sand	234 cu yd	@ 2.20 515
cement	795 bbls.	@ 2.50 1988
Exp. Jt. filler	650 gals.	@ 0.78 507
Contingencies		3594
		160
		3754

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Excavation 100	0 cu yd		
Masonry 1,000	cu yd		
Concrete mortar	530 cu yd		
Crushed stone	467 cu yd	@ 1.25	584
Sand	234 cu yd	@ 1.50	351
Cement	795 bags	@ 2.50	1988
Std Jt filler	650 gals.	@ 0.78	507
			3594
Contingencies			160
			3754

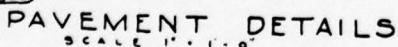
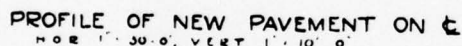
[illegible]

1. FOUNDATION CUT TO GRADES SHOWN INCLUDING TRENCHES FOR CUTOFFS. WHERE EXISTING AT THIS GRADE IS LOOSE TAMPA COUNTY SAND AND GRAY TO BRUSH WITH CAY TAMPA COUNTY SAND EXCEEDING 4" IN THICKNESS. IF CAY TO 4" FROM WHERE TRENCHING STOPPED, EFFECTIVE OF WHITE SILT MATERIAL AND GRAY TO GRADE IN SAME WAY. IF WATER IS ENCOUNTERED AFTER SUCH EXCAVATION, BRING UP TO WATER LEVEL WITH HAND PUMP AND ONE MAN STAYS COVER HOLES IN EXPOSED SAND AND RESUME TAMPA COUNTY SAND TO GRADE.

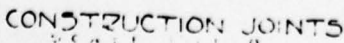
2. CONCRETE Use one part cement, two parts sand and four parts crushed stone. Vary slightly if necessary for different mix. Crushed stone shall not exceed 2 1/2" maximum diameter. Lay 2" bed of concrete under all stone paving and fill joints between stones completely. Where pavement crosses drainage stone or rock in trenches cover with tar paper or roofing material before depositing concrete bed. Concrete must be protected from freezing.

3. **STONE PAVING:** Use clean sandstone or stone which is not a carbonate or calcareous. Place in a 3" thick bed so that thickness of bed and stone is 3" to 4" minimum. Break stone if necessary to exact thickness of pavement from exceeding 3" thick.

4. **EXPANSION JOINTS:** Lay out joint at least one stone from last section to line of joint. Place in a 6" opening using 1" thick separator strips of bent and galvanized section. When concrete has set 24 hours, cut form and remove separator strip. In accordance to manufacturer's suggestions, joint to be formed every 20' or 30' for footings, curbs.



METHOD FOR FORMING EXPANSION JOINT



DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

[illegible]

APPENDIX II

PHOTOGRAPHS



June 1978

TOP OF SOUTH WALL OF SPILLWAY SHOWING
DETERIORATED ROCK SURFACE



June 1978

VIEW FROM BOTTOM OF SPILLWAY CHUTE



June 1978

INTAKE TOWER

APPENDIX III
FIELD OBSERVATIONS

APPENDIX A

CHECK LIST

VISUAL INSPECTION

PHASE 1

Name Dam: Hungry Mother State Park Dam County: Smyth State: Virginia Coordinators: Norfolk District Corps of Engineers

Date(s) Inspection: June 5, 1978 Weather: Clear, warm Temperature: 72°F

Pool Elevation at Time of Inspection: El. 2,200 m.s.l. Tailwater at Time of Inspection: m.s.l.

Gilbert Associates, Inc.
Inspection Personnel:

William J. Santamour
Thomas E. Roberts
Thomas W. Schreffler

Also Present:

George Miller (Asst. Superintendent of Hungry Mother State Park)
Buck Arnold Virginia State Water Control Board

Thomas W. Schreffler - Recorder

CONCRETE/MASONRY DAMS: Not Applicable

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
SEE PAGE ON LEAKAGE	Not Applicable	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Not Applicable	
DRAINS	Not Applicable	
WATER PASSAGES	Not Applicable	
FOUNDATION	Not Applicable	

EMBANKMENT

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
SURFACE CRACKS	None observed.	Entire embankment covered with grass and occasional small trees and bushes.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed.	See riprap failure, below.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Crest observed to be both horizontally and vertically straight.	
RIPRAP FAILURES	Small bench (approximately five feet wide) has formed at pool level.	Repair as part of a regular maintenance program.

