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GILBERT ASSOCIATES INC READING PA
NATIONAL DAM SAFETY PROGRAM. GREEN SWAMP NUMBER 2, (NJ 00210), P--ETC.(U)
AUG 78 J M NORMANN
DACW61-78-C-0114

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PASSAIC RIVER BASIN

WANAQUE RIVER, PASSAIC COUNTY

NEW JERSEY

LEVEL III

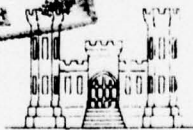
GREEN SWAMP NO. 2

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NJ 00210

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AUGUST 1978

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report cites results of a technical investigation as to the dam's ade- quacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.		

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PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

31 AUG 1978

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Green Swamp Dam No. 2 in Passaic County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given on the first two pages of the report.

Based on visual inspection, available records, calculations and past operational performance, Green Swamp Dam No. 2, a high hazard potential structure, is judged to be in good overall condition. This dam is a concrete saddle dike and is one of nine dams on Wanaque Reservoir. It has no spillway since overflow for the entire reservoir is handled by the Overflow Weir, 1-mile to the east of Green Swamp Dam No. 2. This dam is hydraulically adequate since it will not be overtopped by the Probable Maximum Flood (PMF). To insure the adequacy of the structure, the following actions, as a minimum, are recommended:

a. Within one year from the date of approval of this report, the following remedial actions should be taken:

- (1) The deteriorated gunite surfacing of the concrete should be replaced.
- (2) The gunite surfacing over the expansion joints should be cut away from the expansion joints.
- (3) The covers of the vertical drains should be freed and removed to allow inspection of both vertical and horizontal drains and to determine the extent of longitudinal cracking in the dam crest, where applicable.
- (4) Trees within 20 feet of the toe should be removed and replaced with suitable ground cover.

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NAPEN-D

Honorable Brendan T. Byrne

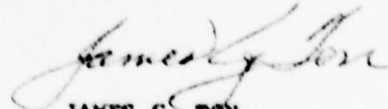
b. The drawdown capabilities of Overflow Weir (I.D. No. NJ00214) and Raymond Dam (I.D. No. NJ00213), which control water release for Wanaque Reservoir, should be increased. Increased drawdown capability will allow for lowering of the reservoir within an acceptable period of time to perform remedial work or for an emergency involving Green Swamp No. 2 Dam, or any other dam on the reservoir. This subject is addressed in the previously issued inspection reports for Overflow Weir and Raymond Dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Robert A. Roe of the Eighth District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, thirty days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia, 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely yours,



JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Cy furn:
Mr. Dirk C. Hofman, P.E.
Department of Environmental Protection

GREEN SWAMP DAM NO. 2 (NJ00210)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 23-26 May 1978 by Gilbert Associates, Inc. under contract to the State of New Jersey. The state, under agreement with the U. S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Green Swamp Dam No. 2, a high hazard potential structure, is judged to be in good overall condition. This dam is a concrete saddle dike and is one of nine dams on Wanaque Reservoir. It has no spillway since overflow for the entire reservoir is handled by the Overflow Weir, 1-mile to the east of Green Swamp Dam No. 2. This dam is hydraulically adequate since it will not be overtopped by the Probable Maximum Flood (PMF). To insure the adequacy of the structure, the following actions, as a minimum, are recommended:

a. Within one year from the date of approval of this report, the following remedial actions should be taken:


(1) The deteriorated gunite surfacing of the concrete should be replaced.

(2) The gunite surfacing over the expansion joints should be cut away from the expansion joints.

(3) The covers of the vertical drains should be freed and removed to allow inspection of both vertical and horizontal drains and to determine the extent of longitudinal cracking in the dam crest, where applicable.

(4) Trees within 20 feet of the toe should be removed and replaced with suitable ground cover.

b. The drawdown capabilities of Overflow Weir (I.D. No. NJ00214) and Raymond Dam (I.D. No. NJ00213), which control water release for Wanaque Reservoir, should be increased. Increased drawdown capability will allow for lowering of the reservoir within an acceptable period of time to perform remedial work or for an emergency involving Green Swamp No. 2 Dam, or any other dam on the reservoir. This subject is addressed in the previously issued inspection reports for Overflow Weir and Raymond Dam.

APPROVED: 
JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 30 Aug 78

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Green Swamp No. 2
State: New Jersey
County: Passaic
USGS Quadrangle Sheet: Wanaque, N.J.
Coordinates: Long. N 41°02'24" Lat. E 74°19'13"
Stream: Not Applicable
Dates of Inventory: May 23-24, 1978

ASSESSMENT OF GENERAL CONDITIONS

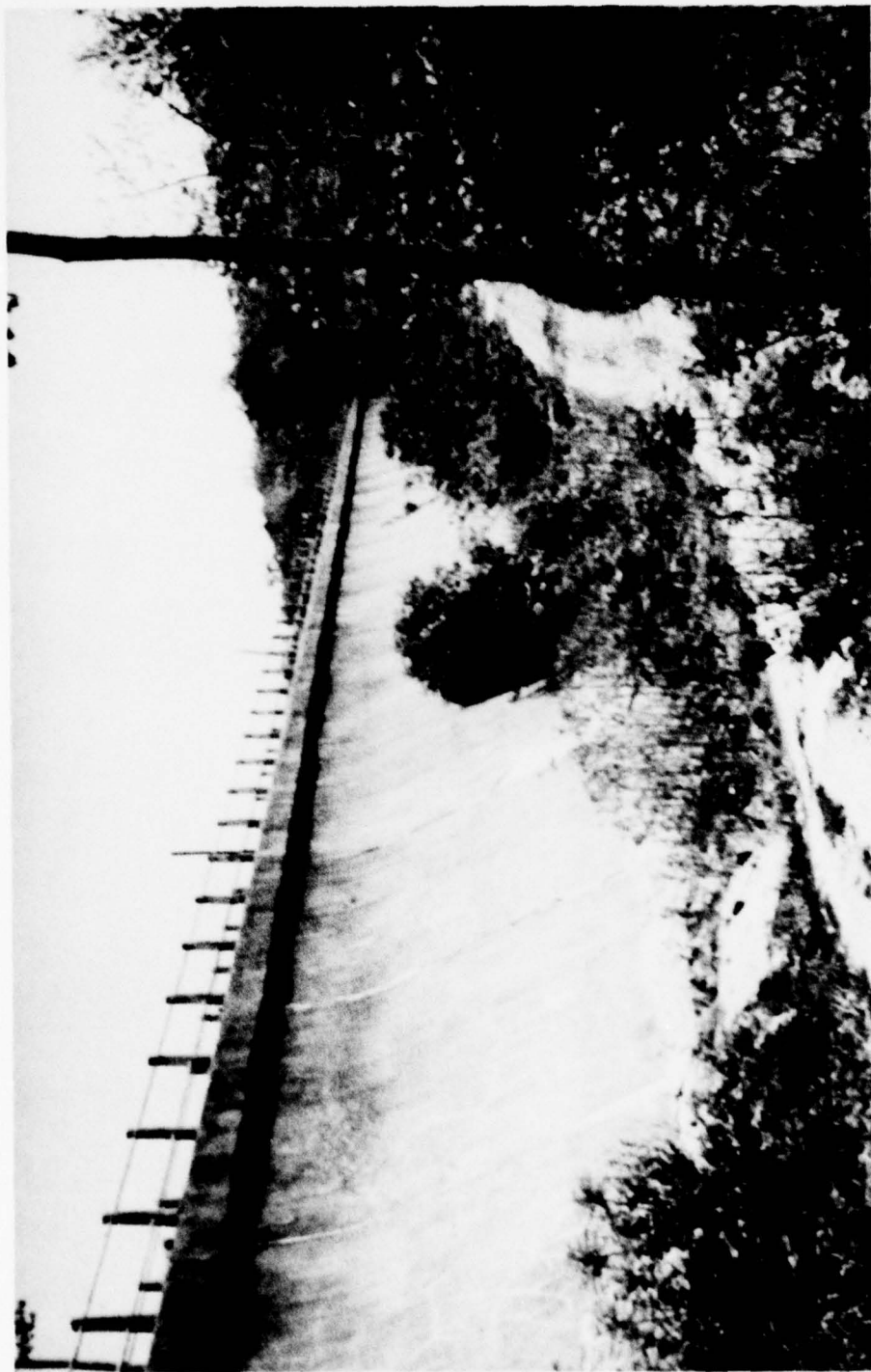
The dam is in good condition as defined in Appendix I, Conditions. No conditions requiring immediate action were observed.

The 11 year old gunite surfacing has deteriorated at every horizontal joint in the dam crest, exhibiting areas of spalled concrete, and was randomly cracked in diverse locations on the downstream slope and at every vertical expansion joint. Some of this cracking shows signs of efflorescence. Even though the gunite surfacing does not enhance the stability of the structure, it does protect the underlying concrete from spalling and should be kept in good repair.

It is recommended that:

1. The deteriorated gunite surfacing be replaced in the future.
2. The gunite surfacing at the expansion joints be cut away from the joints in the future.
3. The covers of the vertical drains be freed and removed in the future to allow inspection of both vertical and horizontal drains and to determine the extent of longitudinal cracking in the dam crest where applicable.
4. Trees within 20 feet of the toe of the dam be removed in the future.
5. The drawdown capability be increased in the future.





June 1978

OVERVIEW PHOTO - GREEN SWAMP 2
(DOWNSTREAM VIEW OF DAM LOOKING EAST)

TABLE OF CONTENTS

	<u>Page</u>
SUMMARY SHEET	
OVERVIEW PHOTO	
TABLE OF CONTENTS	
PHASE I INSPECTION REPORT	
Section 1.0 Project Information	1
Section 2.0 Engineering Data	4
Section 3.0 Visual Inspection	5
Section 4.0 Operational Procedures	7
Section 5.0 Hydraulic/Hydrologic Design	8
Section 6.0 Dam Stability	9
Section 7.0 Assessment, Recommendations/Remedial Measures	11
	<u>FIGURES</u>
Location Map	1
Plan, Profile, and Section	2
APPENDIX A - Visual Checklist	
APPENDIX B - Engineering Data Checklists	
APPENDIX C - Photographs	
APPENDIX D - Hydraulic and Hydrologic Computations	
APPENDIX E - Previous Inspection Reports	
APPENDIX F - Regional Geologic Map	
APPENDIX G - Stability Analysis	
APPENDIX H - References	
APPENDIX I - Conditions	

1.0 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 in the United States. Gilbert Associates, Inc. has entered into contract No. DACW61-78-C-0114 with the Philadelphia Office of the U.S. Corps of Engineers to inspect this dam, Gilbert Work Order 06-7249-050.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the U.S. Corps of Engineers Recommended Guidelines for Safety Inspection of Dams (Reference 1), and contract requirements between Gilbert Associates, Inc. and the Corps of Engineers. The objectives are to expeditiously identify those dams which pose an immediate threat to human life or property and to recommend future studies and/or any obvious remedial actions indicated by the inspection.

