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NATIONAL DAM INSPECTION PROGRAM. BROWNELL DAM (NDS-192), PENNSY--ETC(U)
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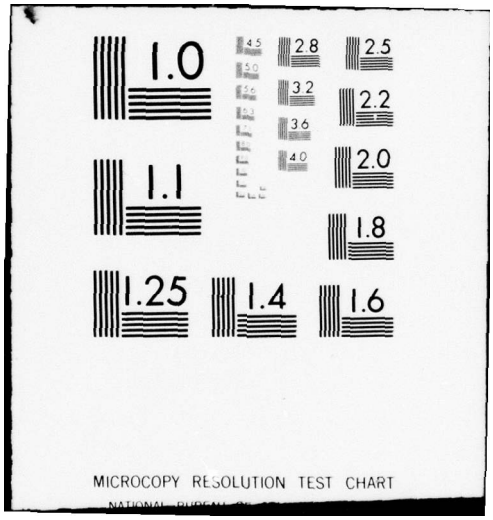
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SUSQUEHANNA RIVER BASIN
RACKET BROOK, LACKAWANNA COUNTY
PENNSYLVANIA

LEVEL II

BROWNELL DAM
NDS ID NO. 192
PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Distribution Unlimited
Approved for Public Release
Contract No. DACW31-78-C-0046

Prepared by
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

MAY 1978

SUSQUEHANNA RIVER BASIN,

RACKET BROOK, LACKAWANNA COUNTY,

PENNSYLVANIA.

BROWNELL DAM

(NDS ID No. 192)

PENNSYLVANIA GAS AND WATER COMPANY,

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM.

(6)

Brownell Dam (NDS-192), Pennsylvania Gas and Water Company. Susquehanna River Basin, Rocket Brook, Lackawanna County, Pennsylvania. Phase I Inspection Report.

Prepared by

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For (15) DACW31-78-C-0046

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

(11) MAY 1978

(12) 98 p.

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

BROWNELL DAM

NDS ID No. 192

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1970

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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Brownell Dam (NDS ID No. 192)
Owner:	Pennsylvania Gas and Water Company
State Located:	Pennsylvania
County Located:	Lackawanna
Stream:	Racket Brook
Date of Inspection:	24 April 1978
Inspection Team:	Gannett Fleming Corddry and Carpenter, Inc. Consulting Engineers P.O. Box 1963 Harrisburg, Pennsylvania 17105

Based on the visual inspection, available records, calculations and past operational performance, Brownell Dam is judged to be in good condition. However, the spillway will not pass the Probable Maximum Flood (PMF) or one-half the PMF without overtopping the dam. Therefore, based on criteria established for these studies by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway capacity is rated as seriously inadequate. Carbondale No. 4 Dam is about 0.6 mile upstream of Brownell Reservoir on Racket Brook. Considering the effects of the combined Brownell Reservoir and Carbondale No. 4 Reservoir surcharge storage, the existing Brownell spillway can accommodate a flood with a peak inflow of 27 percent of the PMF peak inflow.

In view of the concern for the safety of Brownell Dam, the following measures are recommended to be taken by the Owner as soon as practical:

(1) Develop a detailed emergency operation and warning system for Carbondale No. 7, Carbondale No. 4, and Brownell Dam system.

(2) Perform additional studies to more accurately ascertain the spillway capacity required for Brownell Dam, as well as the nature and extent of mitigation measures required to make the spillways hydraulically adequate. Filling in the existing low area of the embankment would help increase the spillway capacity and this should be accomplished.

(3) Implement the proposed repair program to the auxiliary right retaining wall. As part of this program, install two or more observation wells, or other instrumentation, in the earthfill behind the retaining wall. Monitor instrumentation on a regular basis. If readings indicate potential problems, appropriate action should be taken.

In order to correct operational, maintenance, and repair deficiencies, and to more accurately assess the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Replace weathered and missing riprap.

(2) Fill low spot and settling in embankment and provide protection against erosion.

(3) Remove trees from toe and slope of embankment.

(4) Monitor wet area near toe of slope and, if changes are noted, take appropriate action.

(5) Monitor the downstream face of auxiliary spillway for increased seepage or other problems and take appropriate actions as required.

Until remedial work for correcting the hydraulic deficiencies of the spillways is complete, the following measures are recommended to be undertaken by the Owner:

(1) Provide round-the-clock surveillance of Brownell Dam during periods of unusually heavy rains.

(2) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

A. C. HOOKE
Head, Dam Section

Date: June 16, 1978

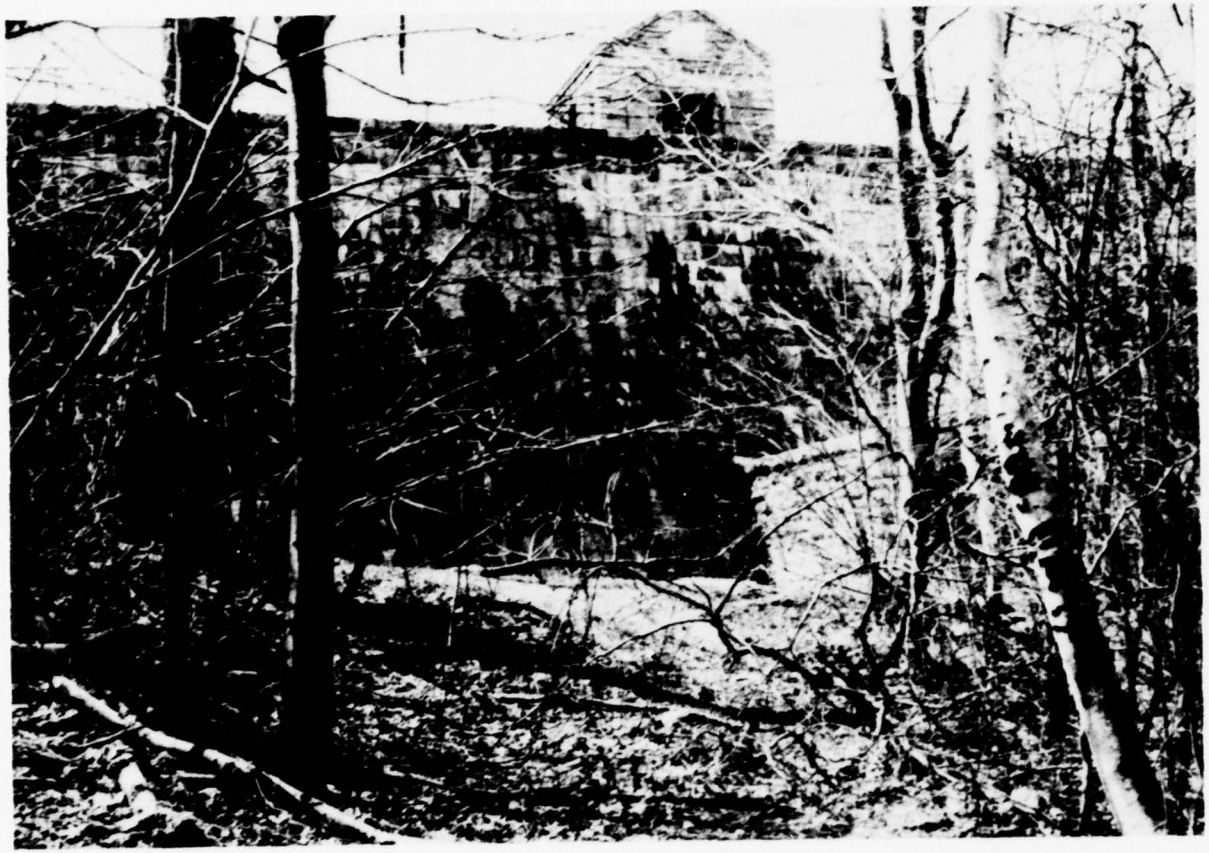
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Date: 28 Jun 78

BROWNELL DAM



Brownell Dam — Looking Upstream

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

BROWNELL DAM

NDS ID No. 192

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

ABSTRACT

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Brownell Dam is an earthfill structure with a masonry core wall. It is 64 feet high at original streambed. The dam has a main and auxiliary spillway. The length of dam, including spillways, is 613 feet. There is a 65-foot long embankment at the left abutment and a 283-foot long embankment at the right abutment. The main 70-foot long spillway is located to the right of the left embankment. It is a stepped, masonry gravity structure with earthfill against the upstream face. Discharge over the spillway flows onto a natural rock ledge. A masonry training wall at the right side of the spillway, downstream of the crest, confines the discharge to the rock

ledge immediately below the spillway. Where the wall ends, the discharge turns right and drops down the rock abutment to the natural stream. Adjacent to the main spillway is a 195-foot long masonry gravity auxiliary spillway. The auxiliary spillway does not have earthfill against its upstream face. Upstream of the auxiliary spillway, at the left side, a masonry wall retains the earthfill that is against the main spillway. At the right side, the auxiliary spillway meets the earth embankment with masonry retaining walls extending both upstream and downstream at the spillway crest. Separate water supply and blowoff lines pass through the auxiliary spillway and are regulated by valves downstream of the dam. Various features of the dam are shown on the Plates at the end of the report and on the Photographs in Appendix D.

b. Location. Brownell Dam is located on Racket Brook about 1.5 miles upstream from its confluence with the Lackawanna River. Brownell Dam is shown on USGS Quadrangle, Waymart, Pennsylvania, with coordinates N41°34'30" - E75°28'20" in Lackawanna County, Pennsylvania, and is 1 mile east of Carbondale, Pennsylvania. Carbondale No. 4 Dam, with a drainage area of 2.3 square miles, is located 0.6 mile upstream of Brownell Dam on Racket Brook and, in turn, Carbondale No. 7 Dam, with a drainage area of 0.6 square mile, is located 0.2 mile upstream of Carbondale No. 4 on the headwaters of Racket Brook. There are no dams located downstream of Brownell Dam between it and its confluence with Lackawanna River. The location of Brownell Dam is shown on Plate 1.

c. Size Classification. Intermediate (64 feet high, 2,995 acre-feet).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Brownell Dam (Paragraph 5.1.e.).

e. Ownership. Pennsylvania Gas and Water Company, Wilkes-Barre, Pennsylvania.

f. Purpose of Dam. Water supply for Carbondale, Pennsylvania.

g. Design and Construction History. Brownell Dam was designed by William Marple, Chief Engineer of the Scranton Gas and Water Company, and built by Burke Brothers, Contractors, between 1905 and 1908. There have been no modifications since completion. Brownell Dam is immediately downstream of Carbondale No. 4 Dam which was built in 1892. Carbondale No. 4 Dam is immediately downstream of Carbondale No. 7 Dam which was built around 1860. Carbondale No. 4 Dam is owned by Pennsylvania Gas and Water Company and is part of the water

supply system. Carbondale No. 7 Dam is no longer owned by Pennsylvania Gas and Water Company. It is now part of Farview State Hospital.

h. Normal Operational Procedure. Water is drawn from the reservoir and flows by gravity through a 24-inch diameter line into the distribution lines of Carbondale. A 24-inch emergency line, or blowoff line, is used to drawdown the reservoir and to remove sediment from the reservoir. Streamflow into Brownell Reservoir can be augmented by releases from Carbondale No. 4 Dam.

1.3 Pertinent Data.

a. Drainage Area. 4.0 square miles (2.3 square miles of which drains into Carbondale No. 4 Reservoir and 0.6 square mile of this area drains into Carbondale No. 7 Reservoir).

b. Discharge at Damsite. (cfs.)

Maximum known flood at damsite - 330 *
(estimated - May 1942).
Water supply line at maximum pool elevation - not available.
Emergency drawdown line at maximum pool elevation - 110 (approximate).
Main spillway capacity with pool at auxiliary spillway crest - 650.
Total spillway capacity (main and auxiliary) at maximum pool elevation - 1,870.

c. Elevation. (Feet above msl.)

Top of dam (top of core wall) - 1586.5.
Top of embankment - 1586.5.
Maximum pool (top of core wall) - 1586.5.
Normal pool (spillway crest) - 1583.4.
Auxiliary spillway crest - 1585.4.
Upstream portal invert outlet works - 1526.8.
Downstream portal invert outlet works - 1524.6.
Upstream invert water supply line - 1534.9.
Streambed near outlet works - 1523.0.

d. Reservoir Length. (Miles.)

Normal pool - 1.00.
Maximum pool - 1.05.

* Owner notes that local storms have topped the auxiliary spillway by 1.0 foot - pool at Elevation 1586.4 which is just below top of dam Elevation 1586.5. Approximate discharge 1,710 cfs.

e. Storage. (Acre-feet.)

Normal pool (main spillway crest) - 2,599.
Maximum pool (top of dam) - 2,995.

f. Reservoir Surface. (Acres.)

Normal pool (main spillway crest) - 126.
Maximum pool (top of dam) - 130.

g. Dam.

Type - Earthfill with masonry core wall.

Length - Right embankment - 283 feet.
Left embankment - 65 feet.

Height - 64 feet.

Top Width - Embankment - 10.0 feet (core wall - 4.0 feet).

Side Slopes - Upstream - 1V on 3.5H.
Downstream - 1V on 2.5H.

Zoning - Homogeneous earthfill.
Central masonry core.

h. Diversion and Regulating Tunnel.

Type - One 24-inch diameter cast-iron pipe.

Length - 109.0 feet.

Access - Intake - none.
Valves - in dry pit below dam.

Regulating Facilities - Two manually operated non-rising stem 24-inch gate valves.

i. Spillway.

Type - Main spillway - broad-crested masonry-gravity spillway with masonry steps (width - 7.0 feet).
Auxiliary spillway - broad-crested masonry-gravity spillway with free overfall (width - 11.0 feet).

Length of Weirs - Main spillway - 70.0 feet.
Auxiliary spillway - 195.0 feet.

Crest Elevations - Main spillway - 1583.4.
Auxiliary spillway - 1585.4.

Upstream Channel - Main spillway - sloping earthfill.
Auxiliary spillway - reservoir.

Downstream Channel - Main spillway - rock ledge with wall on right.
Auxiliary spillway - short reach of seeded area followed by natural channel.

j. Regulating Outlets. None, other than outlet works.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Design Available. Very little engineering data was available for review. In a study performed in 1914 by the Pennsylvania Water Supply Commission, an account of design concepts, geology, construction materials and methods, and design features was prepared for the components of the dam from interviews with the Owner, visual inspection, and other sources. The 1914 study also included analyses for hydrology, hydraulics, and stability of the principal features. Load assumptions and a summary of the results of the analyses are on file.

b. Design Features. Brownell Dam consists of an earthfill embankment with a masonry core wall, a masonry gravity main spillway and a masonry gravity auxiliary spillway. A plan and profile of the dam is shown on Plate 1A. A plan and profile of masonry structures is shown on Plate 2.

There is a 65-foot long embankment at the left abutment and a 283-foot long embankment at the right abutment. The upstream slope is 1V on 3.5H and is riprapped. The downstream slope is 1V on 2.5H and has a grass cover. Sections of the embankment at the right abutment are shown on Plate 5 and sections of the embankment at the left abutment are shown on Plate 7. The core wall in the middle of the embankment is 4 feet wide on top, constructed of conglomerate masonry, and battered so that, at the maximum section the bottom width is 10 feet. At the right abutment, for 230 feet, the masonry core wall is founded on a 2-foot thick concrete footing that is founded on clay. The remainder is founded on rock. The top of embankment elevation varies with a minimum elevation of 1586.5.

A masonry gravity retaining wall, located upstream and downstream of the axis of dam, separates the embankment at the right abutment from the auxiliary spillway. The wall is normal to the dam centerline, except near the upstream end. The downstream wall has a front batter of 8V on 1H and a stepped back batter of 2V on 1H. The upstream wall has a battered front, stepped back with a total ratio of width to height of 0.45. The top-width for both the upstream and downstream walls is 3.5 feet. The entire wall is founded on rock, except for a portion of the upstream wall which is founded on a 2-foot thick concrete footing with clay beneath.