EMBANKMENT

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

JUNCTION OF EMBANKMENT
AND ABUTMENT, SPILLWAY
AND DAM

Observed to be in good condition.

ANY NOTICEABLE SEEPAGE

Large seepage area at right abutment, adjacent to spillway, in the natural slope. Area located approximately 190 feet downslope from the top of spillway crest measured along the spillway wall. Large flat area at the downstream toe of the dam was wet, which appeared to be from seepage, although there was no seepage indicated on the embankment slope.

Total seepage estimated at 5 g.p.m. Institute monitoring program to detect changes in flow rate.

STAFF GAGE AND RECORDER

None

DRAINS

A gravel underdrain system is indicated on the plans and is shown to discharge on each side of the outlet works discharge tunnel exit. A small seepage flow (5 g.p.m.) was observed at each of these locations.

OUTLET WORKS

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

CRACKING AND SPALLING OF
CONCRETE SURFACES IN
OUTLET CONDUIT

At upstream end of tunnel, where steel
gates join concrete structure, some
spalling was observed on the roof of
the structure.

INTAKE STRUCTURE

The sluice gate on the right side of the gate
tower, looking downstream, was inoperable.

OUTLET STRUCTURE

A free discharge into the old streambed.
No serious erosion was observed.

OUTLET CHANNEL

No obstructions.

EMERGENCY GATE

None

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	None	
APPROACH CHANNEL	A stone pavement apron gradually slopes up to and converges at the crest. We were told that some loose stones are removed by visitors and used as steps up the retaining wall, but few stones appeared to be missing.	
DISCHARGE CHANNEL	Few loose stones in channel bottom. Top of south retaining wall disintegrating along most of lower portion of wall.	
BRIDGE AND PIERS	None	

INSTRUMENTATION

<u>VISUAL EXAMINATION</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
MONUMENTATION/SURVEYS	Stone monuments (4" x 4") observed at top of dam crest at 50 foot spacing.	Monuments may have possibly been used for settlement monitoring.
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	Five 2-inch pipes located near the toe of the downstream embankment may have been used for observing water levels.	
OTHER		

RESERVOIR

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
SLOPES	Well vegetated with some heavy brush and trees at toe.	Slopes should be maintained by cutting larger growth.
SEDIMENTATION	None observed.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Right side slope, immediately past right spillway retaining wall, eroded for approximately 20-30 feet. Downstream channel otherwise appears in a stable condition.	
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Downstream channel generally well stabilized.	Eroded side slope should be either laid back and grass covered, or using the existing slope (approximately 1:1) riprap or some other protective covering should be placed.
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 40 homes are shown on USGS quadrangle map (1969) to be near the Hungry Mother Creek.	

APPENDIX IV

REFERENCES

APPENDIX IV

REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, (Washington, D.C., Department of the Army, Office of the Chief of Engineers).
2. HEC-1 Flood Hydrograph Package, (Hydrologic Engineering Center, U.S. Army Corps of Engineers, January 1973).
3. Design of Small Dams, (U.S. Department of the Interior, Bureau of Reclamation, Second Edition, 1973).
4. "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian," Hydrometeorological Report No. 33, (U.S. Weather Bureau, April 1956).
5. "Rainfall Frequency Atlas of the United States," Technical Paper No. 40, (U.S. Weather Bureau, May 1961).

APPENDIX V

CONDITIONS

APPENDIX V

CONDITIONS

This Report is based on a visual inspection of the dam, a review of available engineering data, and a hydrologic analysis performed during a Phase I investigation as set forth in the U.S. Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams and the contract between the U.S. Corps of Engineers and Gilbert Associates, Inc.

The foregoing inspection, review, and analysis are by their nature limited in scope. It is possible that conditions exist which are hazardous, or which might in time develop into safety hazards, that are not detectable by this inspection, review, and analysis. Accordingly, Gilbert Associates, Inc. cannot and does not warrant or represent that conditions which are hazardous, or which may in time develop into safety hazards, do not exist.