1.2 PROJECT DESCRIPTION

1.2.1 Dam and Appurtenances: Green Swamp Dam No. 2 is a 62-foot high, 1140-foot long concrete gravity dam with a 46° bend at about 370 feet from the west abutment. The crest width is 11 feet. According to Figure 2, the dam is founded on final rock surface. There are no outlet provisions at this dam. Record drawing information is included at the end of this report. The water level is controlled at the Wanaque Overflow Weir (NJ 00214) which is a separate structure.

1.2.2 Location: Green Swamp Dam No. 2 is located 1.4 miles due west of Route 511 in Wanaque, New Jersey, and about 2 miles due north of Bloomingdale, New Jersey (see Figure 1). Geologically, the dam is located within the physiographic province of the Precambrian Highlands (see Appendix F).

1.2.3 Size Classification: The dam is classified as a large structure because of its impoundment (76,720 acre-feet), in accordance with Section 2.1.1 of Reference 1.

1.2.4 Hazard Classification: The dam is located about 1.5 miles northwest of Wanaque and Haskell, New Jersey, and upstream of a moderately populated flood plain. The dam is classified as a high hazard potential based on the requirements of Section 2.1.2 of Reference 1.

1.2.5 Ownership: The dam is owned and maintained by the North Jersey District Water Supply Commission (NJDWSC), a New Jersey state commission. They have engineering and maintenance facilities located at Raymond Dam in Wanaque, N.J. The Chief Engineer of the NJDWSC in Wanaque is Mr. Dean C. Noll. The address is:

North Jersey District Water Supply Commission
Ringwood Avenue
Wanaque, N.J. 07465

1.2.6 Purpose of Dam: The Green Swamp Dam No. 2 serves as a dam which closes off low topography in the rim of the Wanaque Reservoir. The reservoir supplies water to residents of Paterson, Passaic, Clifton, Montclair, Glen Ridge, Newark, Kearny, Bloomfield and Bayonne, New Jersey.

1.2.7 Design and Construction History: This dam was constructed from July 5, 1924 to November 16, 1925 by Clifford E. MacEvoy Company, Newark, N.J., as part of the total Wanaque Project. The Project began in 1920 and was completed with the reservoir being filled by March 4, 1929. The original design records could not be located by the staff of the NJDWSC at Wanaque. However, publications indicate the design was performed by employees of the NJDWSC with the assistance of individual consultants. The New Jersey Department of Environmental Protection (DEP) has monthly progress inspection reports and several photographs taken during construction. There is no indication of subsequent construction other than minor maintenance and the application of a gunite surface in 1968.

1.2.8 Normal Operational Procedures: There is no operational procedure for this dam. It relies on adequate freeboard to contain storm surges in the reservoir, with overflow handled by the Overflow Weir (NJ 00214).

1.3 PERTINENT DATA

1.3.1 Drainage Area: 90.4 square miles

1.3.2 Discharge at Dam Site: Not Applicable

1.3.3. Elevation: (Feet above MSL)

Top of Dam - 312

Maximum Spillway Design Flood (SDF) Surcharge - 308.8 (See Section 5.0)

Full Flood Control Pool - Not Applicable

Recreation Pool - Not Applicable

Spillway Crest (gated) - Not Applicable

Upstream Portal Invert Diversion Tunnel - Not Applicable
Downstream Portal Invert Diversion Tunnel - Not Applicable
Streambed at Centerline of Dam - 274.0 (low topography)
Maximum Tailwater - Not Applicable

1.3.4 Reservoir: Length of Maximum Pool - 6.1 miles

1.3.5 Storage (acre-feet):

Recreation Pool - Not Applicable
Flood Control Pool - Not Applicable
Spillway Design Flood (SDF) Surcharge - 69,970
Top of Dam - 76,720

1.3.6 Reservoir Surface (acres):

Top of Dam - 2,680
SDF Surcharge - 2,590
Flood Control Pool - Not Applicable
Recreation Pool - Not Applicable
Spillway Crest - Not Applicable

1.3.7 Dam: Type - Concrete gravity founded on rock.

Length - 1,140 feet with a 134° change of horizontal alignment 370 feet from the right abutment.
Height - Maximum 62 feet, average 32 feet.
Top Width - Top width is 10 feet below top coping. Coping on top of dam is 2 feet thick and 11 feet wide.
Side Slope: Upstream Vertical, Downstream vertical becoming 2 vertical: 1 horizontal.

Zoning - Not Applicable
Impervious Core - Not Applicable
Cutoff - A shallow cut-off in foundation rock formed by a reduction of the concrete gravity section.
Grout Curtain - Grouting was performed from a minimum depth of 4 feet to a maximum depth of 20 feet below final rock surface. (see Sheets 45 and 48 of 61 of the record drawings, available at the North Jersey District Water Supply Commission).

1.3.8 Diversion and Regulating Tunnel: Not Applicable

1.3.9 Spillway: Not Applicable

1.3.10 Regulatory Outlet: Not Applicable

2.0 ENGINEERING DATA

2.1 DESIGN

A plan, profile, grouting record, and maximum section through the dam are shown on original record tracings which are on file at the NJDWSC engineering office (Mr. Dean C. Noll) at Wanaque, N.J. (See Figure 2). No original design data was available other than results mentioned in the North East Water Works Association publication (Reference 3) and a 1925 report (Reference 2) by the Commissioner of the NJDWSC. A recent geologic map covering this area is attached as Appendix F.

2.2 CONSTRUCTION

A set of the record drawings showing plan, cross-sections, and profiles are available at the NJDWSC's office at Wanaque, N.J. A brief description of the construction of this dam, including foundation condition, appeared in the NJDWSC's 1925 report, pages 158-159 (Reference 2). The dam was constructed between July 5, 1924 and November 16, 1925.

2.3 OPERATION - Not Applicable

2.4 EVALUATION

2.4.1 Availability: Foundation exploration and design and construction data were not available, nor were structural and hydraulic design calculations.

2.4.2 Adequacy: Reservoir water level readings were available. Also, see paragraphs 2.1 and 2.2 above. The record drawings supplemented by field data gathered on this inspection appear adequate for this Phase I safety inspection.

2.4.3 Validity: The record drawings appear to adequately represent the actual structure, based on the visual inspection.

3.0 VISUAL INSPECTION

3.1 FINDINGS

3.1.1 General: The Phase I dam inspection was performed by a team of Gilbert Associates, Inc. (GAI) engineers during the period of May 23-26, 1978. A previous inspection of this dam was performed on April 5, 1977 by employees of the North Jersey District Water Supply Commission and is attached as Appendix E.

3.1.2 Dam: The dam is constructed as a concrete masonry gravity section with a change of direction of 134.5° which starts at 370 feet from the west abutment. At this point the dam crosses over a rock outcrop which extends upward to within 7 feet below the top of the dam. The dam has a vertical upstream face, a crest width of 11.0 feet, and a 1 horizontal to 2 vertical downstream face. The entire dam was covered with gunite, and reinforcing mesh was used on the slope sections. According to NJDWSC, the dam received a gunite surface in 1968.

At every vertical expansion joint the gunite had cracked with some spalling and cracking of the underlying concrete. In two locations longitudinal cracking up to 1-3/4 inches deep was observed on the top of the dam in the middle of the block. The gunite on the downstream slope is starting to separate from the underlying concrete, and this has resulted in numerous random cracks, some of which are wet and exhibit exudation. The gunite has cracked and buckled at the expansion joints, and broken off in several places.

There are a few trees growing close to the downstream toe, but most have been cut. There are two swamps in the downstream areas; one is located 70 feet beyond the toe between Station 2+00 and 3+50, and another located 90 feet beyond the toe between Station 9+70 and 10+50. Whether they are formed solely with water draining from the dam is not certain; in two locations standing water was observed about 5-8 feet from the toe. These waterfilled depressions aligned with the vertical 2-foot by 2-foot drains which collect water from the horizontal half round 12-inch drains and exit the dam via 8-inch blind drains (i.e., below the ground surface). See Figure 2. Efforts to open up four of the 31 covers of the vertical drains were futile, and none of the drains were inspected. The owner should remove the covers of the vertical drains to allow inspection of the vertical drains and the horizontal blind drains, and to determine the extent of longitudinal cracking in the crest where applicable.

3.1.3 Appurtenant Structures: None at this dam.

3.1.4 Reservoir Area: The upstream dam area was in good condition. The reservoir rim on either side of the dam appears to have stable slopes. The Precambrian rocks are fully exposed along the shore - the area is densely wooded.

3.1.5 Downstream Channel: None at this dam.

3.2 EVALUATION

All the visual evidence, including the cracks in the gunited surfaces, have led to the conclusion that the dam is not in an imminently dangerous condition. The gunite should be replaced where needed, and at the expansion joints the gunite should be chipped away to expose the joint. The trees growing within 20 feet of the dam toe should be cut.

3.3 ATTENDEES

North Jersey District Water Supply Commission

R. G. Wieland 24 May, 1978

New Jersey Department of Environmental Protection

Larry Woscyna 23 May, 1978

Gilbert Commonwealth, Inc.

Rudolph J. Wahanik 23-24 May, 1978

Fine T. Hsu 23-24 May, 1978

Rudi P. Visser 23-24 May, 1978

4.0 OPERATIONAL PROCEDURES

4.1 PROCEDURES

The water level in Wanaque Reservoir is governed by the Overflow Weir structure 1 mile east to a pool elevation of 302.4 feet MSL. The highest water elevation recorded since October 1950 was 303.93 feet with excess flow passing over the uncontrolled weir. There is no operational procedure at Green Swamp No. 2 Dam.