The 195-foot long masonry gravity auxiliary spillway (Photographs A and B) was built entirely on rock. The rock

foundation is from 1 to 2 feet below the natural rock surface. The upstream face, at the maximum section, is vertical for 22 feet from the top and then is battered on a 8V on 1H slope. The auxiliary spillway crest is 11 feet wide and 1.1 feet below the top of the earth embankment. The downstream face has 6 different breaks in batter. The bottom width is 45 feet at a location 55 feet below the crest.

The main spillway (Photograph F) is a masonry gravity structure, 70 feet long. Earthfill is against the upstream face. Main spillway sections are shwon on Plate 6. Upstream of the spillway, at the right side, a 30-foot long masonry wall, normal to the dam, retains the earthfill. The spillway is 20 feet high and is founded on top of a rock ledge. The crest is 2.0 feet below the auxiliary spillway and is about 7.0 feet wide and battered on a 1V on 8.375H slope which drops in the upstream direction. The upstream face is vertical and the downstream face is stepped so that the base width is 16 feet. The earthfill upstream of the spillway has a 1V on 3H slope and is riprapped. Downstream of the spillway, on each side, are small masonry training walls with the right wall extending further downstream. This right wall channels the spillway discharge until it ends, at which point the spillway discharge turns right and drops over the rock ledge into the natural stream downstream of the dam. The left side of the main spillway ties into the 65-foot long earthen embankment section with masonry core wall founded on rock.

The emergency discharge line or blowoff line is a 24-inch cast-iron pipe, whose upstream invert is 58.5 feet below the top of the auxiliary spillway. It passes through the auxiliary spillway to a valve pit. Two valves, connected in series, control the flow which discharges into the natural channel. A profile through the blowoff line is shown on Plate 4.

The water supply line, a 24-inch cast-iron pipe, starts just downstream of the intake structure and passes through the auxiliary spillway to a valve house with two 24-inch valves connected in series. From the valve house, the line extends downstream to the distribution system. A profile through the water supply line is shown on Plate 3.

The intake structure, which is 38 feet right of the blowoff intake, contains 2 screens and also a sluice gate downstream of them. The structure is about 19 feet by 20 feet in plan. The working floor, which is about 0.5 feet above the auxiliary spillway crest, has slots for the screens and a manual operator for the sluice gate. The sluice gate shuts off the entrance to the 24-inch supply line, the upstream invert of which is 52.1 feet below the working floor.

2.2 Construction.

a. Data Available. Construction data available for review for Brownell Dam was limited to information contained in the 1914 report prepared by the Pennsylvania Water Supply Commission. That information was obtained by interviews with the Owner, and it gives details of construction operations.

b. Construction Considerations. The 1914 report by the Pennsylvania Water Supply Commission praises the quality of construction used for the structure. For example, information is cited that indicates that hand excavation in rock was used to avoid opening seams in rock by blasting and that all rock surfaces were thoroughly cleaned. In general, the accounts of construction are such that it appears reasonable care was used in construction of Brownell Dam.

2.3 Operation. No formal records of operation were reviewed. Based on information from the Owner and the caretaker of the dam, all structures have performed satisfactorily with some exceptions. Five blocks from the crest of the auxiliary spillway fell from the crest several years ago and were immediately replaced. The downstream auxiliary spillway retaining wall has not functioned satisfactorily. A detailed description and evaluation of this condition is covered in Section 3, Visual Inspection.

2.4 Other Investigations. The Owner's records indicate that consideration has been given to increasing the spillway capacity. No formal plans have been formulated. Plans and specifications have been prepared to repair the downstream auxiliary spillway right retaining wall.

2.5 Evaluation.

a. Availability. Engineering data was provided by the Division of Dams and Encroachments, Bureau of Water Quality Management, Department of Environmental Resources, Commonwealth of Pennsylvania and by the Owner, Pennsylvania Gas and Water Company. The Owner made available an engineer, a caretaker, and a valve crew for information and operation demonstrations during the visual inspection. The Owner also researched his files for additional information upon request of the inspection team.

b. Adequacy. The type and amount of design data and other engineering data is limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The general appearance of Brownell Dam is good, with the exceptions noted below.

b. Embankment.

(1) The embankment section at the right abutment is in generally good condition. No seepage, wet areas, or other deficiencies were observed anywhere on the embankment. The sod is intact and well maintained. The riprap on the upstream slope (Photograph C) that is above normal pool is very weathered. It is shale and in many cases has completely deteriorated. The Owner reports trouble with vandals taking riprap and tossing it on the downstream side of the dam and has, therefore, replaced vandalized areas with gravel. The Owner reported other instances of vandalism, such as finding persons equipped with picks and shovels trying to excavate through the embankment. The riprap does not appear to extend all the way to the right abutment. For a distance of 65 feet to the right of the auxiliary spillway right retaining wall, the embankment is lower than the as-built construction plans indicate. The maximum difference is about 0.9 foot at the retaining wall. The top of the core wall is exposed for a portion of this length. At the auxiliary spillway right retaining wall, on the downstream side of the top of embankment, is a very small dry masonry wall. There is a small erosion gully leading below this wall and behind the downstream right abutment wall, where the embankment has settled. There is a 9-foot square wet area 100 feet right of the auxiliary spillway right retaining wall and 75 feet downstream of the toe of embankment. The area was firm and covered with leaves. There was no observable seepage. The tree line is approximately at embankment toe. There is a 2-inch tree in the embankment near the downstream end of the auxiliary spillway right retaining wall.

(2) The embankment at the left abutment is indiscernible from the surrounding ground, which is heavily wooded. The core wall is exposed for 16 feet beyond the left main spillway wall. The ground is flat in this area.

c. Appurtenant Structures.

(1) The entire downstream face of the auxiliary spillway (Photograph B) is wet from about 6 feet below the crest. There are white powdery deposits, or efflorescence, over most of the face. The seepage was insufficient to cause flow at the toe

of the structure and was not localized in any particular areas. The mortar was in excellent condition. No cracks were observed. The handrail on the downstream side of the crest is corroded badly.

(2) The main spillway (Photograph F) appears to be in excellent condition. Water was flowing over the spillway during the inspection and detailed observations could not be made. However, the stones appeared to be in good condition. Where the spillway discharge turns right and drops over the natural rock ledge, there is evidence of some rock erosion at locations downstream of the right spillway wall. The upstream left and right retaining walls were submerged and therefore only the tops were visible below the water surface. The Owner has not reported any problems with these walls.

(3) The downstream auxiliary spillway right retaining wall (Photographs G and H) has a major structural crack extending from the bottom of the wall 16.5 feet from the downstream end to the top of the wall at the top of the embankment. The crack travels up at approximately a 30° angle with the horizontal and extends through the middle of some masonry blocks. The upper portion of the wall protrudes up to 0.7 foot beyond the lower portion. The face of the lower portion of the wall has a distinct batter while the face of the upper portion appears vertical. In plan, the top of the wall is bowed (Photograph I) with the middle of the wall about 2 feet out of line with the ends. Seepage is evident below this crack but is intermittent along the length. There is insufficient seepage to do more than wet the blocks. The downstream 15.5 feet of this wall is concrete (Photograph J) badly spalled at the edges and peeling over 80 percent of the face.

(4) The outlet of the 24-inch diameter blowoff and a short length of the 24-inch diameter water supply line were observable. Both appeared to be in good condition with no exterior pitting. There was no seepage evident near them. The operation of the blowoff was observed. The valve was opened fully by three men in 10 minutes. No problems were noted. An attempt was made to close the emergency shutoff valve, upstream of the one usually operated. This valve is usually fully open. It was so stiff that it was unable to be operated without special equipment. Its operation was not viewed, nor was the operation of the sluice gate or the valves on the water supply line.

d. Reservoir Area. The reservoir slopes are wooded, mostly with hardwoods. No evidence was visible of creep, rock slides, or land slides. The Owner indicated that sedimentation is not a problem from the standpoint of reduced reservoir capacity. The watershed is almost wholly owned and controlled by the Owner and is almost entirely undeveloped. Carbondale No. 4 and No. 7 Dams are located upstream of Brownell Reservoir. These upstream dams are discussed in Paragraph 5.1.a.(2).

e. Downstream Channel. The channel immediately below the dam runs over rock outcrop (Photograph E). The channel is a series of cascades with an estimated average slope of 30 percent. A few small trees were lying in the stream.

3.2 Evaluation.

a. Embankment.

(1) The riprap on the upstream slope is evidencing the long term effects of weathering. Vandalism has made this condition worse. Unless the lost riprap on the upstream surface is replaced and extended to the abutment, the upstream slopes adjacent to the spillway will probably progressively erode and slough. The embankment near the auxiliary spillway right retaining wall was not observed to be lower than the adjacent section. Only after the reduction of survey data acquired for this inspection, was the condition discovered. The cause of this condition is not clear. The construction drawings available indicate that the embankment in this area was originally about 1 foot higher and that the core wall is founded on rock. There was probably no settlement of the core wall. It is improbable that rainfall runoff could cause this amount of erosion. It is possible that the embankment was overtopped previously and that the top was eroded. There was no evidence, however, of overtopping on the downstream slope. The erosion gully under the small dry masonry wall does appear to have been caused by rainfall runoff. This condition will eventually lead to increased erosion of the top of dam. The wet area downstream of the toe is not of great concern at the present time. There was snow, still existing in patches, at the toe of the auxiliary spillway. The wet area could have been caused by snow melt. The continued growth of trees on the embankment slopes and along the toe of embankment is undesirable.

(2) The trees in the embankment at the left abutment are undesirable. The root system could eventually begin to disintegrate the core wall. Although the top of this embankment section is lower than that at the right abutment, it is felt that overtopping this section would not present a hazard.

b. Auxiliary Spillway.

(1) The slight seepage on the downstream face of the auxiliary spillway is of slight concern at the present time. The cause of the calcium-like deposits on the face is unknown but they did not seem to be associated with any potential problems. The corroded handrail could be a hazard to personnel. It could also collect debris during flow over the auxiliary spillway and reduce the discharge.

c. Appurtenant Structures.

(1) Erosion at the drop, downstream of the right spillway wall, is of slight concern at the present time.

(2) No problems were noted with the auxiliary spillway upstream retaining walls. Problems with these walls are not anticipated unless an attempt is made to drawdown the reservoir. If the reservoir is drawn down, the loads on the upstream walls could be greater than the loads on the downstream wall. Since the downstream wall is cracked, it seems likely that additional loads on the upstream wall, caused by drawdown, would cause cracking of the wall.

(3) Failure of the downstream auxiliary spillway right retaining wall could threaten the stability of the embankment. The Owner is aware of this problem and, as noted in Paragraph 2.4, has remedial measures prepared.

(4) The overall condition of the operating equipment was adequate. Regular maintenance is needed on the upstream blowoff valve. The valve pit for the blowoff and the valve house for the water supply line would not be accessible with flow over the auxiliary spillway.

d. Reservoir Area. No conditions were observed in the reservoir area that might present significant hazard to the dam.

e. Downstream Channel. No conditions were observed in the downstream channel that might present significant hazard to the dam. Additional discussion on downstream conditions is presented in Paragraph 5.1.e..

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is maintained at main spillway crest Elevation 1583.4 with excess reservoir inflow cascading over the stepped masonry spillway. A 24-inch diameter cast-iron pipe water supply line draws water from the reservoir at Elevation 1534.9 to gravity feed the distribution lines in Carbondale. The two gate valves on the water supply line are normally at least partially open. A 24-inch diameter cast-iron pipe emergency line or blowoff line at Elevation 1526.8 can discharge water into the outlet channel of the main spillway. The upstream valve on the blowoff line is normally open and the downstream valve is normally closed. The blowoff line is very seldom used.

4.2 Maintenance of Dam. The dam is visited daily by a caretaker who checks the reservoir elevation. When the reservoir is below the main spillway crest, the caretaker reports the reservoir elevation to the Owner's Engineering Department. This information is used by the Engineering Department for regulating flows in the distribution system. A Pennsylvania Gas and Water Company engineer makes a formal inspection of the dam each year, and the records are kept on file and are used for determining priority of repairs. Informal inspections are also made when the engineer is on the site for other reasons. Special problems, such as the condition of the auxiliary spillway right retaining wall, are monitored at intervals as determined by the Owner's Engineering Department. The embankment is mowed at regular intervals.

4.3 Maintenance of Operating Facilities. The two rows of screens in the masonry screen chamber are cleaned in the fall when leaves tend to clog them or whenever there is indication of a pressure drop. The downstream blowoff is operated annually. The upstream blowoff valve is not regularly maintained.

4.4 Warning Systems in Effect. The Owner furnished the inspection team with a chain of command diagram for Brownell Dam and a generalized emergency notification list that is applicable for all the Pennsylvania Gas and Water Company dams. The Owner said that during periods of heavy rainfall, available personnel are dispatched to the dams to observe conditions. All company vehicles are equipped with radios, and the personnel can communicate with each other and with a central control facility. Evaluation of risk is made by the Owner's Engineering Department. The Owner's Engineering Department is also responsible for notification of emergency conditions to the local authorities. Detailed emergency

operational procedures have not been formally established for Brownell Dam, but are as directed by the Owner's Engineering Department.

4.5 Evaluation. The operational procedure appears to be satisfactory except for the maintenance of the upstream blowoff valve. Since this valve remains open all the time, it is of minor importance to the functioning of the blowoff. The procedures used by the Owner for inspecting the dam are adequate, but the repairs have not been made. The trees in the embankment at the left abutment should be removed and any new growth should be cut annually. The Owner's security measures seem reasonable. Continued vigilance is required to prevent vandalism creating a hazard to the dam. In general, the warning system is adequate, but it is not in sufficient detail for Brownell Dam when its overall condition and importance is considered.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data.

(1) No hydrologic and hydraulic analysis for the original Brownell Dam design was available for review. The spillway capacity was estimated for the main spillway by the Pennsylvania Water Supply Commission for their 1914 report. Spillway capacity, as used in this section, represents the combined capacity of the main and auxiliary spillways.

(2) In the recommended guidelines for safety inspection of dams, the Department of the Army, Office of the Chief of Engineers (OCE) established criteria for rating the capacity of spillways. The recommended spillway design flood for the size (intermediate) and hazard potential (high) classification of Brownell Dam is the PMF. If the dam and spillway are not capable of passing the PMF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a 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 dam an spillway are not capable of passing one-half of the PMF without overtopping failure.

(3) Although the spillway capacity and hydrology have been estimated a number of times by the Owner, the design storms used were far below a probable maximum flood. Most of the analyses failed to include the effects of the dams upstream of Brownell Dam. The Owner's most recent estimate of spillway capacity was 3,835 cfs with 2 feet of water over the auxiliary spillway and therefore 4 feet of water over the main spillway. As was noted in Section 3, the embankment has a low area which limits the head on the main and auxiliary spillways to 3.1 and 1.1 feet, respectively. The total spillway capacity computed for this study is 1,870 cfs, with the head on the auxiliary spillway being 1.1 feet and the head on the main spillway being 3.1 feet.

(4) Carbondale No. 4 Dam (Photographs K and L) is located on Racket Brook about 0.6 mile upstream of Brownell Reservoir and Carbondale No.7 Dam is located on Racket Brook about 0.2 mile upstream of Carbondale No. 4 Reservoir. These two upstream dams are described below:

(a) Carbondale No. 7 Dam at one time was owned by Pennsylvania Gas and Water Company but it is now owned by the Farview State Hospital, supposedly for fire protection. The Owner's records state that the dam is an earthen embankment with timber plank core and that it was built in 1860. The dam is 250 feet long, 11 feet high with a 10-inch diameter cast-iron discharge pipe. The spillway consists of a 3 foot by 3 foot box culvert, with unknown invert. The normal pool is listed as containing 95 acre-feet with an area of 20 acres. The drainage area at the site is 0.6 square mile. It is unknown if any modifications have been made since the Owner's records were last updated. In view of the small size of this reservoir, it was not included in the hydraulic and hydrologic analysis.

(b) Carbondale No. 4 Dam is a masonry gravity dam with downstream earth embankment. It is 508 feet long, 29 feet high, and was built in 1892. The dam was overtopped by a flood in May, 1942. In 1945, the spillway on this dam was greatly enlarged to its present 100-foot length and 4.1-foot head to top of dam. At spillway crest, the reservoir contains 783 acre-feet and has a surface area of 62 acres. The spillway capacity at the dam is estimated by the Owner at 2,700 cfs. This was considered to be reasonable and was accepted for use. The drainage area is 2.3 square miles. Carbondale No.4 Dam was visited during the field inspection. Except for the spillway dimensions that were obtained in the field, all other data was taken from the Owner's records.

(5) The hydrologic analysis for this study was based on existing conditions of Brownell watershed and the effects of future development of the watershed were not considered.

b. Experience Data. The PMF peak discharge was estimated by transposition of the PMF peak discharge derived for the hydrologically similar potential reservoir site on Fall Brook. PMF peak discharge for Carbondale No. 4 Dam watershed was derived by identical methods. The PMF peak discharge for the entire Brownell Dam watershed is estimated at 9,440 cfs. The Carbondale No. 4 component of the Brownell PMF is 5,430 cfs. For the drainage area between Brownell Dam and Carbondale No. 4 Dam, the component of the Brownell PMF is 4,010 cfs. The peak PMF discharge for the Carbondale No. 4 Dam watershed is estimated at 6,060 cfs. Hydrology computations are presented in Appendix C.

c. Visual Observations. On the date of the inspection, it was observed that the metal handrail on the downstream edge of the auxiliary spillway could possibly collect debris and therefore reduce the discharge over the auxiliary spillway. Since the handrail is in poor condition, it would probably break under substantial loads.

d. Overtopping Potential. One case was analyzed to check the overtopping potential of Brownell Dam from a PMF storm. This case considered a PMF storm only over that portion of the drainage area between Brownell Dam and Carbondale No. 4 Dam. This portion of the drainage area is 1.7 square miles. This analysis is equivalent to assuming that Carbondale No. 4 Dam will hold back the entire PMF runoff from its drainage area (2.3 square miles). The PMF peak inflow into Brownell Reservoir for this case is 4,010 cfs and it is greater than the spillway capacity of Brownell Dam. A check of the surcharge, storage effect of Brownell Reservoir shows that the surcharge storage available is insufficient to contain an inflow with a peak of 4,010 cfs without overtopping the dam. It is apparent, therefore, that a PMF storm over the entire Brownell watershed would also cause overtopping of Brownell Dam regardless of any mitigating effects of Carbondale No. 4 Dam.

One case was analyzed to check the overtopping potential of Carbondale No. 4 Dam from a PMF storm. This case considered the Carbondale No. 4 component of the Brownell PMF. The PMF peak inflow into Carbondale No. 4 Reservoir for this case is 5,430 cfs and is greater than the spillway capacity of Carbondale No. 4 Dam. A check of the surcharge storage effect of Carbondale No. 4 Reservoir shows that the surcharge storage available is insufficient to contain an inflow with a peak of 5,430 cfs without overtopping the dam.

Two cases were analyzed to check the overtopping potential of Carbondale No. 4 Dam from a storm equal to one-half of the PMF. Case 1 was based on the Carbondale No. 4 one-half PMF. Case 2 was based on the Carbondale No. 4 component of the Brownell one-half PMF. For Case 1, the one-half PMF peak inflow into Carbondale No. 4 Reservoir is 3,030 cfs and is greater than the spillway capacity of Carbondale No. 4 Dam. A check of the surcharge storage effect of Carbondale No. 4 Reservoir shows that the surcharge storage available is insufficient to contain an inflow with a peak of 3,030 cfs without overtopping the dam. For Case 2, the one-half PMF peak inflow into Carbondale No. 4 Reservoir is 2,715 cfs and is slightly greater than the spillway capacity of Carbondale No. 4 Dam. A check of the surcharge storage effect of Carbondale No. 4 Reservoir shows that the surcharge storage available is sufficient to contain an inflow with a peak of 2,715 cfs without overtopping the dam.

Two cases were analyzed to check the overtopping potential of Brownell Dam from a storm equal to one-half of the PMF. Case 1 was based on the Brownell one-half PMF in which the storm on the Carbondale No. 4 watershed is equal to the Carbondale No. 4 component of the Brownell one-half PMF. Case 2 was based on a storm over the Carbondale No. 4 watershed equal to the Carbondale No. 4 one-half PMF with overtopping and assumed failure of Carbondale No. 4 Dam and no runoff from the drainage area between Brownell Dam and Carbondale No. 4 Dam. Case 1 was analyzed considering the surcharge storage effect of both Carbondale No. 4 Reservoir and Brownell Reservoir. As reported above, Carbondale No. 4 Dam would not be overtopped. Results of the analysis show that the surcharge storage available is insufficient to contain the Brownell one-half PMF without overtopping Brownell Dam. The approximate 2,700 cfs passing Carbondale No. 4 Dam is sufficient to overtop Brownell Dam. For Case 2, a failure hydrograph for Carbondale No. 4 Dam was estimated and a peak inflow as high as 75,000 cfs could rush into Brownell Reservoir, totally emptying Carbondale No. 4 Reservoir in about 20 minutes. Results of the Case 2 analysis shows that the surcharge storage available in Brownell Reservoir is insufficient to contain the Carbondale No. 4 failure hydrograph without overtopping Brownell Dam.

e. Downstream Conditions. Brownell Dam is located on Racket Brook, 1.9 stream miles above the confluence with the Lackawanna River. Racket Brook flows through a heavily populated area of Carbondale, Pennsylvania. Some structures in Carbondale are less than 20 feet above stream grade. The downstream conditions indicate that a high hazard classification is warranted for Brownell Dam.

f. Spillway Adequacy.

(1) Considering the effects of the surcharge storage of Carbondale No. 4 Reservoir, Carbondale No. 4 Dam will not pass the Carbondale No. 4 component of the Brownell PMF nor one-half of the Carbondale No. 4 PMF without overtopping the dam. Considering the effects of the surcharge storage of Carbondale No. 4 Reservoir, Carbondale No. 4 Dam will pass its component of the Brownell one-half PMF without overtopping the dam. Considering the effects of the combined surcharge storage of Carbondale No. 4 Reservoir and Brownell Reservoir, Brownell Dam will not pass the Brownell PMF or one-half of the Brownell PMF without overtopping the dam. Furthermore, considering the effects of the surcharge storage of Brownell Reservoir, Brownell Dam will not pass the maximum spillway discharge of Carbondale No. 4 nor the Carbondale No. 4 failure hydrograph without overtopping the dam. In general, however, Brownell Dam should be overtopped before Carbondale No. 4 Dam is overtopped.

(2) The maximum tailwater is estimated to be Elevation 1530.7 at the spillway capacity of 1,870 cfs. At maximum pool elevation, there is a difference of about 56 feet between headwater and tailwater. If Brownell Dam should fail due to overtopping, the hazard to loss of life downstream from the dam will be significantly increased from that which would exist just prior to overtopping.

(3) Based on established OCE criteria as outlined in Paragraph 5.1.a.(2), the spillway capacity of Brownell Dam is rated as seriously inadequate. For Carbondale No. 4 Dam, considering the effects of the surcharge storage of 258 acre-feet, the Carbondale No. 4 spillway discharge capacity of 2,700 cfs can accommodate a flood with a peak inflow of 2,980 cfs for a storm of the same duration as the Carbondale No. 4 PMF. This is 49 percent of the Carbondale No. 4 PMF peak inflow. Considering the effects of the combined Brownell Reservoir and Carbondale No. 4 Reservoir surcharge storage of 654 acre-feet, the Brownell spillway discharge capacity of 1,870 cfs can accommodate a flood with a peak inflow of 2,540 cfs for a storm of the same duration as the Brownell PMF. This is 27 percent of the Brownell PMF peak inflow.

(4) If the low area of the embankment were to be brought up-to-grade, which would be a relatively minor maintenance task, the spillway capacity of Brownell Reservoir can be increased to 3,310 cfs. This would permit the accommodation of a flood with a peak inflow of approximately 4,100 cfs or 43 percent of the Brownell PMF peak inflow. The spillway capacity of Brownell Dam would still be rated as seriously inadequate.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of the dam resulted in a number of observations relevant to structural stability. These observations are listed herein for various features.

(2) Embankment. At the junction of the embankment at the right abutment and the auxiliary spillway right retaining wall, settlement of the embankment edge behind the wall has occurred. This settlement could be related to the observed crack and movement in the right abutment wall. A detailed description of the condition is in Paragraphs 3.1.b.(1) and 3.1.d.(3). A detailed evaluation of the condition is in Paragraphs 3.2.a.(1) and 3.2.c.(3).

(3) Auxiliary Spillway. Slight seepage along the entire downstream face was observed. The description and evaluation are presented in Paragraphs 3.1.c.(1) and 3.2.b.(1) respectively. A major crack extends along most of the auxiliary spillway downstream right retaining wall. A detailed description and evaluation are presented in Paragraphs 3.1.d.(3) and 3.2.c.(3) respectively, including the potential hazards to the upstream retaining wall during drawdown conditions.

b. Design and Construction Data. No record of design data or stability analysis for the original structures was available for review. However, a stability study for the auxiliary spillway was performed in 1914 by the Pennsylvania Water Supply Commission. The results of the analysis are on file.

The 1914 analysis for the auxiliary spillway was reviewed to assess the stability of the section. The maximum loading condition that was used included the following: full hydrostatic pressure on the upstream face from reservoir level at the top of embankment, no tailwater, and uplift varying uniformly from two-thirds of the headwater pressure at the heel to zero at the toe. The results of this analysis, as presented in the 1914 report, show that the resultant falls within the middle third of the section from the top of structure to level of foundation. The computations accompanying the report, however, are not in complete agreement with the report, as the resultant was computed to be 2.0 feet outside the middle third at foundation level. Toe pressure as well as resistance to overturning and sliding were found to be satisfactory.

Stability considerations for the main spillway were not mentioned in the 1914 report.

Stability analyses for both the main spillway and the auxiliary spillway were performed in this study. Only the bottom sections were considered. The loading assumptions for both sections were as follows: reservoir level at the top of the embankment, full hydrostatic pressure on upstream face and uplift varying uniformly from full tailwater at the toe to full tailwater at the heel plus two-thirds of the difference between the headwater and tailwater also at the heel.

The results of the stability analysis performed for the auxiliary spillway showed that the toe pressure and sliding factor are within acceptable limits and the resultant is outside the middle third, but within the base, about 13.0 feet from the downstream toe. OCE guidelines on overturning recommended that the resultant be within the middle third. Although the resultant is outside the middle third, it is within the base. Considering that the auxiliary spillway is on a rock foundation and the toe pressure is within acceptable limits, the resultant being outside the middle third is not considered to be a significant deviation from the recommended guidelines.

The results of the stability analysis performed for the main spillway showed that the toe pressure and sliding factor are within acceptable limits and the resultant is within the middle third, and, consequently, would meet OCE recommended guidelines for stability.

The auxiliary spillway right retaining wall at the downstream side has a crack as previously discussed. The Owner has prepared plans and specifications to repair the wall. However, no definite schedule has been established for this repair work.

c. Operating Records. Based on the operating records, there is no evidence that any stability problems have occurred for the embankments, the upstream abutment walls, the spillway, or the auxiliary spillway. Experience data is available to confirm this. According to the Owner, water was within 0.1 foot of the present maximum pool; during a local storm the auxiliary spillway was overtopped by about 1.0 foot, but no stability problems were noted.

d. Post-Construction Change. No modifications have been made to Brownell Dam since its construction.

e. Seismic Stability. Brownell Dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe

for any expected loading. However, since there is the potential of earthquake forces moving or cracking the masonry core wall, the theoretical seismic stability of this dam cannot be assessed.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on the visual inspection, available records, calculations and past operational performance, Brownell Dam is judged to be in good condition. However, some maintenance and repair deficiencies were noted. A summary of features and obser-ed deficiencies are listed below:

Feature and Location	Observed Deficiencies
Embankment (right abutment):	
Upstream slope	Weathered and missing riprap.
Top of embankment	Low spot and erosion gully.
Downstream slope	Tree in embankment and settling behind wall.
Toe of downstream slope	Contiguous tree line and wet area.
Embankment (left abutment):	
Upstream and downstream slopes	Trees in embankment.
Auxiliary Spillway:	
Downstream face	Seepage and efflorescence.
Crest	Deteriorated handrail.
Appurtenant Structures:	
Main spillway discharge channel	Erosion of rocks.
Auxiliary spillway right retaining wall	Major crack and deteriorating concrete.
Blowoff line	Stiff valve operation.
Damsite:	Occurrences of vandalism.

(2) The overtopping potential analysis shows that Brownell Dam will be overtopped by the PMF and one-half the PMF. Therefore, based on OCE criteria, as outlined in Paragraph 5.1.a.(2), the spillway capacity is rated as seriously inadequate. The existing spillway can accommodate a flood with a peak inflow of 27 percent of the PMF peak inflow. If the existing low area of the embankment were filled in, the existing spillway could accommodate a flood with a peak inflow of 43 percent of the PMF peak inflow. Additional analyses for the overtopping potential of Brownell Dam included consideration of the hydrologic and hydraulic effects of Carbondale No. 4 Dam, which is located on Racket Brook about 0.6 mile upstream from Brownell Dam. Results of the analyses show that Carbondale No. 4 Dam will be overtopped by one-half the PMF (storm over Carbondale No. 4 watershed only). A failure hydrograph of Carbondale No. 4 Dam was made and it was found that if Carbondale No. 4 Dam failed, the spillway capacity and surcharge storage effect of Brownell Dam were insufficient to contain the Carbondale No. 4 failure hydrograph without overtopping the dam.

(3) Stability computations that are on file and computations performed for this study indicate that the main spillway and the auxiliary spillway are apparently structurally adequate for the maximum pool condition. For the maximum pool condition, computations show that the resultants are outside the middle third in some cases, but within the base, and that sliding factors and toe pressures are within acceptable limits. The Owner's estimate of the flood of record indicates that water was within 0.1 foot of the present maximum pool elevation, with no stability problems noted.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, computations performed prior to and as a part of this study, and other information.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented as soon as practical or in a timely manner as noted.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations will be required.

7.2 Recommendations and Remedial Measures.

a. In view of the concern for the safety of Brownell Dam, the following measures are recommended to be taken by the Owner as soon as practical:

(1) Develop a detailed emergency operation and warning system for Carbondale No. 4, and Brownell Dam system.

(2) Perform additional studies to more accurately ascertain the spillway capacity required for Brownell Dam, as well as the nature and extent of mitigation measures required to make the spillways hydraulically adequate. Filling in the existing low area of the embankment would help increase the spillway capacity and this should be accomplished.

(3) Implement the proposed repair program to the auxiliary spillway right retaining wall. As part of this program, install two or more observation wells, or other instrumentation, in the earthfill behind the retaining wall. Monitor instrumentation on a regular basis. If readings indicate potential problems, appropriate action should be taken.

b. In order to correct operational, maintenance and repair deficiencies, and to more accurately assess the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Replace weathered and missing riprap.

(2) Fill low spot and settlement areas in embankment and provide protection against erosion.

(3) Remove trees from toe and slope of embankment.

(4) Monitor wet area near toe of slope and if changes are noted, take appropriate action.

(5) Monitor the downstream face of auxiliary spillway for increased seepage or other problems and take appropriate action as required.

(6) Monitor erosion in the spillway outlet channel and perform remedial action when required.

(7) Maintain constant vigilance against vandalism.

c. Until remedial work for correcting the hydraulic deficiencies of the spillways is complete, the following measures are recommended to be undertaken by the Owner:

(1) Provide round-the-clock surveillance of Brownell Dam during periods of unusually heavy rains.

(2) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency and warning system procedures.