4.2 MAINTENANCE OF DAM

The reservoir rim is traversed daily by NJDWSC guards who report apparent maintenance problems to the Chief Engineer. In addition, periodic inspections are made by engineers and/or other personnel of the NJDWSC and reports written regarding maintenance requirements. The 1977 inspection report (Appendix E) recommended repairing the loose gunite, and tar insertion at the expansion joints. This still remains to be done.

4.3 MAINTENANCE OF OPERATION FACILITIES - Not Applicable

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

No automatic warning systems exist at this dam. A daily patrol is made by the NJDWSC security guards equipped with radios. According to NJDWSC personnel, the guards are instructed to radio the guard house, or failing that, to directly radio the Wanaque police of any obvious, impending hazard to residents from the dams on the Wanaque Reservoir.

4.5 EVALUATION

The maintenance procedures for this dam are generally inadequate. Even though the gunite surfacing does not enhance the stability of the structure, it does protect the underlying concrete from spalling and should be kept in good repair. The concrete covers of the vertical drains should be freed and removed in order to check functioning of both vertical and horizontal drains. At the same time in the areas where longitudinal cracking has occurred in the dam crest, the extent of this cracking should be determined.

5.0 HYDRAULIC/HYDROLOGIC DESIGN

5.1 EVALUATION OF FEATURES

Other than the dam, there are no hydraulic structures or control facilities at this location. Reservoir overflow is provided by the Overflow Weir, 1 mile to the east. Details on the methodology used and the hydrologic results for this Report are presented in Appendix D.

5.1.1 Design Data: The maximum pool elevation for the design discharge of 18,000 cfs is 304.3 feet. This is based on a spillway elevation of 300.3 feet plus a head of 4.0 feet, for the Overflow Weir. With the flashboards in place, the overflow becomes a sharp edged weir with an elevation of 302.4 feet, and a pool elevation of 306.6 feet with the design flow of 18,000 cfs.

5.1.2 Experience Data: The maximum recorded reservoir level since October, 1950 is 303.9 feet, 8.1 feet lower than the crest of Green Swamp Dam No. 2. This level was reached in March 1951 (References 6 and 7).

5.1.3 Visual Observations: There is no visual evidence to indicate the dam has ever been overtopped.

5.1.4 Overtopping Potential: The probable maximum flood (PMF), when developed as described in Appendix D and with the flashboards in place on the Overflow Weir, results in a reservoir elevation of 308.8 feet. One-half of the PMF results in a reservoir elevation of 306.0 feet, with the flashboards in place. Since the top of the dam is at elevation 312.0 feet, the PMF will not overtop this dam.

5.1.5 Reservoir Drawdown: The existing drawdown facilities installed in the several dams of the Wanaque Reservoir are not adequate to lower the water level of the reservoir in a short period of time. It is recommended that the owner design and construct water release structures that will allow lowering of the water level within an acceptable period of time.

A preliminary evaluation of the performance of the existing drawdown facilities is given in Appendix D. The time required to draw down the Green Swamp Dam No. 2 to the bottom surface level of 272 feet using the existing facilities at Raymond Dam is:

<u>System in Use</u>	<u>Time in Days</u>
Aerator System	128
36-inch Diameter Blowoff	400
Aerator and Blowoff	97

6.0 STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

6.1.1 Visual Observations: The wet areas observed on the downstream concrete face from the concrete joint do not appear to significantly affect the stability of the dam.

Although not all drains could be visually examined, at least one blind drain appears to discharge water into the adjacent swamp. Well-drained granular fill was placed in low areas along the toe area for draining the water out of the blind drains and improving road drainage. This fill provides additional stability to the dam.

Various types of metamorphic rocks, mainly gneissic rock and serpentinous limestone of various quality, were observed from the outcrops around the dam site. This complex foundation condition made special foundation treatments necessary during construction as indicated in the record drawing and Reference 2.

In general, the visual observations did not reveal any evidence of dam instability.

6.1.2 Design and Construction Data: There are no design data available at NJDWSC. This dam was started on July 5, 1924 and completed November 16, 1925. Reference 2 covers the Wanaque Project, of which this dam is a part, up to July 1925. Record drawing sheets 45, 46, and 48 in a set of 61 provide data on site topography, gravity section details, and grouting information.

According to Reference 2 (page 56) the concrete masonry gravity dam was designed to withstand the maximum static water pressure, uplift pressures, plus an assumed ice pressure, exerted at the flow line, of 20,000 pounds/linear foot.

Record drawings, sheet 45 in a set of 61 (see Figure 2), indicate that the deepest point of the foundation excavation extends down to 28 feet below original ground giving the dam a maximum height of 66 feet.

A large quantity of foundation rock excavation was necessary during construction because of the presence of local weathered zones and soft seams. Foundation grouting was extensively performed throughout the foundation area. These special treatments of foundation rocks were to ensure an adequate, stable, and watertight foundation (Reference 2). According to record drawing, sheet 48 of a set of 61, grouting was performed through a total of 3,592 linear feet of drill holes, using 2,665 gallons of grout consisting of 261 bags of cement.

6.1.3 Operating Records: No distress of any kind was reported in the data examined during this inspection.

6.1.4 Post-Construction Changes: A comparison of the record drawings with the visual inspection data indicated no post-construction changes.

6.1.5 Stability Analysis: The stability analysis is based on the PMF water level and 100 percent uplift at the upstream toe. The calculations indicate that the structure has an adequate factor of safety against sliding, overstressing, and overturning. Details of forces involved and magnitude of the safety factors are given in Appendix G. Because of the above facts, the Green Swamp No. 2 Dam has an adequate margin of safety with respect to overturning according to the screening criteria established by the Corps of Engineers (paragraph 4.4.4.4 of Reference 1) and can be considered structurally stable.

6.1.6 Seismic Stability: The dam is located within Zone 1 on the Algermissen Seismic Risk Map of the United States (1969 Edition). The results of the static stability analyses, as per paragraph 6.1.5 and Appendix G, verify that the static stability conditions are satisfactory and conventional safety margins exist; therefore, in accordance with paragraph 3.6.4 of Reference 1, the dam may be assumed to present no hazard due to earthquake.

7.0 ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

The assessment and remedial measures contained herein are based on the provisions of Appendix I, Conditions.

7.1 DAM ASSESSMENT

7.1.1 Safety: On the basis of the visual inspection and available record data, the dam does not exhibit any critical signs of distress such as structural cracking, severe differential settlement between the 30-foot sections, or horizontal alignment dislocation.

The dam top will not be overtopped by the PMF or one-half the PMF as discussed in Section 5.0. The dam has adequate factors of safety against sliding, overstressing, and overturning, in accordance with the analyses in paragraph 6.1.5 and Appendix G.

7.1.2 Adequacy of Information: The visual inspection generally verifies the overall geometry of the dam as presented in the record drawings.

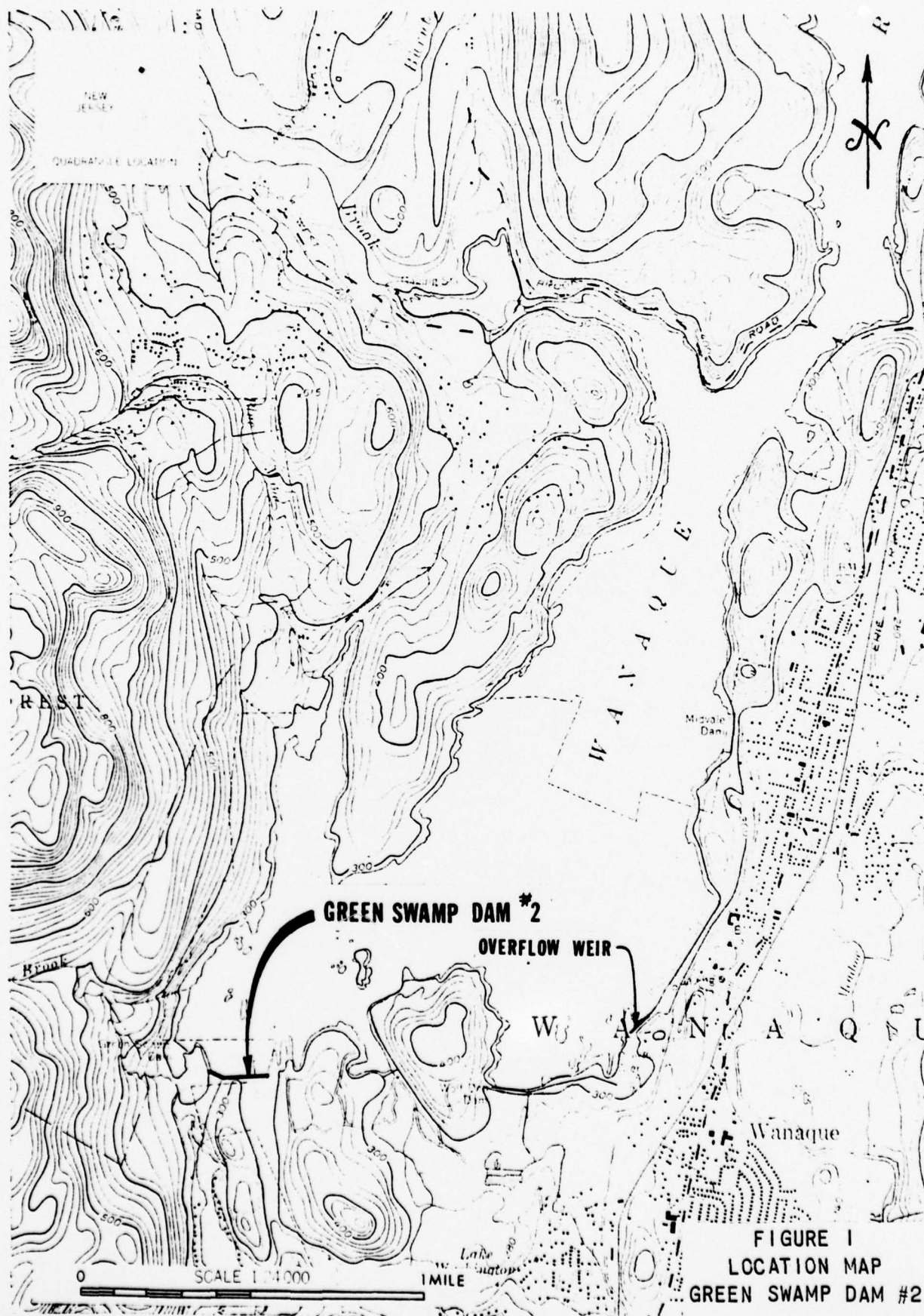
7.1.3 Urgency: Remedial measures recommended in paragraph 7.2 should be implemented in the future.