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

BROWNELL DAM

NDS ID No. 192

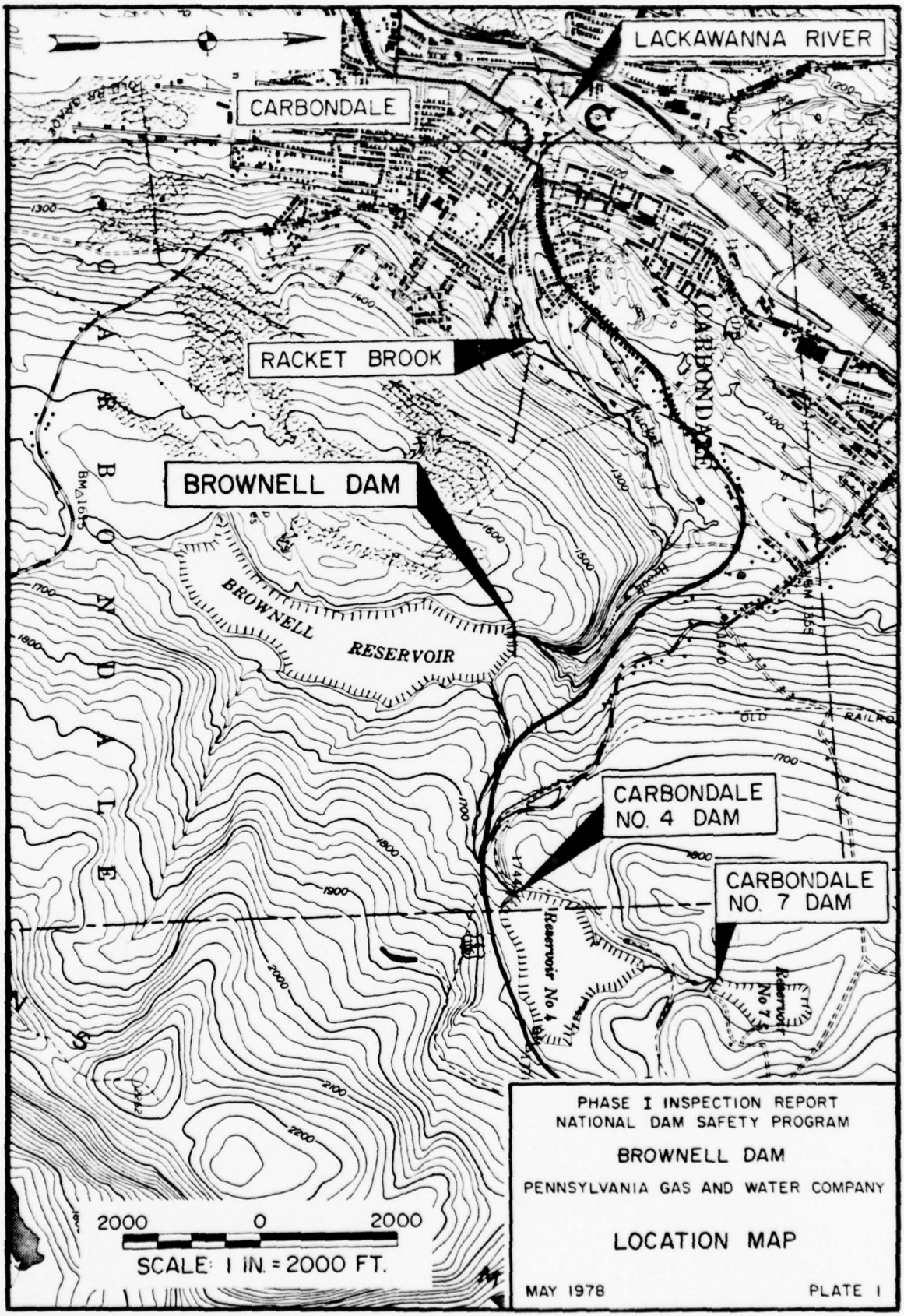
PENNSYLVANIA GAS AND WATER COMPANY

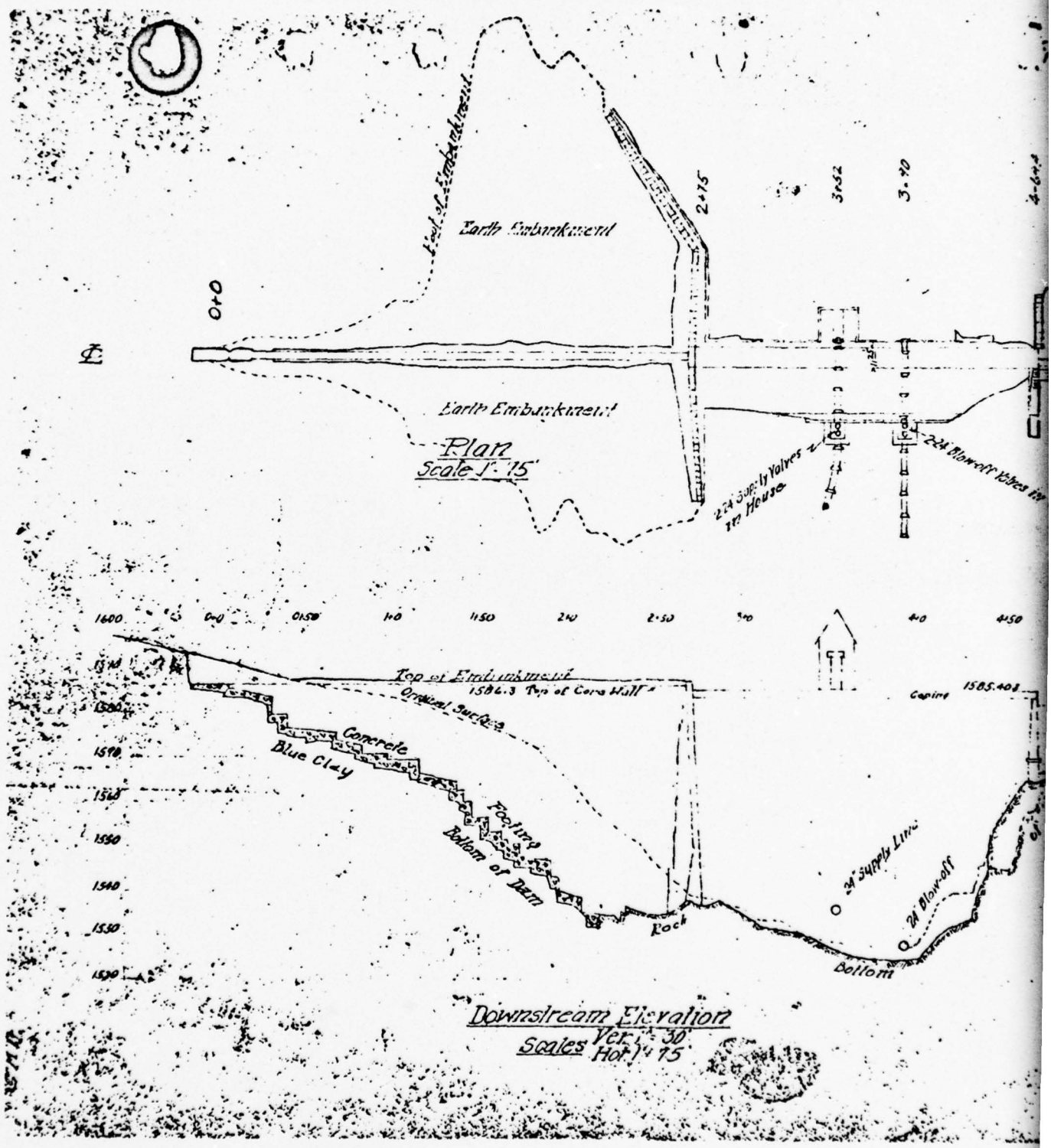
PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

PLATES


LACKAWANNA RIVER
CARBONDALE
RACKET BROOK
BROWNELL DAM
BROWNELL RESERVOIR
CARBONDALE NO. 4 DAM
CARBONDALE NO. 7 DAM
Reservoir No 4
Reservoir No 7
BOWMANS
2000 0 2000
SCALE: 1 IN. = 2000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BROWNELL DAM
PENNSYLVANIA GAS AND WATER COMPANY
LOCATION MAP
MAY 1978
PLATE 1



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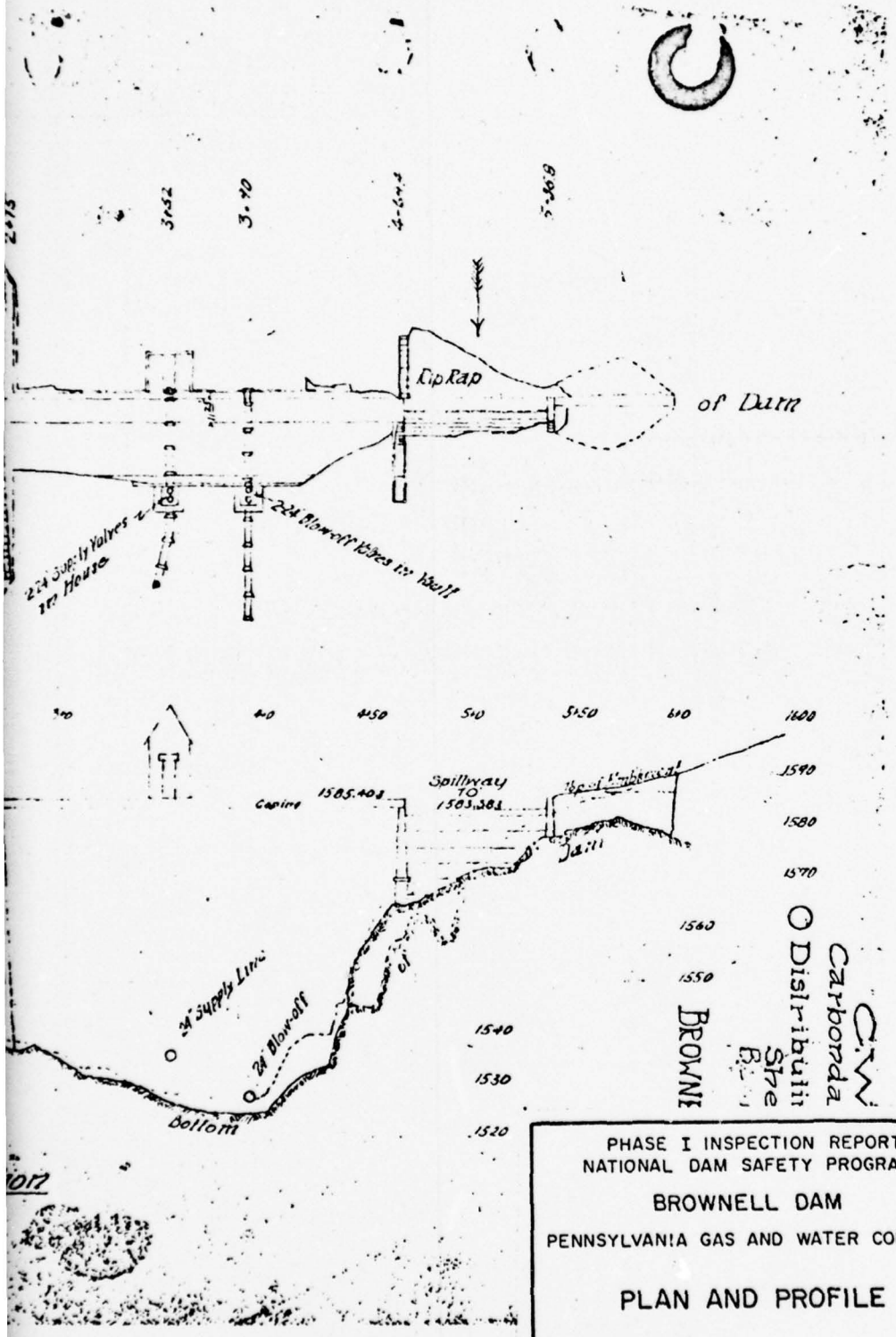

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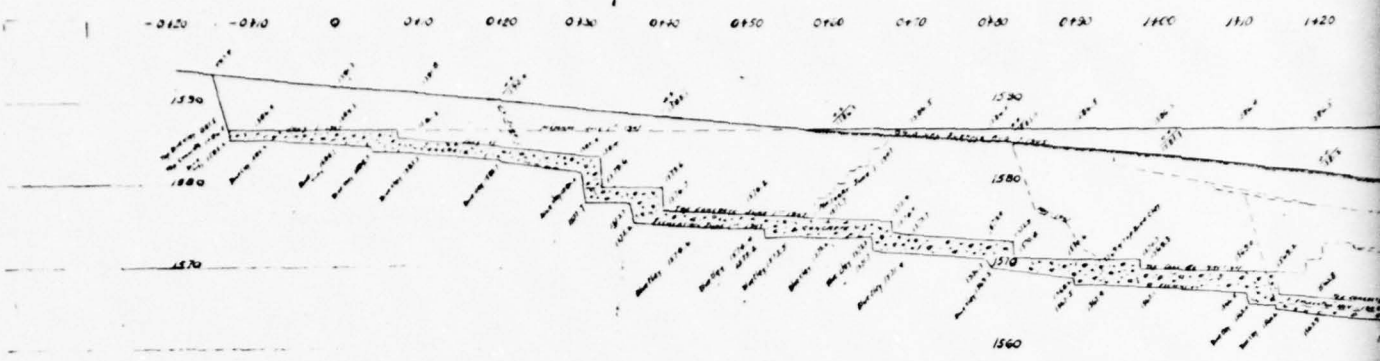
NATIONAL DAM SAFETY PROGRAM