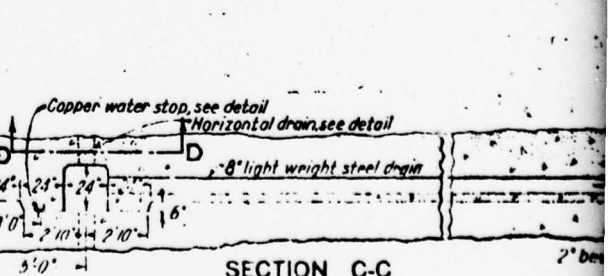
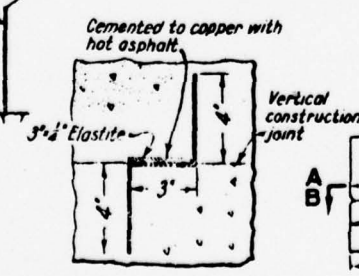
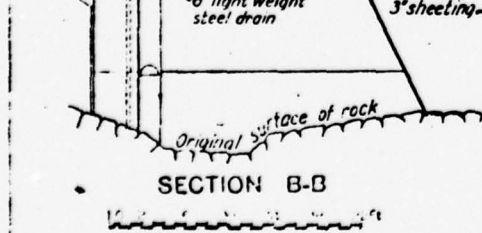
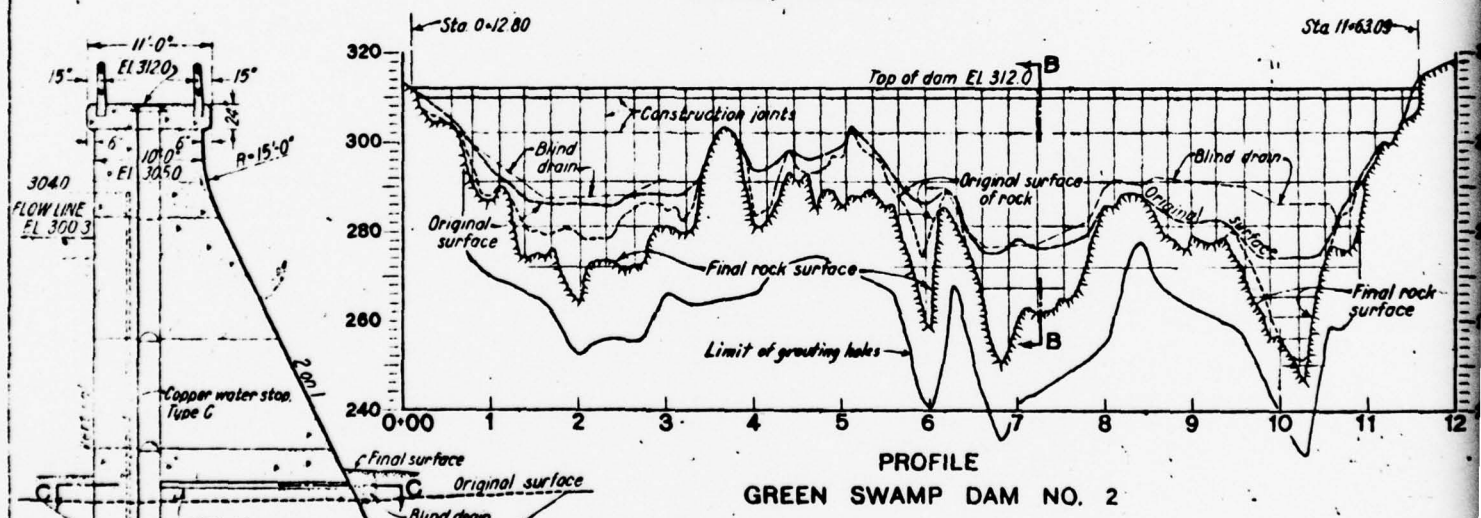
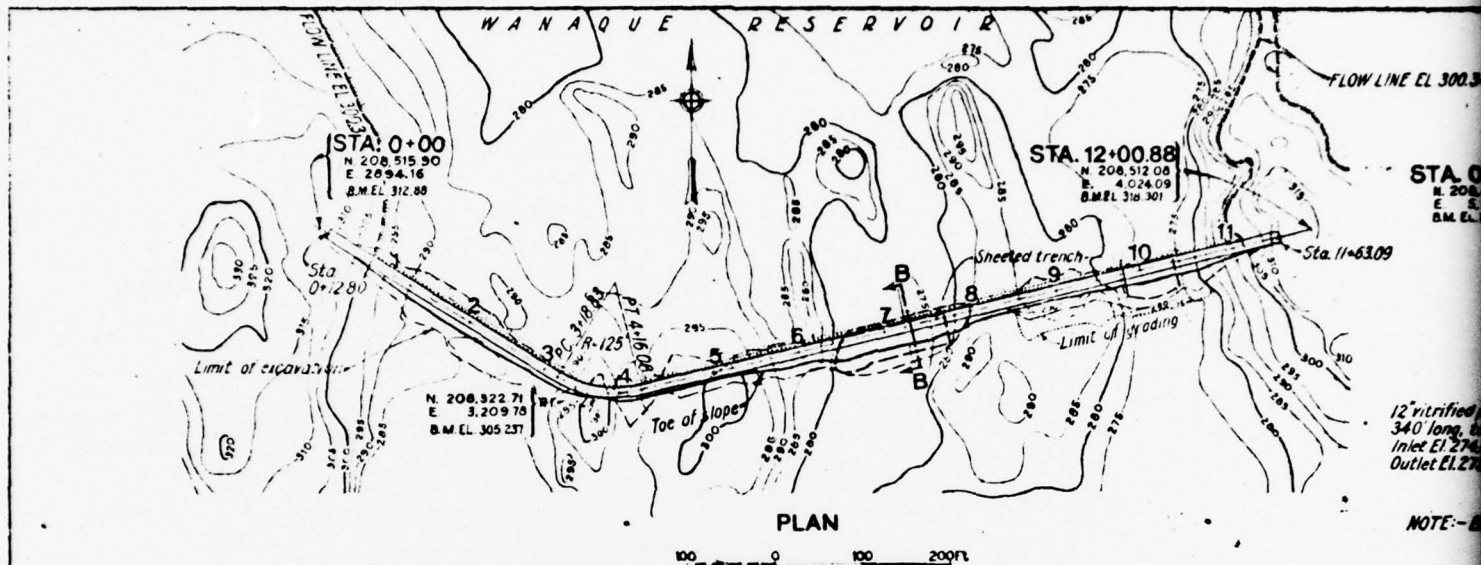
7.1.4 Necessity for Further Studies: None.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

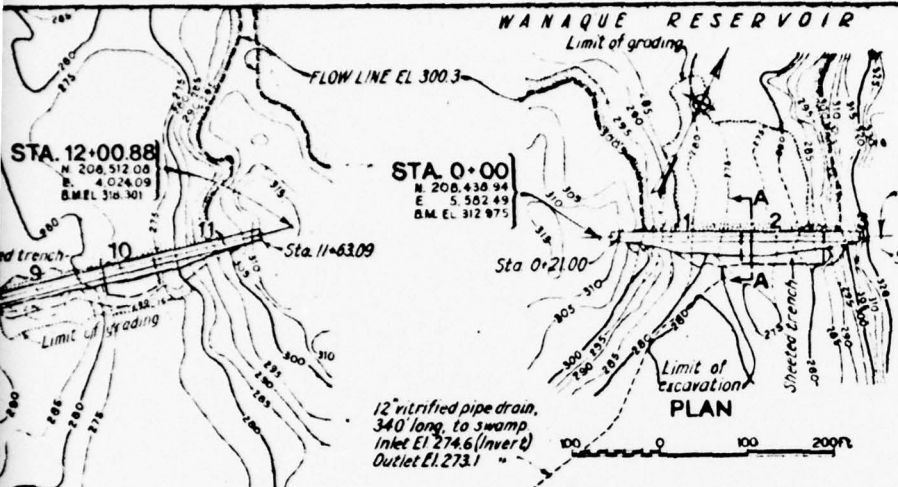
7.2.1 Recommendations: The following measures are recommended:

- a. All cracked and loose gunite be replaced.
- b. The gunite at expansion joints be cut away.
- c. The concrete covers of the vertical drains be freed and removed to allow inspection of both vertical and horizontal drains, and to determine the extent of longitudinal cracking in the dam crest where applicable.
- d. Trees growing within 20 feet of the dam be removed.
- e. The owner design and construct water release structures that will allow lowering of the water level within an acceptable period of time.



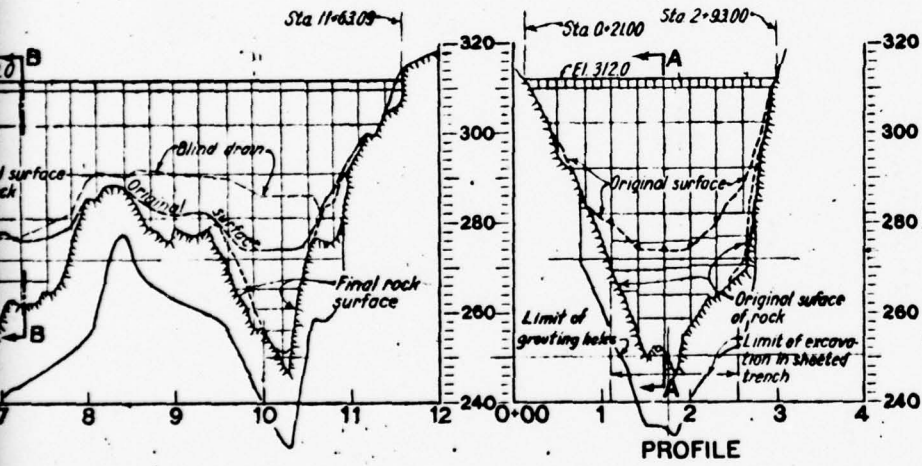
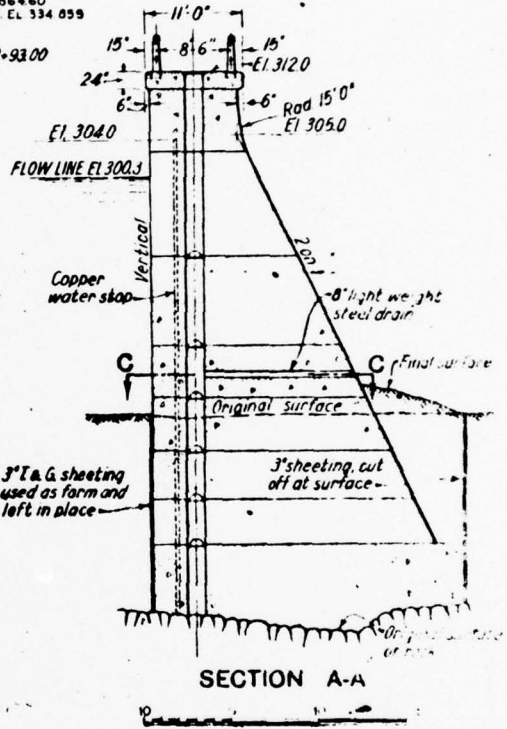


DETAILS COMMON



12 vitrified pipe drain,
340' long, to swamp
Inlet El. 274.6 (Invert)
Outlet El. 273.1

NOTE: - Bench marks are 3/8\"/>

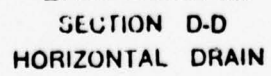
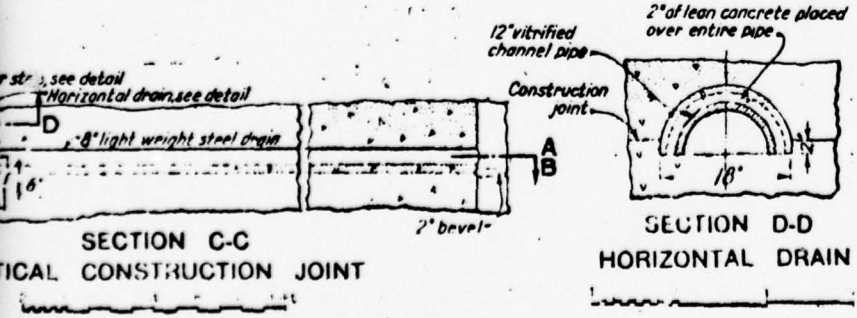


GREEN SWAMP DAM NO. 4

CONSTRUCTION RECORD
Dam No. 2 built July 5, 1924 to Nov. 16, 1925.
Dam No. 4 built May 24, 1925 to July 19, 1926
under Contract 7, Clifford F. MacEvoy Co.,
Newark, N.J., Contractor, in accordance with
this record drawing.

Engineer in charge
NORTH JERSEY DISTRICT
WATER SUPPLY COMMISSION

WANAQUE RESERVOIR
GREEN SWAMP DAMS NOS. 2 AND 4
PLANS, PROFILES AND SECTIONS



DETAILS COMMON TO BOTH DAMS

Neil O. Haedrege
Asst. Chief Engineer

APRIL 30, 1931 FIGURE 2

2

APPENDIX A
VISUAL CHECKLIST

Check List
Visual Inspection
Phase I

Name Dam: Green Swamp No. 2 County: Passaic State: New Jersey Coordinators: Philadelphia District
Corps of Engineers

Date(s) Inspection: May 23, 1978
May 24, 1978

Weather: Sunny - Dry Temperature: 76°F (air)

Pool Elevation at Time of Inspection: 302.7 MSL Tailwater at Time of Inspection: Not Applicable

Gilbert Associates, Inc.

Others:

Inspection Personnel:

R. J. Wahanik

R. G. Wieland - North Jersey District Water Supply Commission

Fine T. Hsu

Larry Woscyna - New Jersey Department of Environmental Protection

Rudy P. Visser

Rudolph J. Wahanik - Recorder

Dam Type: It is a gravity dam of concrete masonry with a vertical upstream slope, and a downstream slope which begins vertical and becomes 2 vertical:1 horizontal. The dam is used as a water retaining structure and is one of the nine dams that form Lake Wanaque.

Crest Elevation - 312.00 feet

Crest Width - 11 feet

Dam Length - 1,140 feet

Spillway Location: The reservoir spillway is located 1 mile away from Green Swamp Dam No. 2 and a separate inspection report has been prepared to cover Overflow Weir NJ00219.

CONCRETE DAMS

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEEPAGE OR LEAKAGE	<p>At Station 2 + 70 a damp spot was found on the downstream face, 5 feet above ground surface. Some cracking of gunite surface and exudation was noted at this spot.</p>	
STRUCTURE TO ABUTMENT JUNCTIONS	<p>Exposed rock can be observed at both abutments and their elevation is higher than the dam crest. The connection between the abutments and dam is dry and in good condition without any signs of past or recent leakage.</p>	
DRAINS	<p>The dam is provided with thirty-one 8-inch diameter drain pipes placed below the downstream grade. Two of the drain outlets (Station 2 + 72 and Station 4 + 75) were partially exposed and the adjacent area was wet. No seepage flow could be visually detected. Each of the horizontal drain pipes is connected to a 24-inch by 24-inch vertical shaft capped with a concrete manhole cover at the dam crest. Four of the vertical manhole shafts were slated to be opened (Station 2 + 73; Station 4 + 55; Station 6 + 35 and Station 9 + 95); all efforts to open same failed.</p>	<p>Owner should free and remove all manhole covers so vertical and horizontal drains can be inspected.</p>
WATER PASSAGES	<p>Besides the 8-inch diameter drains described above, this dam does not have any specific passages to discharge or receive water because it is used as a water retention structure.</p>	

CONCRETE DAMS

Sheet 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FOUNDATION	<p>Basically, these are two groups of foundation rocks at the dam site. Serpentinous limestone is distributed at the west end section of the dam, whereas quartz-oligoclase-biotite gneiss to granitic gneiss crops out around the east section of the dam. Variable weathering or alternation of rocks would be expected, especially along the contact zone. A large amount of foundation rock overexcavation was done during construction due to the presence of local weathered zones and soft seams and grouting was extensive.</p>	<p>Granular fills were placed in the low area along the toe and form an access road.</p>
SURFACE CRACKS CONCRETE SURFACES	<p>The exposed dam surfaces were gunited during the fall of 1968. The gunited surface exhibits random cracking along the crest and the downstream surface of the dam. There are some vines growing along the downstream face and approximately 15% of the gunited surface is loose. The exposed surface is starting to deteriorate but no remedial action is recommended at this time, except for replacing the loose gunite.</p>	
STRUCTURAL CRACKING	<p>No structural cracking could be visually detected or inferred during the site visit.</p>	
VERTICAL AND HORIZONTAL ALIGNMENT	<p>The vertical and horizontal alignment follows the original design drawings.</p>	
MONOLITH JOINTS	<p>Not Applicable</p>	

CONCRETE DAMS

Sheet 3

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONSTRUCTION JOINTS	<p>Besides some small areas where a few moist whitish exudations exist along the downstream surface, no leakage or apparent displacement of the construction joints could be observed.</p>	
OTHER	<p>There are bushes and some large trees (up to 10-inch diameter) growing along the toe of the dam. 410 feet of the steel railing along the crest of the dam has been painted and there are still 730 feet of unpainted railing left.</p>	<p>Cut the trees within 20 feet of the toe of the dam.</p>

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Not Applicable	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Not Applicable	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Not Applicable	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Not Applicable	
RIPRAP FAILURES	Not Applicable	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Not Applicable	
ANY NOTICEABLE SEEPAGE	Not Applicable	
STAFF GAGE AND RECORDER	Not Applicable	
DRAINS	Not Applicable	

OUTLET WORKS
(NONE AT GREEN SWAMP DAM NO. 2)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not Applicable	
INTAKE STRUCTURE	Not Applicable	
OUTLET STRUCTURE	Not Applicable	
OUTLET CHANNEL	Not Applicable	
EMERGENCY GATE	Not Applicable	

UNGATED SPILLWAY
(NONE AT GREEN SWAMP DAM NO. 2)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Not Applicable	
APPROACH CHANNEL	Not Applicable	
DISCHARGE CHANNEL	Not Applicable	
BRIDGE AND PIERS	Not Applicable	

GATED SPILLWAY
(NONE AT GREEN SWAMP DAM NO. 2)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not Applicable	
APPROACH CHANNEL	Not Applicable	
DISCHARGE CHANNEL	Not Applicable	
BRIDGE AND PIERS	Not Applicable	
GATES AND OPERATION EQUIPMENT	Not Applicable	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS Slated To Be Inspected On May 23, 1978	All efforts to open the 2-foot by 2-foot covers of the vertical drains failed after 3-5 persons working three hours were not able to budge the covers.	The record drawings show cast iron frame with lid closing off the vertical drains; these have been replaced by a concrete lid of at least 4 inches in thickness.
WEIRS	None Observed.	
PIEZOMETERS	None Observed.	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

SLOPES

The gentle rocks slopes along the reservoir rim near the dam were observed to be in a very stable condition.