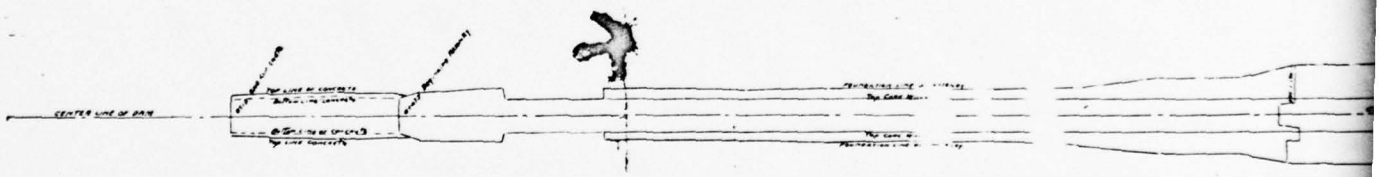
BROWNELL DAM

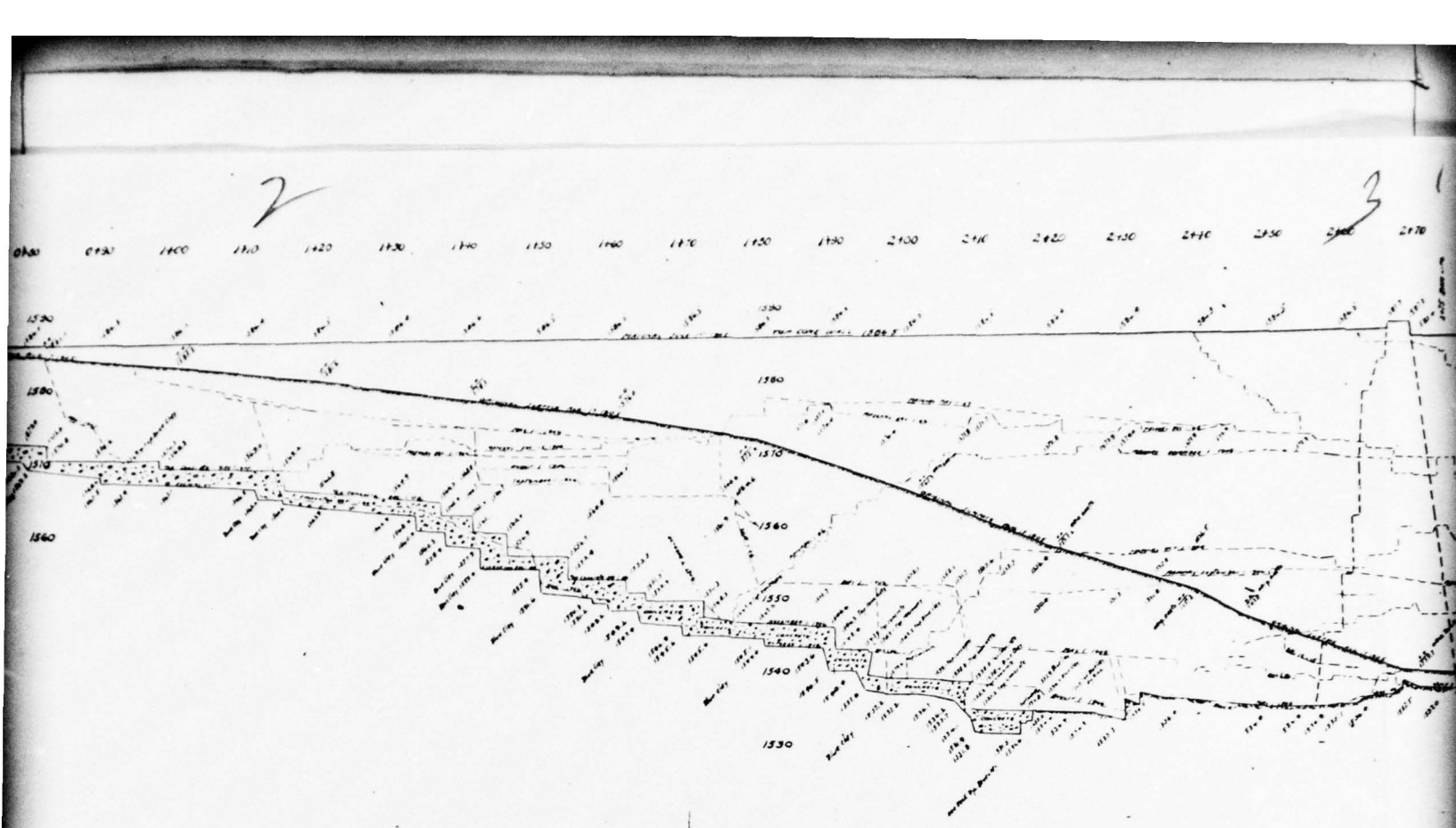
PENNSYLVANIA GAS AND WATER COMPANY

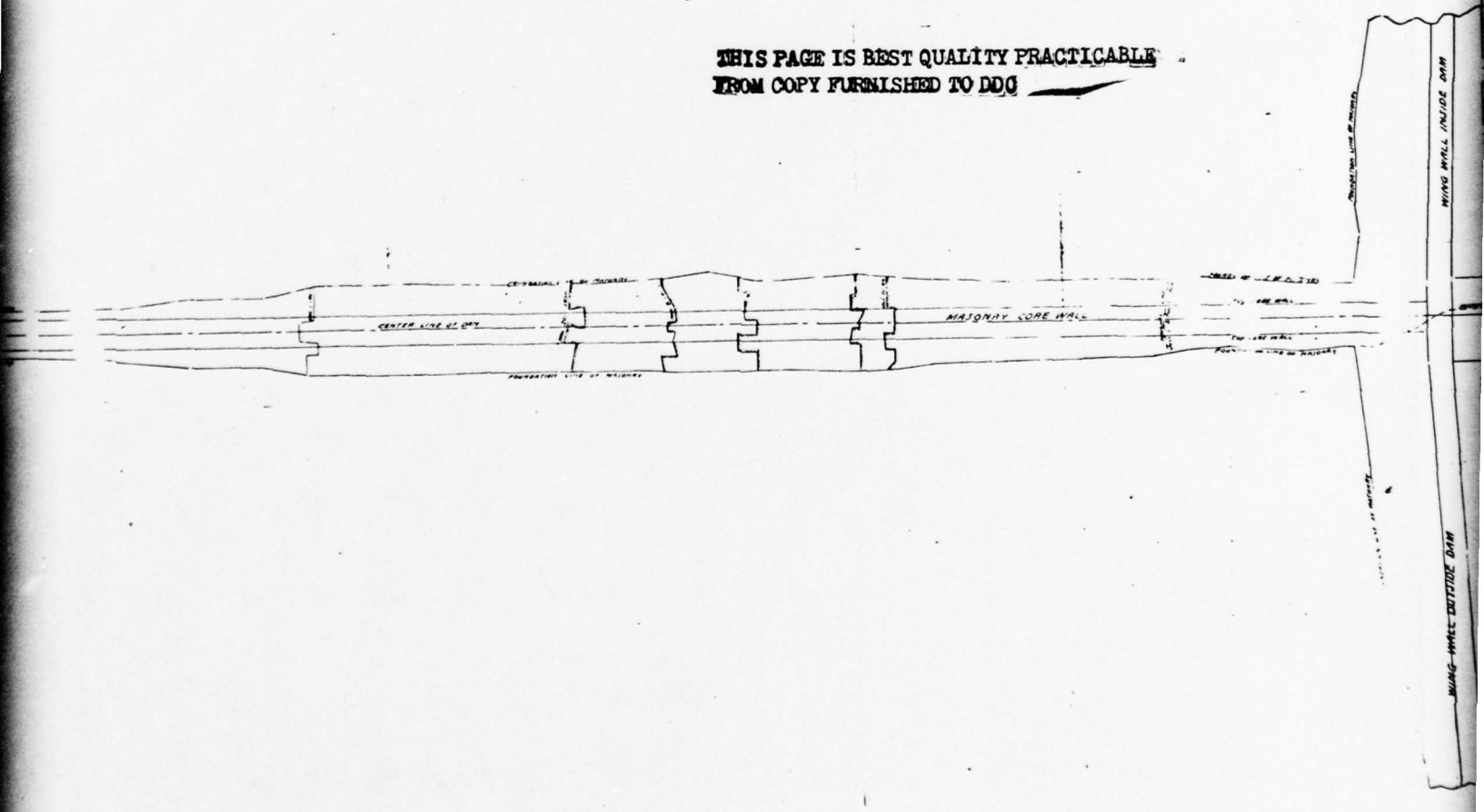
PLAN AND PROFILE

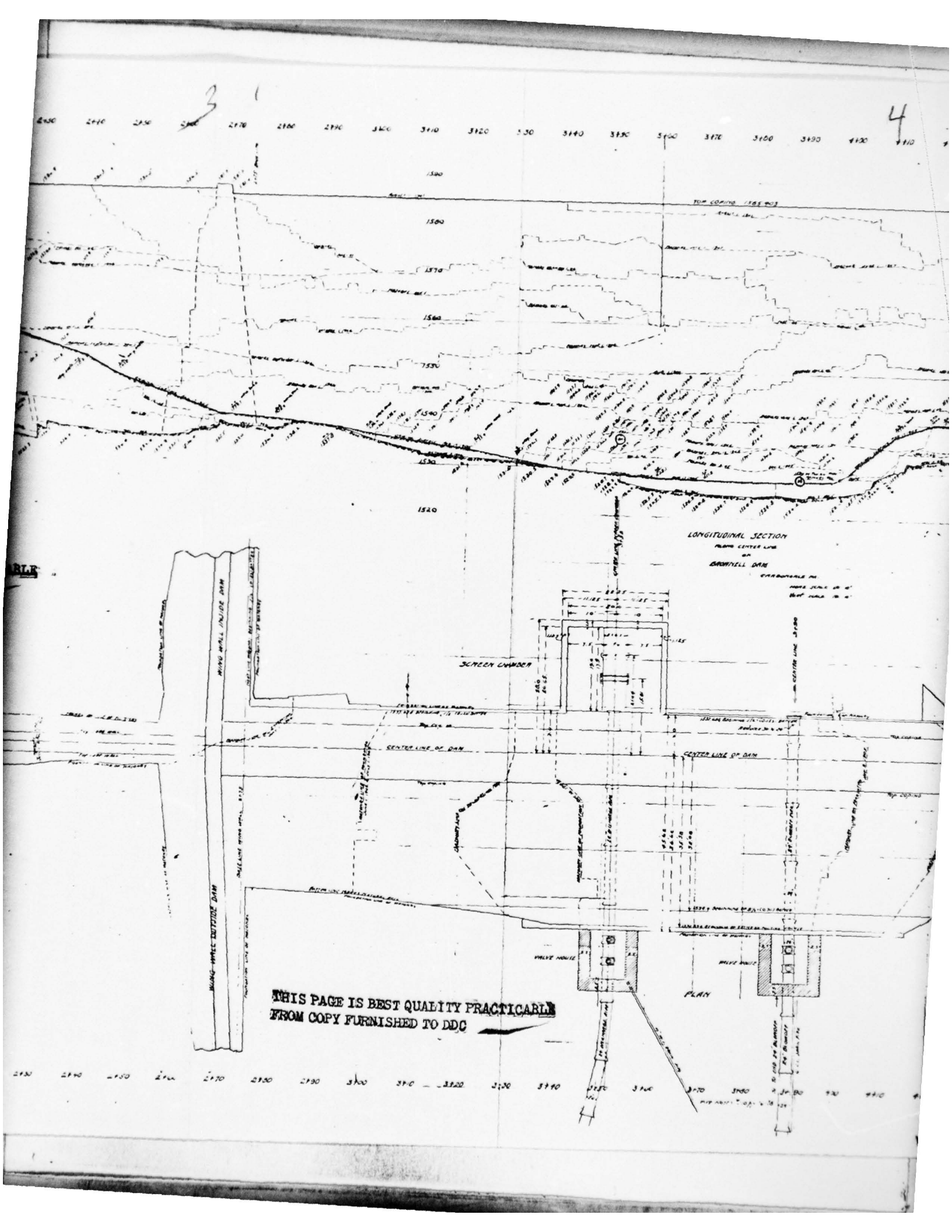
MAY 1978 PLATE IA

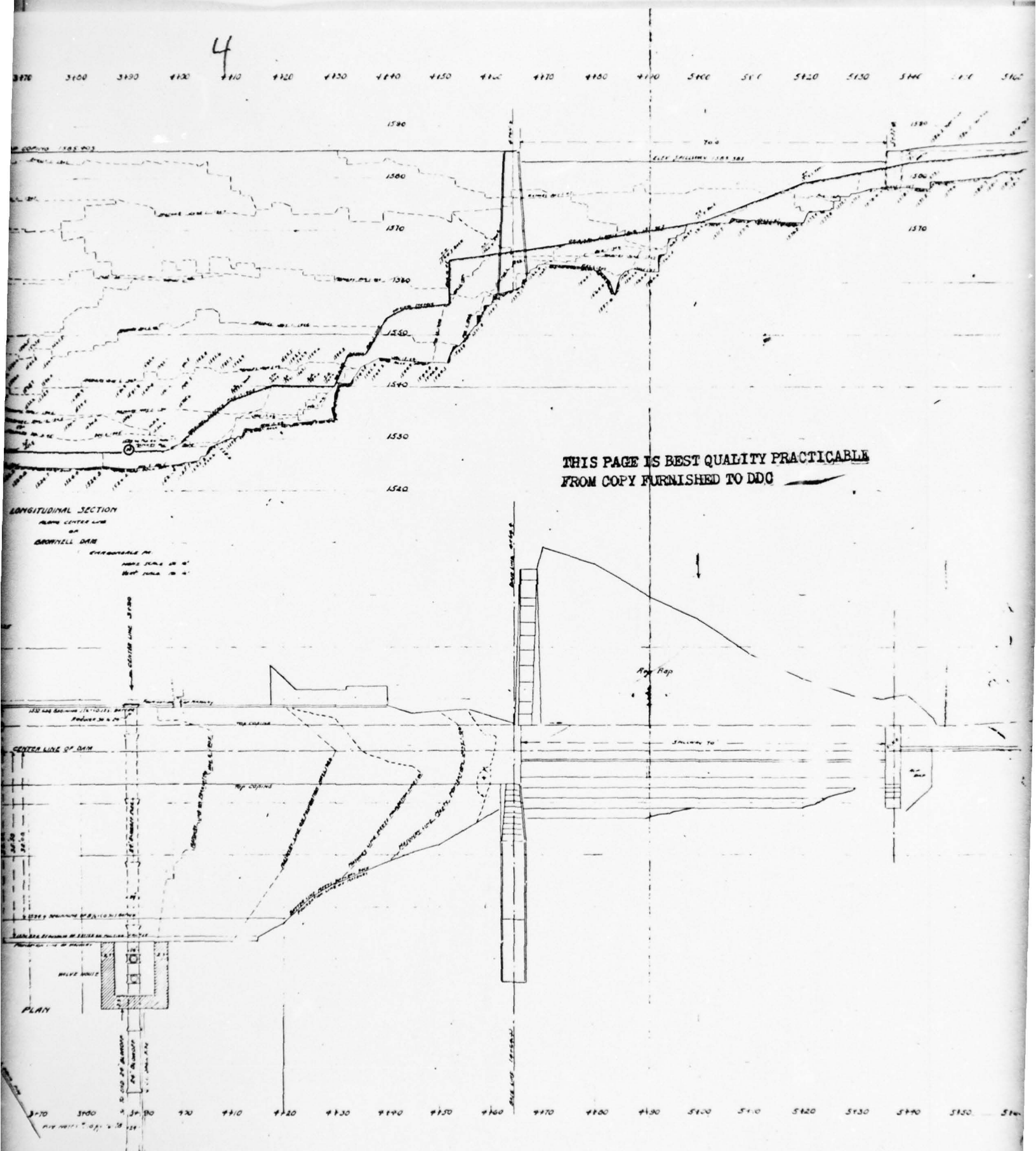


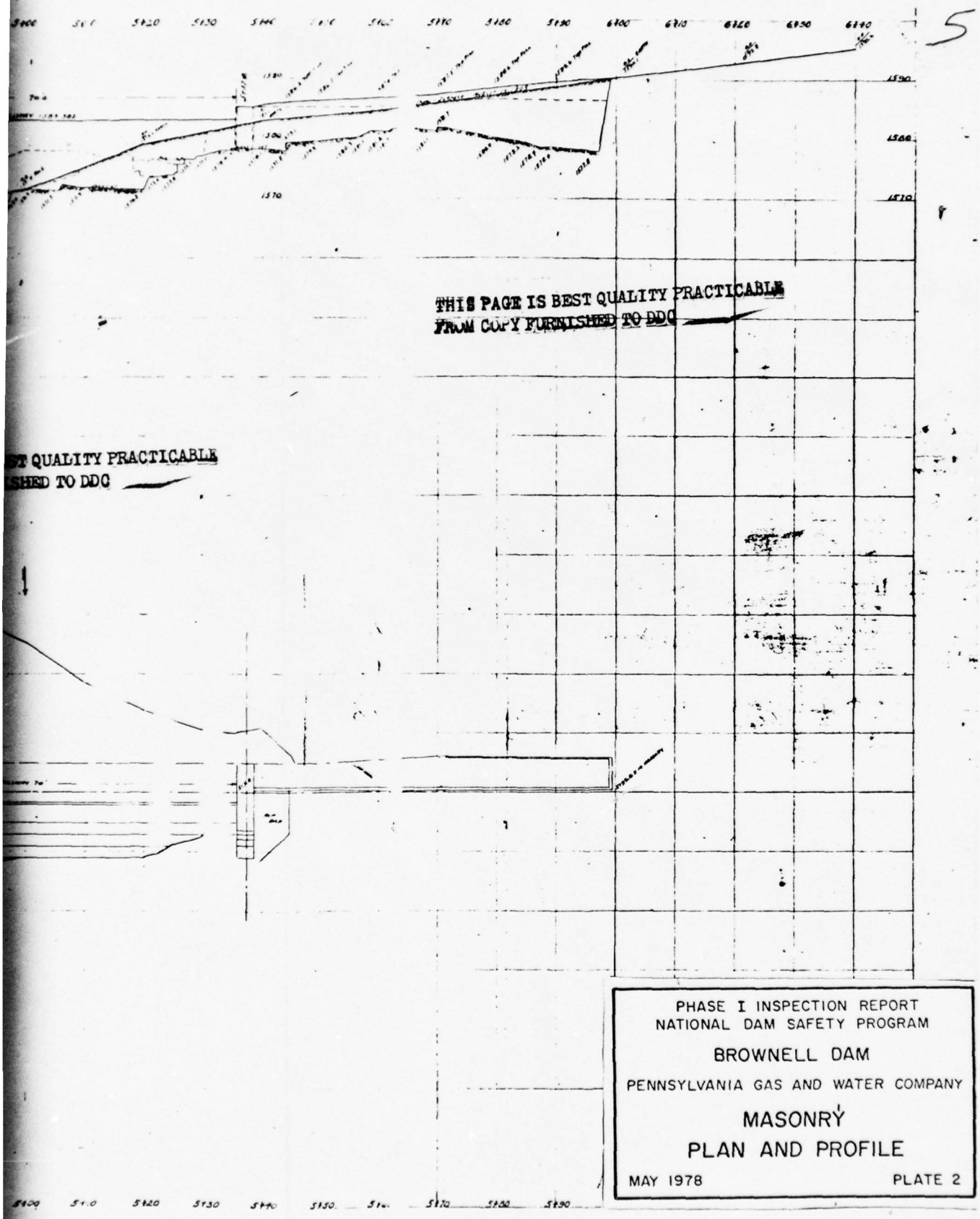












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NATIONAL DAM SAFETY PROGRAM

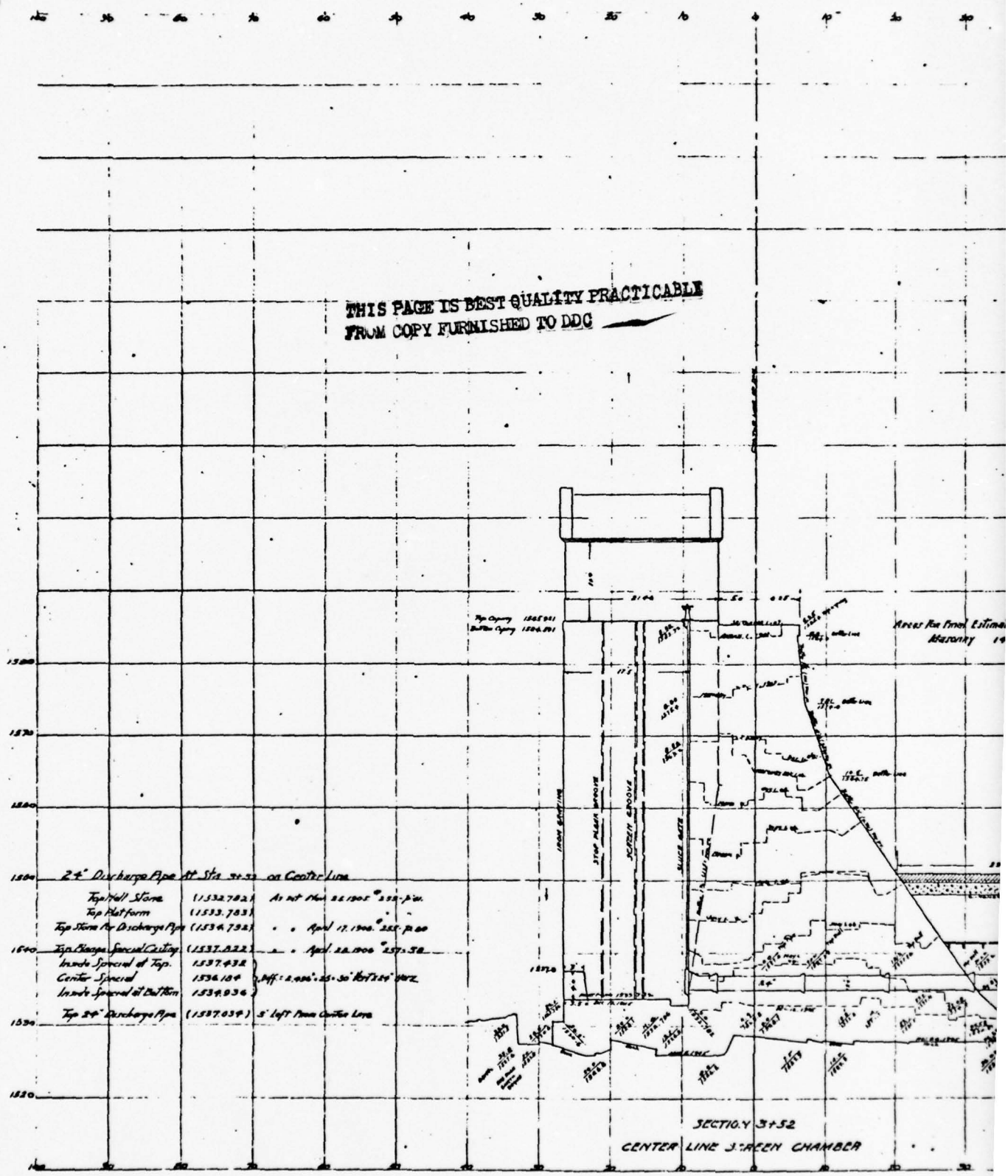
BROWNELL DAM

PENNSYLVANIA GAS AND WATER COMPANY

MASONRY

PLAN AND PROFILE