SEDIMENTATION

Excessive erosion and formation of sediments are not expected in this part of the reservoir area with gentle rock slopes and dense vegetation cover.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	<p>There is no downstream channel at this dam. The area downstream of the dam is heavily wooded with a swamp \pm 80 feet from the toe, between Station 2 + 0 and 3 + 50.</p>	
SLOPES	<p>The longitudinal slope between the dam toe and Lake Ioscoe along the lowest ground elevations seem to be less than 5%.</p>	
APPROXIMATE NO. OF HOMES AND POPULATION	<p>There are some homes in an exclusive development built on the vicinity of Lake Ioscoe. The houses are built on high ground and are not visible from the road. The population is estimated to be 75 inhabitants.</p>	

APPENDIX B

ENGINEERING DATA CHECKLISTS

Check List
Engineering Data
Design, Construction, Operation

ITEM	REMARKS
PLAN OF DAM	Detailed construction drawing exist, see following drawing of Case C, Dr. 12: File 3.43 Wa, Acc. 3245 (plans) (284) Profiles and Sections for Dams 2 and 4. All drawings are stored at the NJDWSC office in Wanaque, N.J.
REGIONAL VICINITY MAP	USGS Wanaque, N.J. Quadrangle, Photoview 1971.
CONSTRUCTION HISTORY	A report was published in 1925 and contains a detailed account of the construction procedure used and of some of the foundation problems encountered.
TYPICAL SECTIONS OF DAM	Drawing Case C, Dr. 12; File 3.43, Acc. 3242, shows miscellaneous Profiles and Drawings 2 and 4, Case C, Dr. 12. File 3.42 Wg, Acc. 3248, shows: grouting records for G.S. #2.
HYDROLOGIC/HYDRAULIC DATA	There are continuous records since 1919. The USGS monitors a gaging station downstream of Wanaque Reservoir. Station 01387000 Wanaque River at Wanaque, N.J.
OUTLETS - PLAN	Not Applicable - This dam is a water retention structure that together with eight other dams forms Lake Wanaque.
- DETAILS	Not Applicable
- CONSTRAINTS	Not Applicable
- DISCHARGE RATINGS	Not Applicable
RAINFALL/RESERVOIR RECORDS	There are continuous records since 1892.

Check List
Engineering Data
Design, Construction, Operation

ITEM	REMARKS
DESIGN REPORTS	A brief description of the design criteria used in the design of this dam is shown in pages 52 thru 56 of the Wanaque Water Supply Report published in July 1925, by the North Jersey District Water Supply Commission of the State of New Jersey.
GEOLOGY REPORTS	See page 54 of July 1925 Report.
DESIGN COMPUTATIONS HYDROLOGY AND HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Besides the description of the July 1925 report, no specific calculation sheets or descriptions of the results are known to exist. Volume of materials used in the dams as a function of height is shown in: Case C, Dr. 11, File A3.43, Acc. 1128.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Although detail boring records for the dam could not be found, borings were probably made because pages 54 and 55 of the July 1925 report says: "Consideration of foundation conditions and the quantity of material available resulted in the selection in the masonry type dam for sites Nos. 2 and 4 where ledge rock is near the surface and embankment material of difficult access."
POST-CONSTRUCTION SURVEYS OF DAM	See report of July 1925 for account of construction of the dam.
BORROW SOURCES	See page 106 of report, Case C, Dr. 2, File 3.43 with Acc. 673 and Case C, Dr. 1, File 3.42 with Acc. 182, 211, 227, 228 and 331. These are for the materials used in the nine dams.

Check List
Engineering Data
Design, Construction, Operation

ITEM	REMARKS
SPILLWAY PLAN	Not required due to nature of dam.
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Not required due to nature of dam.
MONITORING SYSTEMS	None
MODIFICATIONS	Besides guniting the concrete surfaces of the dam, no modifications to the original design have been made.
HIGH POOL RECORDS	Daily water level records available, maximum pool elevation 303.93, March 31, 1951.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Inspection reports dated 3/30/28, and 4/5/77 (See Appendix E).
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None.
MAINTENANCE OPERATION RECORDS	Available at NJDWSC.

APPENDIX B

Check List
Engineering Data
Hydrologic and Hydraulic Data

DRAINAGE AREA CHARACTERISTICS: Densely forested, few homes, very hilly with minimal cover on bedrock.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 302.4 (56,000 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Not Applicable

ELEVATION MAXIMUM SPILLWAY DESIGN FLOOD POOL: 308.8

ELEVATION TOP OF DAM: 312.00

CREST: 2-foot thick concrete coping, 11-foot wide with handrailings.

- a. Elevation: 312 feet
- b. Type: Non-overflow
- c. Width: 11 feet
- d. Length: 1,150 feet
- e. Location Spillover: Not Applicable*
- f. Number and Type of Gates: Not Applicable*

OUTLET WORKS:*

- a. Type: Not Applicable
- b. Location: Not Applicable
- c. Entrance Inverts: Not Applicable
- d. Exit Inverts: Not Applicable
- e. Emergency Draindown Facilities: Not Applicable

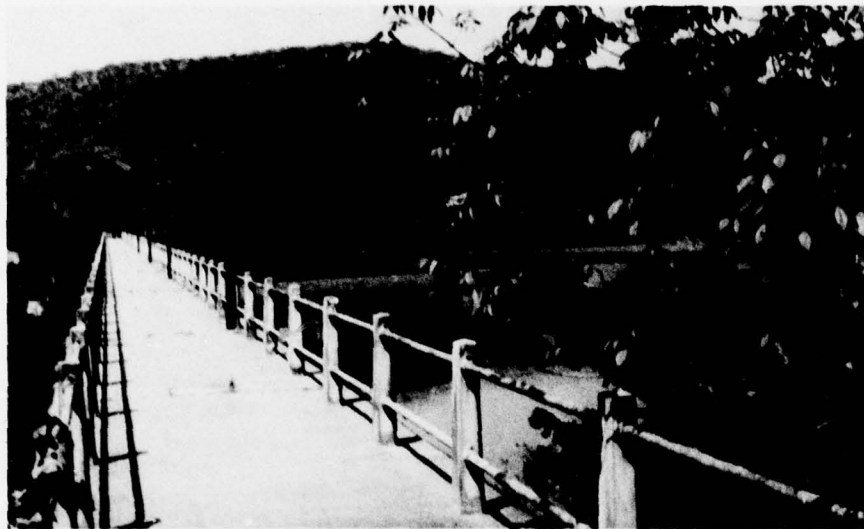
HYDROMETEOROLOGICAL GAGES:

- a. Type: Rainfall recording chart, 24-hour precipitation can, and maximum and minimum temperature recorder. Float type continuous stream level recorder with drum chart.
- b. Location: Raymond Dam in Wanaque, New Jersey.
- c. Records: Weather data published as climatological Data-Wanaque-Raymond Dam by the National Oceanic and Atmospheric Administration. Streamflow data is recorded by the USGS.

MAXIMUM NON-DAMAGING DISCHARGE: Non-overflow dam.

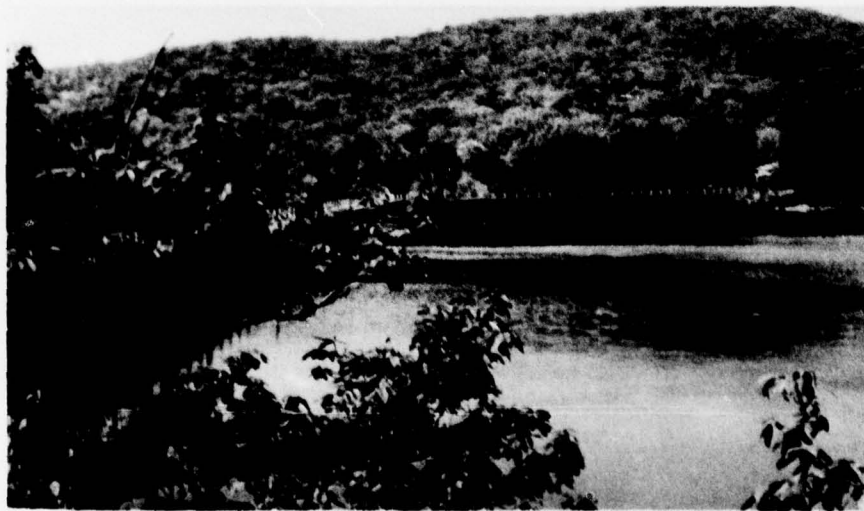
* See Report No. N.J. 00214, "Overflow Weir".

APPENDIX C
PHOTOGRAPHS



June 1978

TOP OF DAM LOOKING TOWARDS RIGHT ABUTMENT



June 1978

UPSTREAM VIEW



June 1978

LEFT ABUTMENT



June 1978

CRACKED SURFACE ALONG TOP OF DAM STA 4+55
(FROM BEGINNING OF CONCRETE DAM AT RIGHT ABUTMENT)

APPENDIX D

HYDRAULIC AND HYDROLOGIC COMPUTATIONS

Complete hydraulic and hydrologic information is on file in the U.S. Army Engineer District, Philadelphia Office. Copies of the computations will be made available when typing, drafting, and reproduction are completed.

APPENDIX E

PREVIOUS INSPECTION REPORTS

NORTH JERSEY DISTRICT WATER SUPPLY COMMISSION

MEMORANDUM

TO: Dam Inspection File
FROM: Joseph Foley, Engineer
DATE: April 5, 1977

On March 31, 1977 Roscoe Jennings, Doug De Lorie and I inspected the dams at the Wanaque Reservoir; the following is a report on their conditions and recommendations on maintenance of same.

FURNACE ROAD DAM

Condition: There are trees and brush on the wet and dry sides of the dam and also a small swamp of apparently trapped water behind the dam.

Recommendations: The trees should be killed and removed using poison suitable for potable water.

MIDVALE DAM

Condition: Some trees are growing on the wet and dry sides of the dam. There is a small spring flowing from the foot of the dam at the north end. Wet spots and soft wet sand are also apparent at the foot of the dam. No sink holes or other indications of dam failure were apparent at this location. A sample of water from this spring and a sample from the reservoir were taken and analyzed, the results are as follows:

Spring Water:	Specific conductivity	68
	pH	6.3
Reservoir Water:	Specific conductivity	102
	pH	6.9

The results indicate that this water is more likely to be ground water than reservoir water. (For additional information, please refer to a memo from Bob Wieland to George Destito dated May 3, 1976).

Recommendations: The trees on the dam should be killed and removed. The dam should also be checked periodically to be sure the spring is not a leak in the dam.