MAY 1978 PLATE 2



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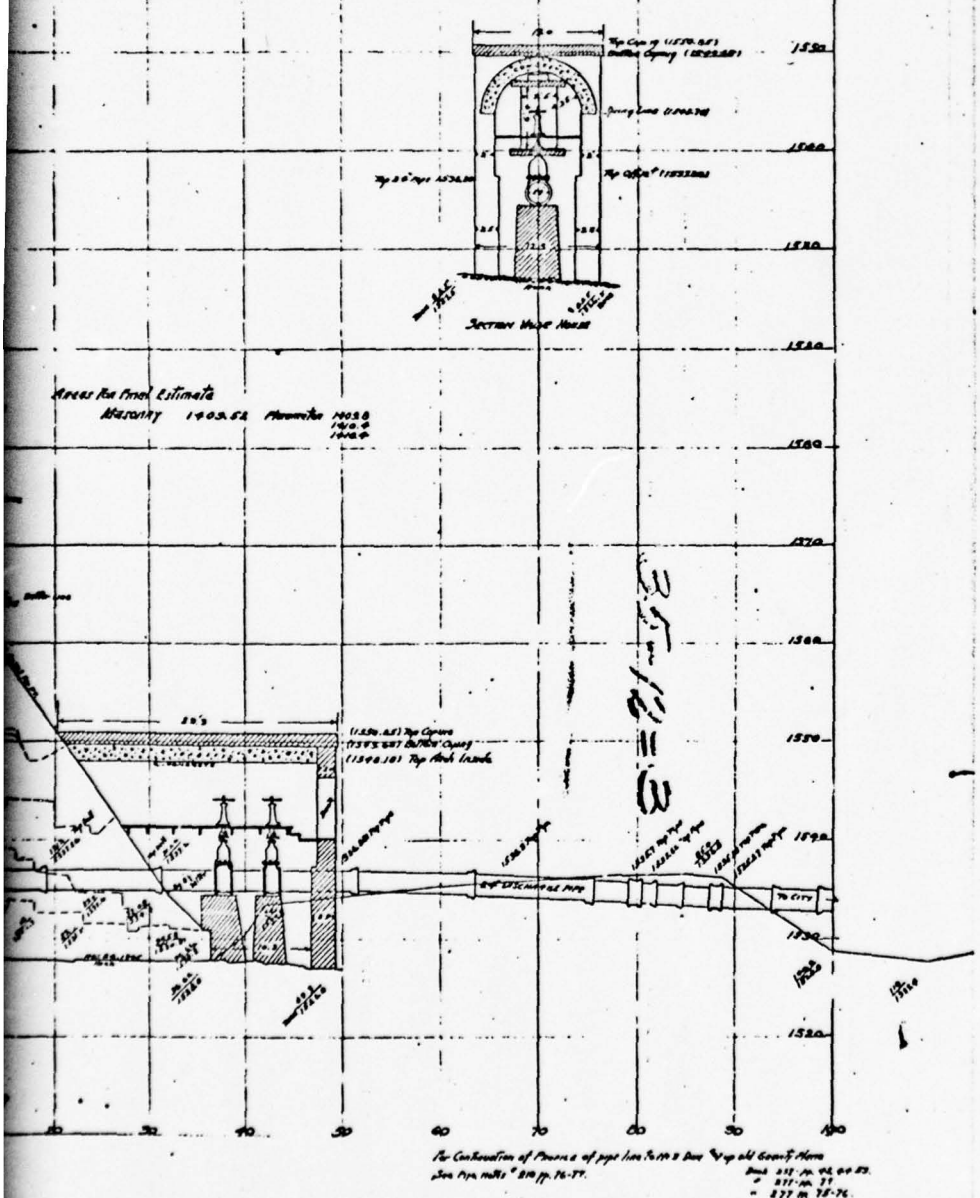

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BROWNELL DAM

PENNSYLVANIA GAS AND WATER COMPANY

WATER SUPPLY PROFILE

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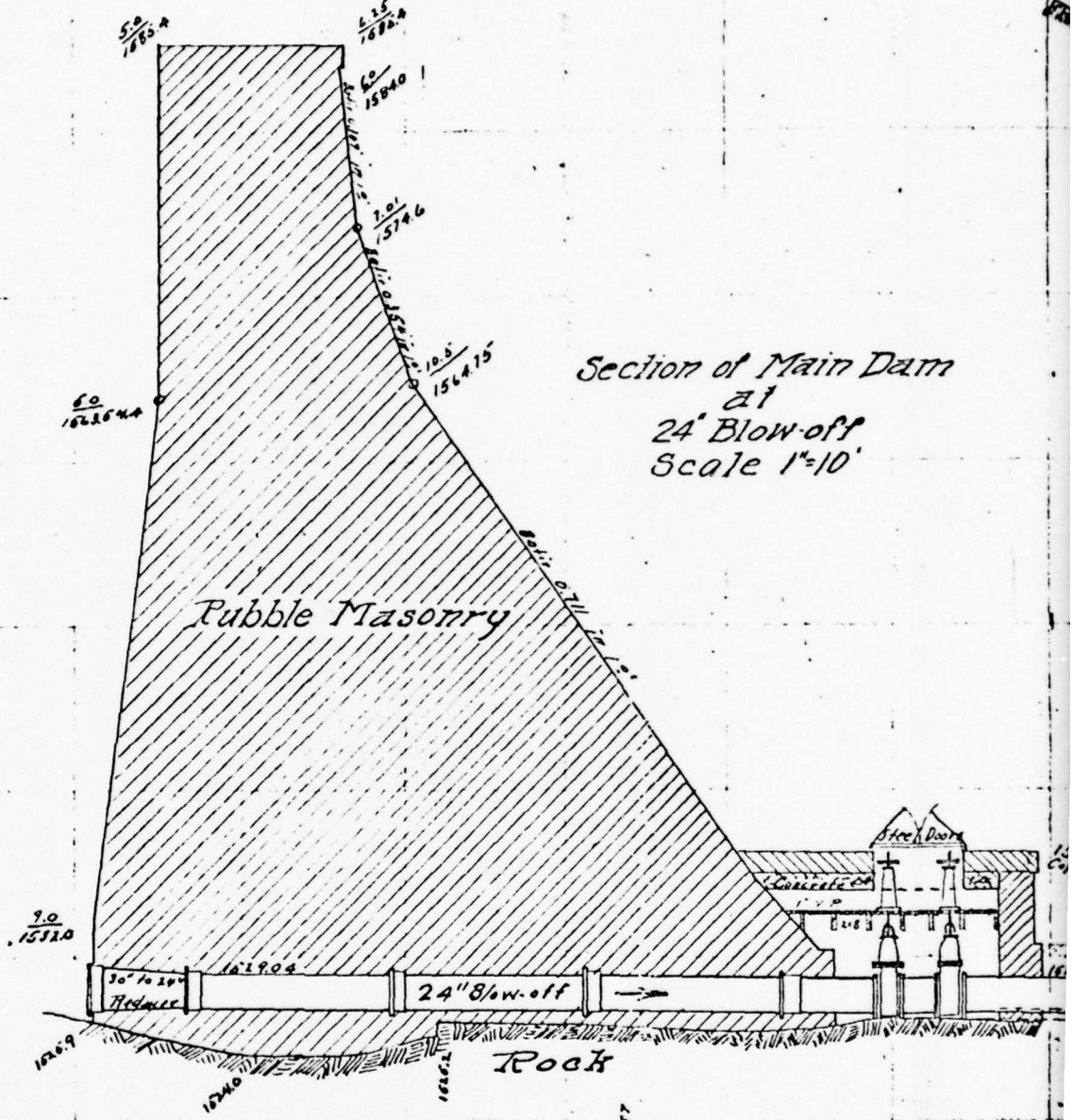
142-3 24



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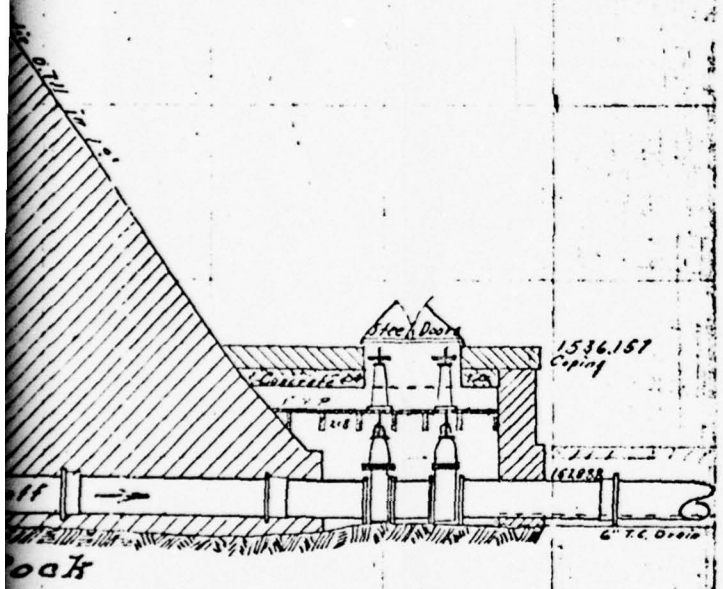
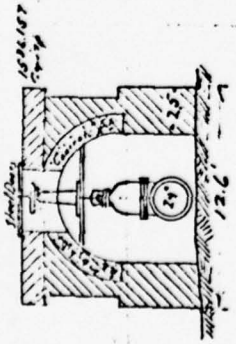
Section of Main Dam
at
24" Blow-off
Scale 1"=10'





SECTION OF VAULT

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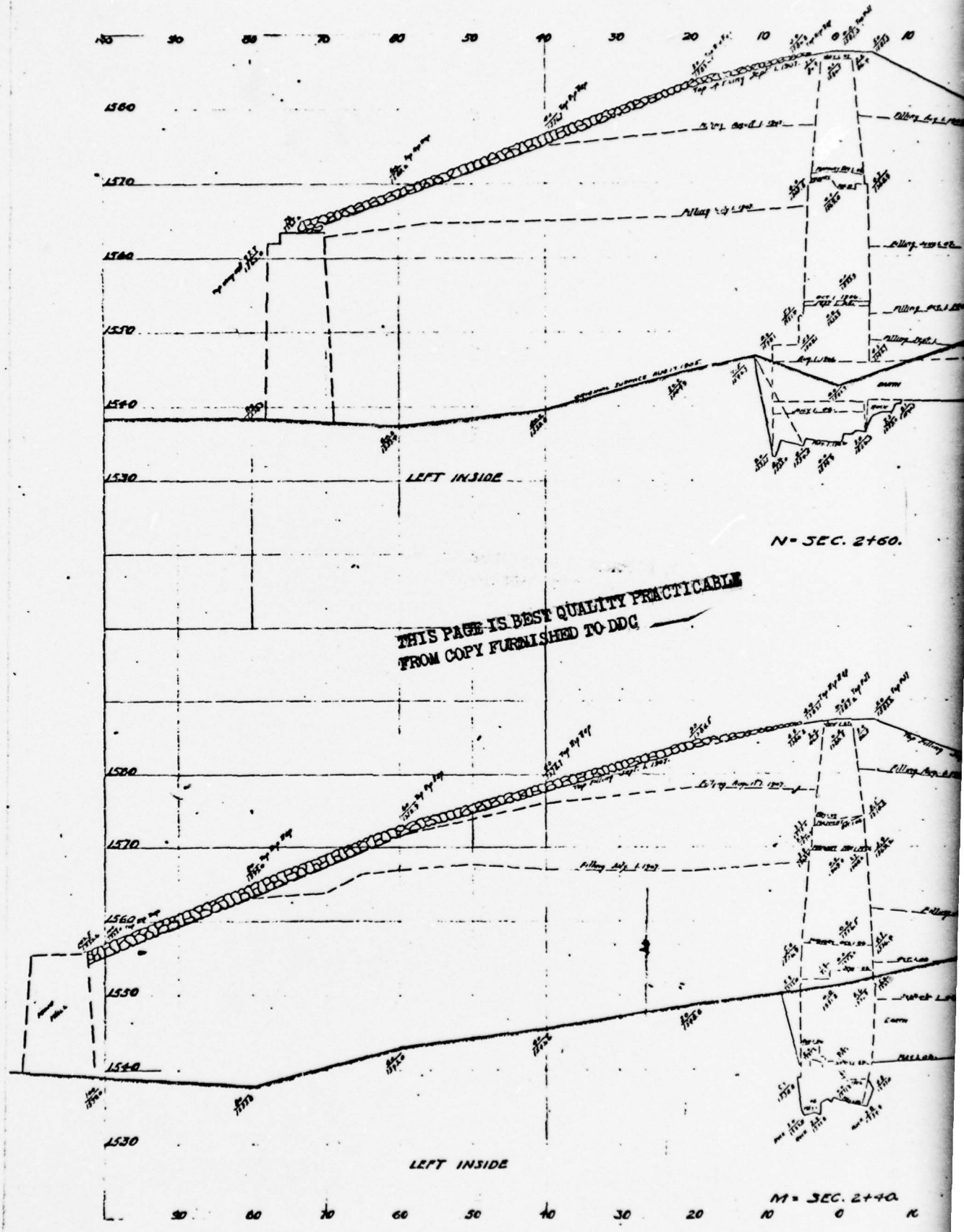
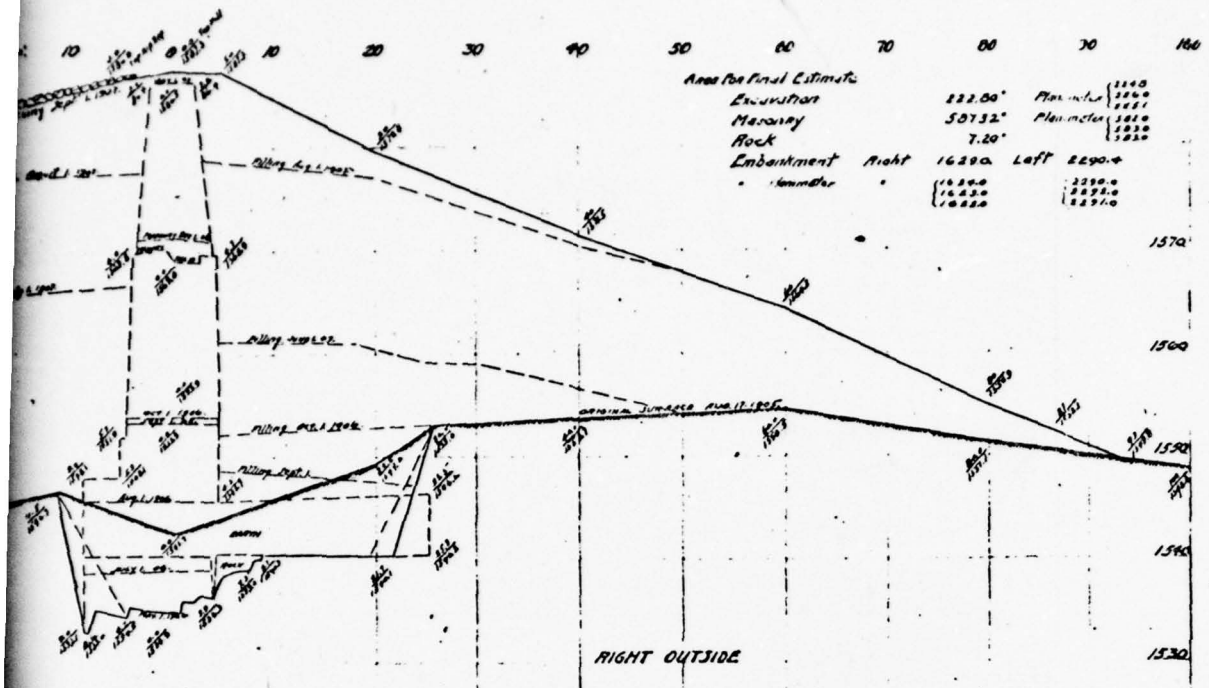
BROWNELL DAM

PENNSYLVANIA GAS AND WATER COMPANY

BLOWOFF PROFILE

MAY 1978 PLATE 4





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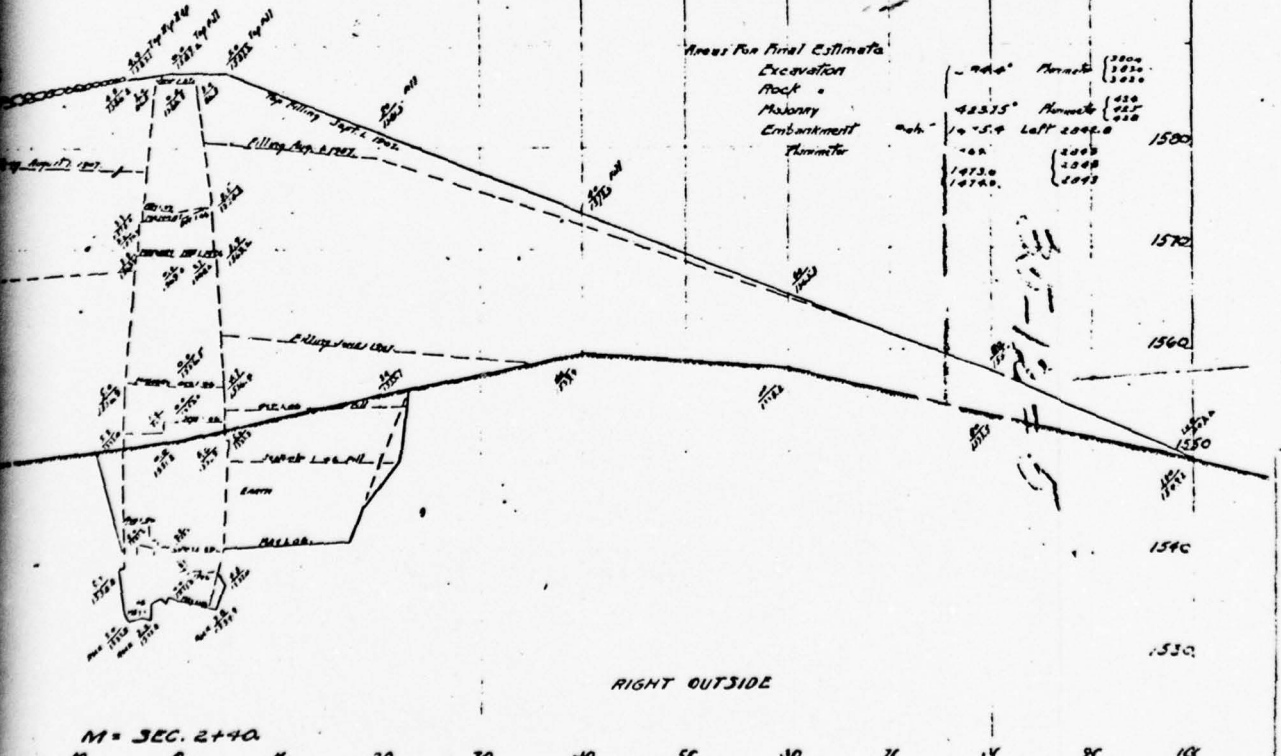


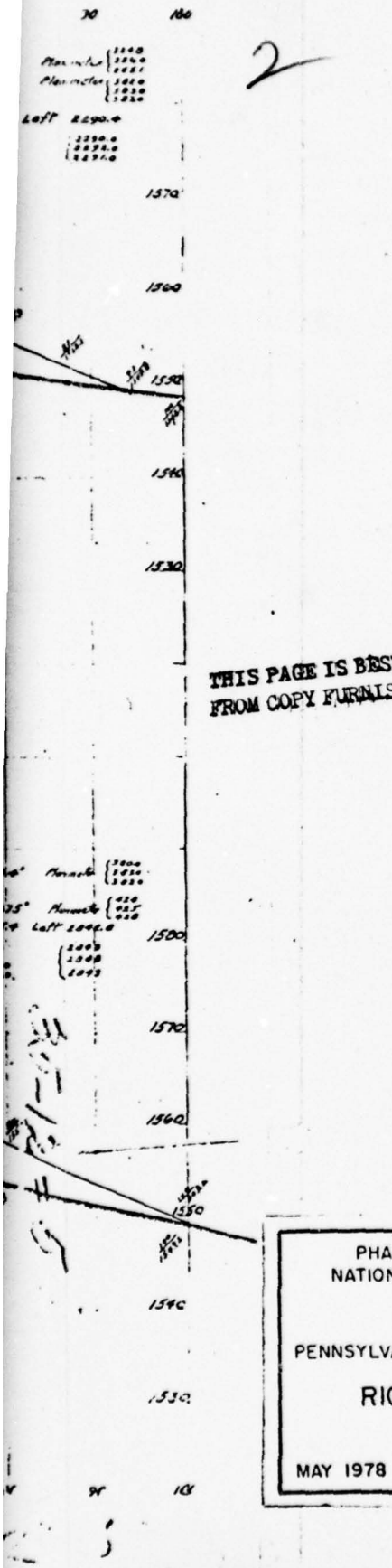
PHASE I INSPECTION
NATIONAL DAM SAFETY

BROWNELL DA

PENNSYLVANIA GAS AND WA

RIGHT EMBANKM
SECTIONS

MAY 1978



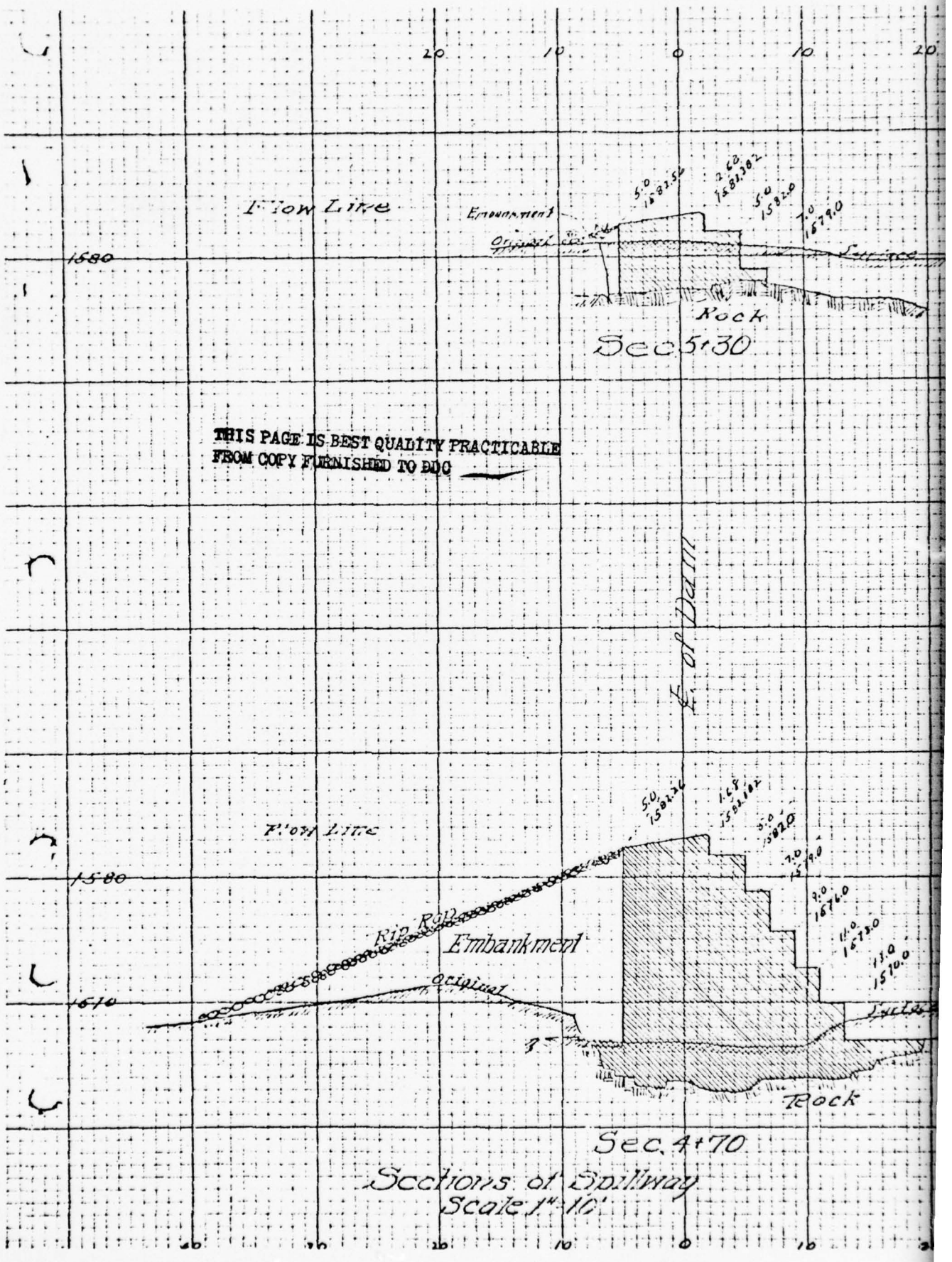
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