RAYMOND DAM

Condition: Excellent

SPILLWAY

Condition: Good, except that it was indicated by Ernie Restaino that there is a small leak in the spillway. I did not observe it because of the overflow. I will check it again when the reservoir goes down.

Recommendations: The leak in the spillway should be fixed when the reservoir goes down.

WOLF DEN DAM

Condition: There are trees and shrubs on both the wet and dry sides. There are small springs flowing from the low sections behind the dam. Some samples were also taken here and the results were that the water had a specific conductivity of 90 and a pH of 6.3, so this water is most likely ground water also.

Recommendations: I recommend that the trees and shrubs be removed.

GREEN SWAMP

#4 Dam

Condition: The general condition of the dam is good, although sections of the gunite surfacing are cracked and have fallen off (especially near the expansion joints), due to moisture that found its way under the gunite. There was water running out of the drain but this flow was not excessive.

Recommendations: The cracked and loose gunite should be chipped away and replaced and at the expansion joints, the gunite should be chipped and tar poured in to allow expansion of the concrete.

#3 and #2A Dams

Condition: Both small dams are heavily wooded and there is a small swamp behind the #3 dam.

Recommendations: The only recommendation for these dams is that the trees be removed from both sides of the dams.

#2 Dam

Condition: This dam is in excellent condition, except around the expansion joints where the gunite is cracked due to the fact that no allowance was made for expansion when the gunite was applied to the dam. There is also a swamp behind this dam, but this looks like a natural swamp.

Recommendations: The gunite at the expansion joints should be chipped away and tar poured in to allow expansion and any other cracks in the gunite should be chipped and repaired.

#1 Dam

Condition: There are trees and shrubs on both wet and dry sides of this dam. There is also a swamp behind the dam.

Recommendations: The dam should be cleared of trees and shrubs.

As a result of my research, so far on dam inspection, I received a booklet, "Supervision of Dams by State Authorities" published by the United States Committee on large dams, July 1966. This publication had little information on the actual inspection of dams but it did have some useful information such as: the function of dam supervision in New Jersey is performed by the Chief Engineer, Division of Water Policy and Supply, Department of Conservation and Economic development. Inspection of dams is done by the State at the State's own expense on the complaint of potential failure.

Additional information on dam inspection is also coming from the Corps of Engineers and the United States Committee on Large Dams.

JF:lk

cc: Dean C. Noll
Robert G. Wieland

Report on Dam Inspection

MANAQUE PROJECT

Application No. 32.

Location 23.31.5.4.9 and nearby.

On March 23, 1928, the gates in the main dam were closed except for the passage of 27 m. g. d. through the blow-off, and on March 29, 1928, the water in the reservoir had risen 7 feet.

On March 29, 1928, in company with Mr. H. T. Critchlow, inspection was made of all of the dams in the Manaque project.

Furnace Road dam was found to be about 50 per cent complete.

Post Brook Diversion dam, weir and control house were complete except for closing a small breach which was left in the dam for stream control, and installation of recording gage in the control house.

Manaque Main dam.

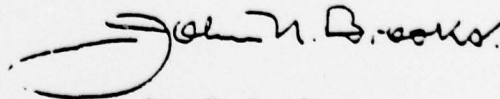
Midvale Dam.

Overflow Weir.

Wolf Den Dam, and

Green Swamp Dams Nos. 1, 2, 3 and 4 were complete and were given final inspection.

The construction of all dams has been done in accordance with the approved plans and in a thoroughly workmanlike and satisfactory manner.



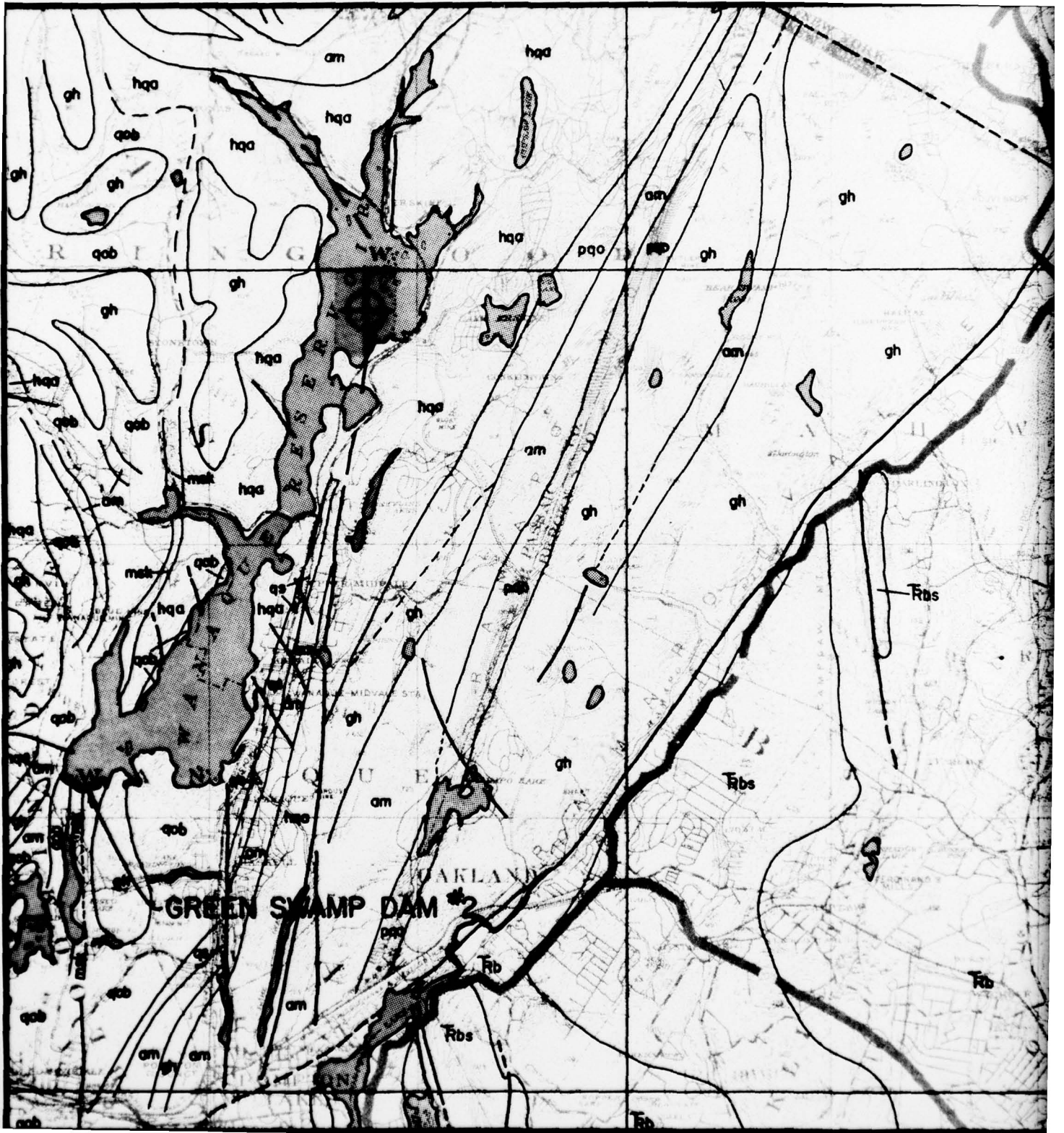
John H. Brooks
Hydraulic Engineer.

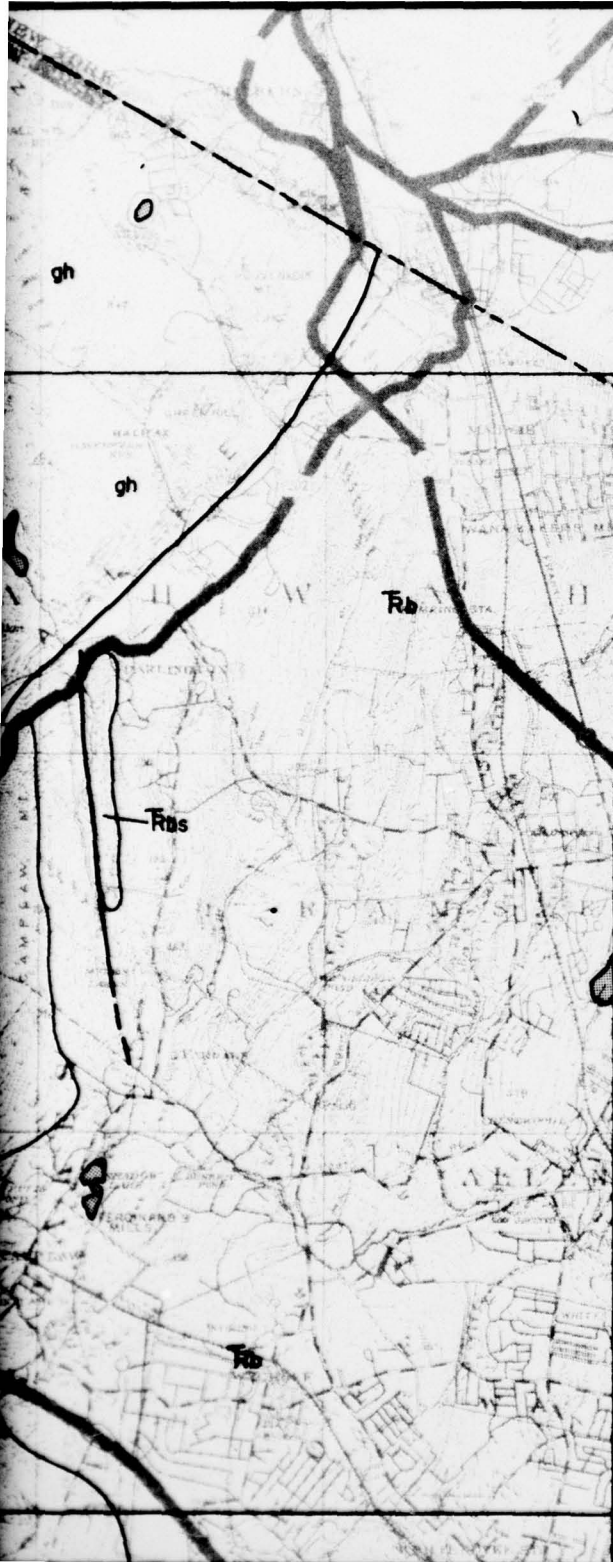
C 31
30
Trenton, N. J.

March 30, 1928.

(New Jersey - Dept. of Environmental Protection)

APPENDIX F
REGIONAL GEOLOGIC MAP





LEGEND

TRIASSIC

Rb BRUNSWICK FORMATION
 Rbs BASALT FLOWS

PRECAMBRIAN

gh MOSTLY HORNBLENDE GRANITE AND GRANITE GNEISS
 am AMPHIBOLITE
 pqo PYROXENE GNEISS; MAINLY QUARTZ-OLIGOCLASE -
 CLINOPYROXENE GNEISS
 hqa PYROXENE GNEISS; MAINLY QUARTZ-ANDESINE GNEISS
 WITH BOTH ORTHO-AND CLINOPYROXENE
 qo QUARTZ-OLIGOCLASE-GNEISS
 qob QUARTZ-OLIGOCLASE-BIOTITE GNEISS
 qs SILLIMANITE GNEISS
 msk MARBLE AND SKARN

— CONTACT LINE
 - - - FAULT LINE

NOTES:

1. THE PRECAMBRIAN MAP UNITS REPRESENT GENERALIZED GROUPINGS OF ROCK TYPES BASED MAINLY ON MINERAL COMPOSITION. THERE IS MUCH LOCAL VARIATION IN THE MINERAL COMPOSITION.
2. THE CONTACT LINES AND FAULT LINE SHOWN ON THE DRAWING ARE DASHED WHERE INFERRED.

SOURCE:

NEW JERSEY GEOLOGICAL SURVEY TOPOGRAPHIC SERIES
 AND GEOLOGIC OVERLAY SHEETS 23.



APPENDIX F
 REGIONAL GEOLOGIC MAP
 SHOWING DAM LOCATION

2

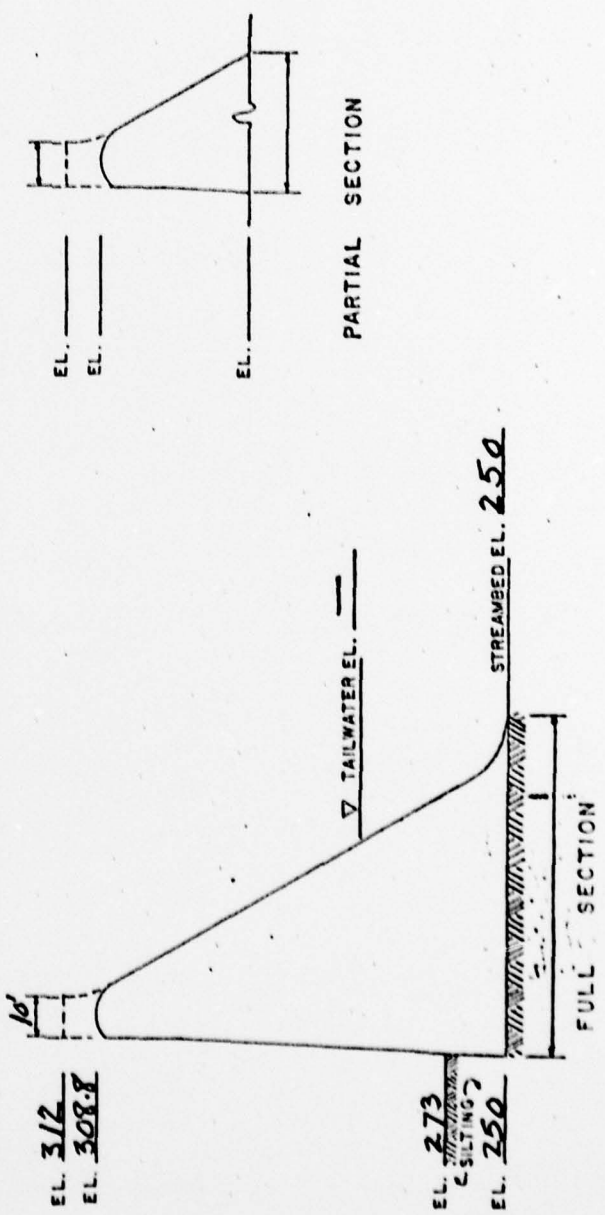
APPENDIX G

STABILITY ANALYSIS

GRAVITY DAM DESIGN STABILITY ANALYSIS

ANALYSIS DONE ON FULL SECTION PARTIAL SECTION
 LOCATION OF SECTION GREEN SWAMP DAM #2 (Sta. 10+20)
 ANALYSIS PREPARED BY R.F. Nell

LOADING CASE	ELEV. HEAD WATER	ELEV. TAIL WATER	EV	ΣH	ΣH / EV	LOCATION RESULTANT FROM TOE	% BASE IN COMPRESSION	FACTOR SAFETY SLIDING	FOUNDATION PRESSURE	
									TOE KSF	HEEL KSF
PROBABLE MAX. Flood	308.8	—	137.4	108 1/2	0.79	9.18'	73	51.1	9.95	0



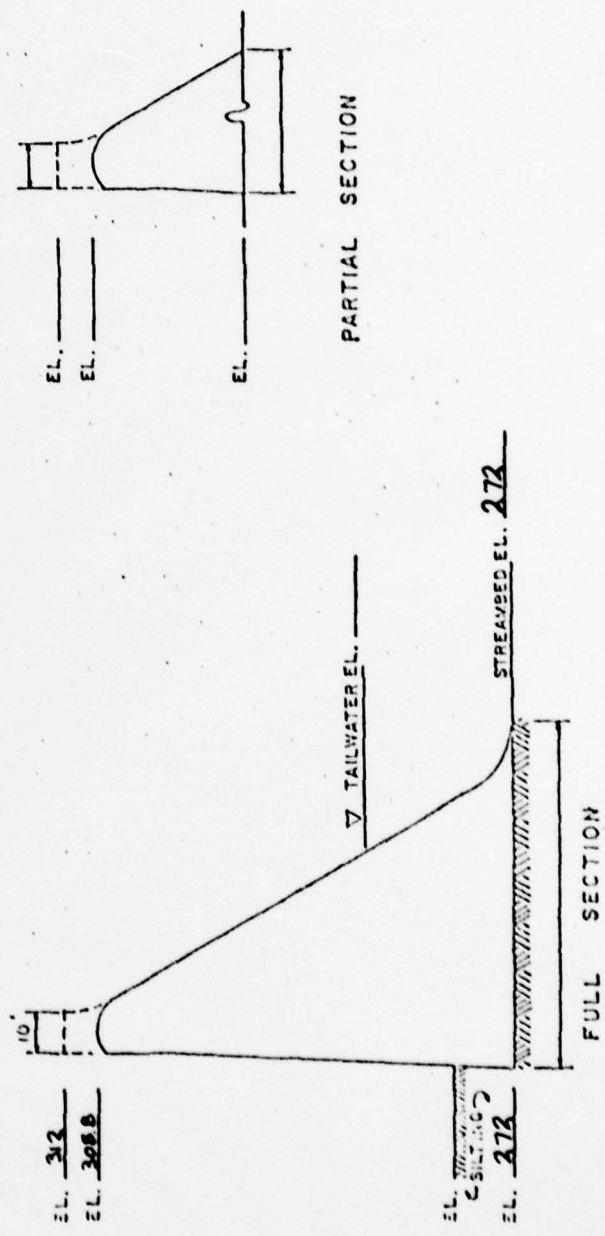
Page 15
 Eng. No. 7/19/78
 Renewal J.C. Beckhard 7/20/78

GRAVITY DAM DESIGN STABILITY ANALYSIS

ANALYSIS DONE ON X FULL SECTION PARTIAL SECTION
 LOCATION OF SECTION Grand Swamp Dam #2 Sta 800
 ANALYSIS PREPARED BY DC BRICKER

LOADING CASE	ELEV. HEAD WATER	ELEV. TAIL WATER	ΣV	ΣH	ΣM / ΣV	LOCATION RESULTANT FROM TOE	% BASE IN COMPRESSION	FACTOR SAFETY SLIDING	FOUNDATION PRESSURE	
									TOE	HEEL
Pressure at maximum flood	308.0	—	67.3 K/FT	42.3 K/FT	0.64	9.38 FT.	100.	91.5	4.77 KSF	0.32 KSF

*Reviewed by
Ray Holl 07/11/78*



APPENDIX H

REFERENCES

APPENDIX H

REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Appendix D, (Washington, D.C., Department of the Army, Office of the Chief of Engineers).
2. North Jersey District Water Supply Commission - Report 1925, (Newark, N.J., Office of the Commission), 1925.
3. Public Works, Vol. 54, No. 5, May 1923.
4. Water Resources Data for New Jersey, Part 1, Surface Water Records, United States Department of the Interior, Geologic Survey.
5. HEC-1 Flood Hydrograph Package, Hydrologic Engineering Center, Corps of Engineers, January, 1973.
6. Daily Reservoir Water Level and Discharge Record Files from October 1950 to date, owned by the NJDWSC.
7. Water Resources Data for New Jersey, Part 1, Surface Water Records, USGS, Department of the Interior.
8. "Passaic River Basin - New Jersey and New York Survey Report for Water Resources," New York District Corps of Engineers, June 1972.

APPENDIX I

CONDITIONS

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This report is based on a visual inspection of the dam, a review of available engineering data and a hydrologic analysis performed during Phase I Investigation as set forth in the "Recommended Guidelines for Safety Inspection of Dams", as modified by the contract between the U.S. Corps of Engineers and Gilbert Associates, Inc., Contract No. DACW61-78-C-0114.

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

As required by the Corps of Engineers the terms "good", "fair", "poor", "condition" have been used in this report to characterize the information obtained from the aforesaid review, inspection, and analysis. The definitions of these terms as used are:

- "good condition" - minor studies or remedial measures are required.
- "fair condition" - sizeable studies or remedial measures are required due to deficiencies which could be hazardous depending on conditions. Immediate attention is required.
- "poor condition" - major studies or remedial measures are required due to deficiencies which could be hazardous depending on conditions. Immediate studies or corrective action is required.