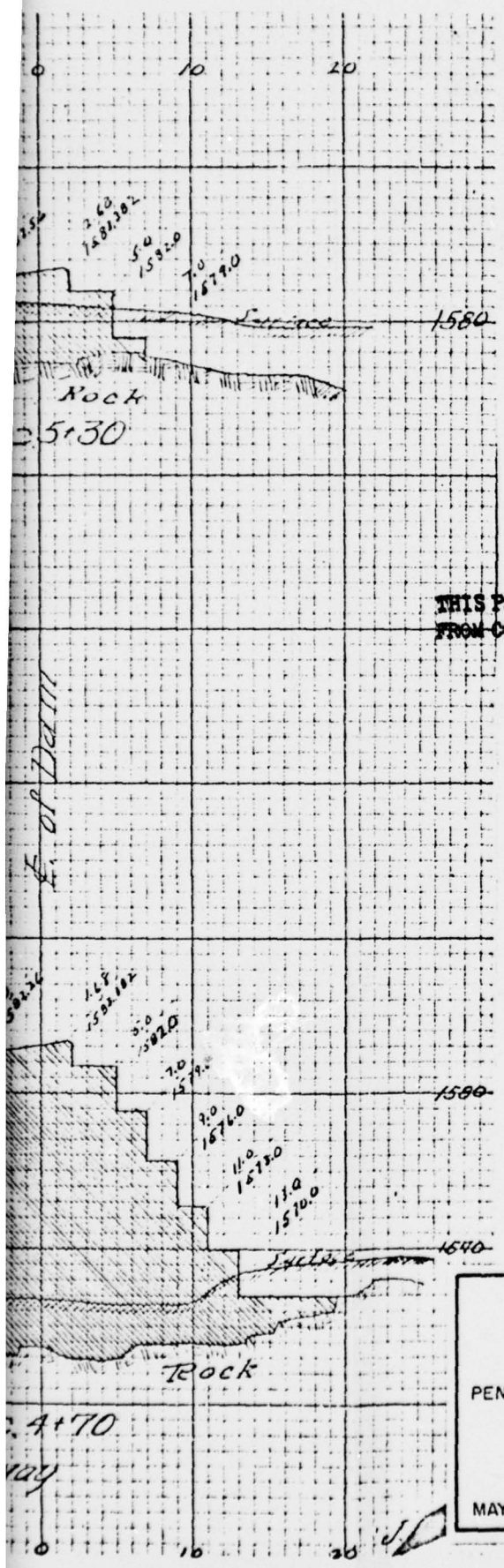
BROWNELL DAM

PENNSYLVANIA GAS AND WATER COMPANY

RIGHT EMBANKMENT
SECTIONS

MAY 1978 PLATE 5


20
10
0
10
20
Flow Line
Embankment
Original
1580
5.0
1582.50
2.68
1581.382
5.0
1582.0
7.0
1579.0
Surface
Rock
Sec 5+30
THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC
E of Dam
Flow Line
5.0
1582.26
1.68
1581.182
5.0
1582.0
7.0
1579.0
7.0
1576.0
11.0
1573.0
13.0
1570.0
1580
Rip Rap
Embankment
original
1570
Surface
Rock
Sec. 4+70
Sections of Spillway
Scale 1" = 10'
20
10
0
10
20



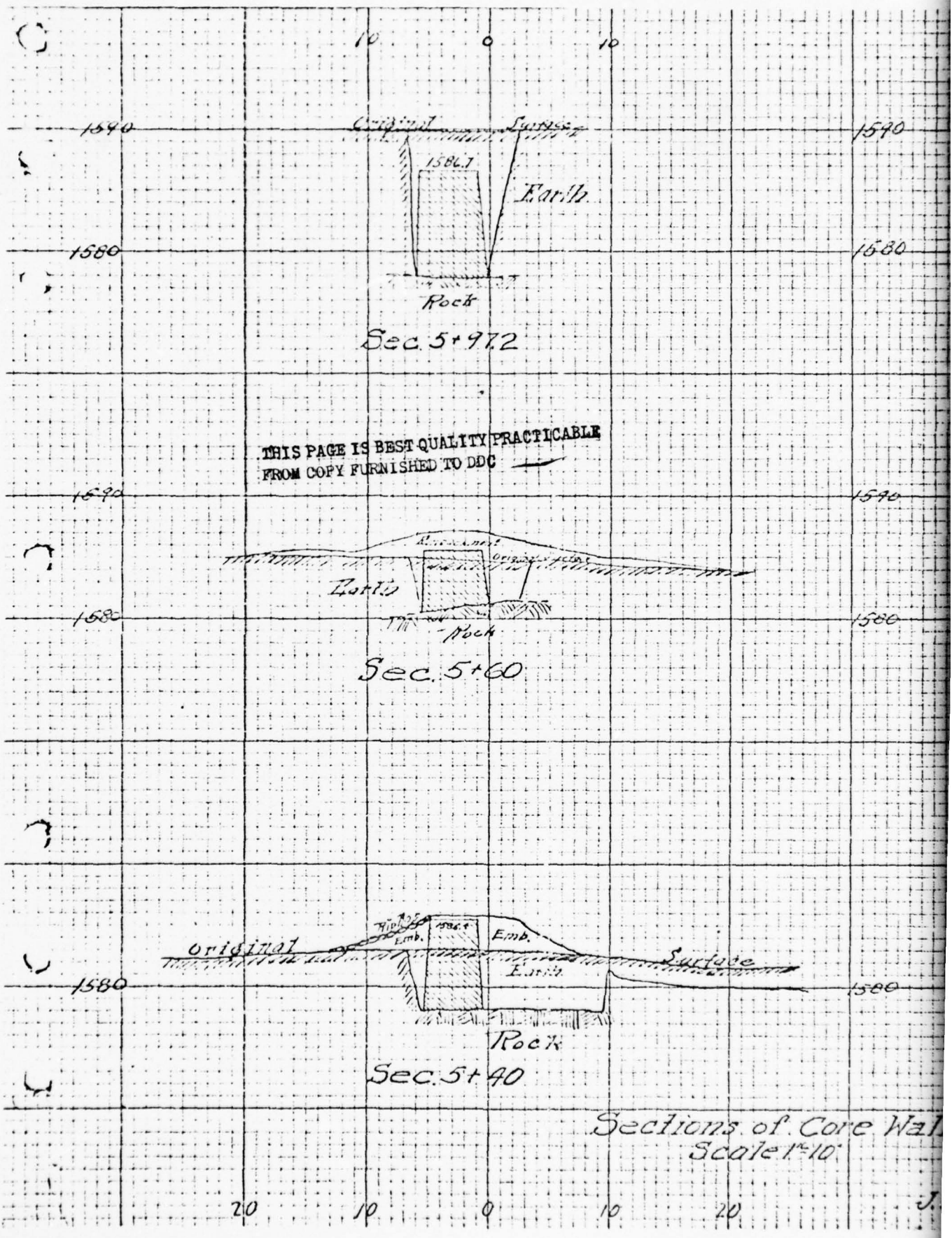
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

BROWNELL DAM

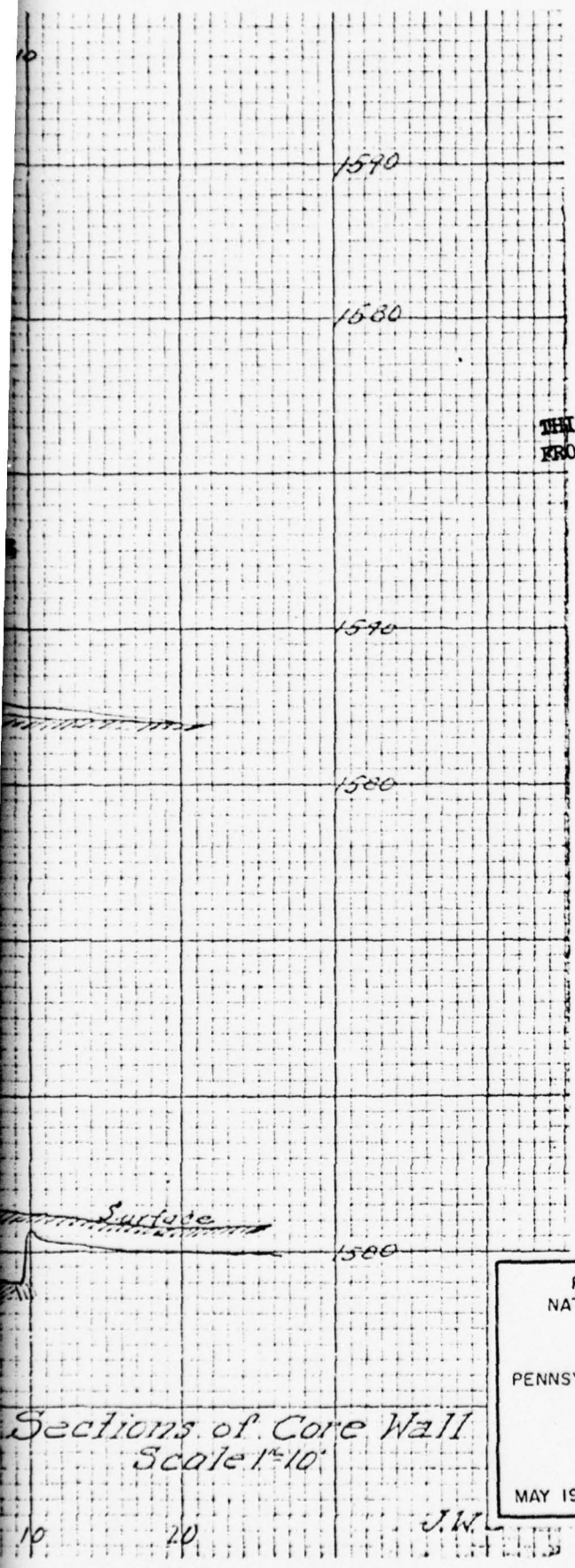
PENNSYLVANIA GAS AND WATER COMPANY

SPILLWAY SECTIONS

MAY 1978 PLATE 6



Sections of Core Wal
Scale 1"=10'



PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

BROWNELL DAM

PENNSYLVANIA GAS AND WATER COMPANY

LEFT EMBANKMENT
SECTIONS

MAY 1978 PLATE 7

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

BROWNELL DAM

NDS ID No. 192

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: BROWNELL

NDS ID NO.: 192 DER ID NO.: 35-12

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	Final quantity survey drawings available.
REGIONAL VICINITY MAP	Project is shown on Waymart, Pa. - Quandrangle sheet N 4130-W 7522.517.5 1946 photo revised 1969
CONSTRUCTION HISTORY	Built 1906-1908
TYPICAL SECTIONS OF DAM	See "As Built Drawings"
OUTLETS: Plan Details Constraints Discharge Ratings	Plan and profile of outlets available. Details and ratings not available.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NONE
DESIGN REPORTS	NONE
GEOLOGY REPORTS	1914 Report on History and Design, has general geologic description.
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	1914 hydraulic and stability analysis of dam.
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	NONE
POSTCONSTRUCTION SURVEYS OF DAM	NONE

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	Materials obtained from onsite. Embankment material is clay with gravel. Masonry is conglomerate.
MONITORING SYSTEMS	Dam tender visits dam daily to check equipment and note water level.
MODIFICATIONS	NONE
HIGH POOL RECORDS	No systematic records. Owner states 1 foot over auxiliary spillway.
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	1914 report of hydraulics and stability
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	1975 - 5 masonry blocks fell from auxiliary spillway. Present - structural crack in downstream right abutment wingwall.

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	No detailed operation records.
SPILLWAY: Plan Sections Details	Sections, plans, and profiles are available.
OPERATING EQUIPMENT: Plans Details	Plans are available.
PREVIOUS INSPECTIONS Dates Deficiencies	1919 - Slight seepage through masonry joints. 1925 - Small amount seepage through dam. 1928 - Seepage through masonry joints and retaining wall confining earth embankment. 1932 - Seepage through masonry joints. Leakage under blowoff. Water flowing by toe, 3/4" ±. Cracks (small) at upstream end of abutment. 1941 - Leakage under blowoff pipe. Seepage through joints. Riprap removed from right abutment of auxiliary spillway. 1944 - Slight seepage at blowoff and through masonry joints.
(CONTINUED)	1953 - Slight seepage at toe. 1957 - Seepage through dam face. Broken riprap to right of stone wall. Crack in right wingwall extending 25 feet. 1965 - Slight seepage at right spillway wall.

CHECKLIST

ENGINEERING DATA

HYDROLOGY AND HYDRAULICS

NAME OF DAM: Brownell NDS ID NO.: 192 DER ID NO.: 35-12

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1583.4

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1586.5

ELEVATION MAXIMUM DESIGN POOL: 1586.5

ELEVATION TOP DAM: 1586.5

SPILLWAY CREST:
- a. Elevation 1583.4
- b. Type Broad-crested masonry overflow with stepped cascade.
- c. Width 7.0'
- d. Length 70.0'
- e. Location Spillover Left abutment
- f. Number and Type of Gates None

OUTLET WORKS:
- a. Type 1 - 24 inch CIP with valves downstream
- b. Location center
- c. Entrance Inverts
- d. Exit Inverts
- e. Emergency Draindown Facilities 1 - 24 inch CIP s/valves downstream

HYDROMETEOROLOGICAL GAGES:
- a. Type None
- b. Location None
- c. Records None

MAXIMUM NONDAMAGING DISCHARGE: 1864 cfs

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

BROWNELL DAM

NDS ID No. 192

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Brownell County: Lackawanna State: Pennsylvania

NDS ID No.: 192 DER ID No.: 35-12

Type of Dam: Combination masonry gravity earthfill with core wall Hazard Category: high

Date(s) Inspection: 24 & 25 April, 1978 Weather: sunny, dry Temperature: 60°F

Soil moist, snow still remaining at toe of dam

Pool Elevation at Time of Inspection: 1583.5 msl/Tailwater at Time of Inspection: 1524.0 msl

Inspection Personnel:

F. Mansour (GFCC)	D. Kauffman (PG&W)	
P. Van Der Goes (GFCC)	J. Skoritowski (PG&W)	
D. Ebersole (GFCC)	J. Hessling (PG&W)	

A. Whitman (GFCC) Recorder

EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	NONE	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	NONE	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	Erosion gully at top of right abutment wall leading under small dry masonry wall. See "Junction with Abutment".	Appears to be caused by runoff.
CREST ALIGNMENT: Vertical Horizontal	Horizontal - straight Vertical - surveyed	
RIPRAP FAILURES	Upstream slope - riprap above spillway crest, apparently shale, very weathered. Some appears to be gravel.	Riprap extends 100' ± RT of masonry section. Owner reports some riprap replaced with gravel because of vandalism.

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	Settling behind right abutment wall. Wall is cracked.	
ANY NOTICEABLE SEEPAGE	Wet spot, 3' x 3', observed 75' below toe of right embankment, 100' right of auxiliary spillway.	
STAFF GAGE AND RECORDER	NONE	
DRAINS	NONE	

CONCRETE/MASONRY DAMS

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Entire downstream face of dam, from 6' below crest, is damp. No noticeable flow at toe. Seepage, with no flow at toe, from crack in right abutment wall.	On dam face, no localized seepage points were observed.
JUNCTION OF STRUCTURE WITH: Abutment Embankment Other Features	NO DEFECTS	Upstream walls submerged.
DRAINS	NONE	
WATER PASSAGES	NOT OBSERVABLE	
FOUNDATION	Outcrop at left evident. No apparent defects.	

CONCRETE/MASONRY DAMS

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MASONRY ~~CONCRETE~~ SURFACES: Surface Cracks Spalling	Toe of right abutment wall is concrete, spalled at edges and peeling over 80% of face.	
STRUCTURAL CRACKING	Major crack in right abutment wall starting 15.5' from toe and extending up, at 30^{o} $\pm$, through blocks.	Maximum differential 0.7' section above crack has lost its batter and appears vertical.
ALIGNMENT: Vertical Horizontal	No defects except right abutment wall bowed at center.	
MONOLITH JOINTS	Mortar tight.	Owner reports 5 blocks on left downstream top of auxiliary spillway fell in 1975 and were replaced.
CONSTRUCTION JOINTS	NONE	
STAFF GAGE OR RECORDER	NONE	

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Cast-iron pipe not observable.	
INTAKE STRUCTURE	Wet intake tower.	
OUTLET STRUCTURE	Valve pit 24" gate opened by 2 men in 10 minutes.	Upstream blowoff valve is very stiff.
OUTLET CHANNEL	NONE	
EMERGENCY GATE	NONE	

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MASONRY ~~CONCRETE~~ WEIR	No defects.	Water is 0.1' over crest.
APPROACH CHANNEL	Submerged	
DISCHARGE CHANNEL	Natural rock ledge has some rock eroded.	
BRIDGE AND PIERS	NONE	
	Deteriorated handrail on auxiliary spillway	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE	
OBSERVATION WELLS	NONE	
WEIRS	NONE	
PIEZOMETERS	NONE	
OTHER	NONE	

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Mild and rock in vicinity of reservoir. Wooded.	
SEDIMENTATION	No problems seen or reported.	
WATERSHED DESCRIPTION	Heavily wooded with deciduous trees. No observable habitations.	Owner owns most of watershed.

DOWNSTREAM CHANNEL

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	A series of waterfalls 30% ± average slope.	
SLOPES	Left bank - vertical outcrop. Right bank - IV on 1 H with much outcrop.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	None observable from dam.	

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

BROWNELL DAM

NDS ID No. 192

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

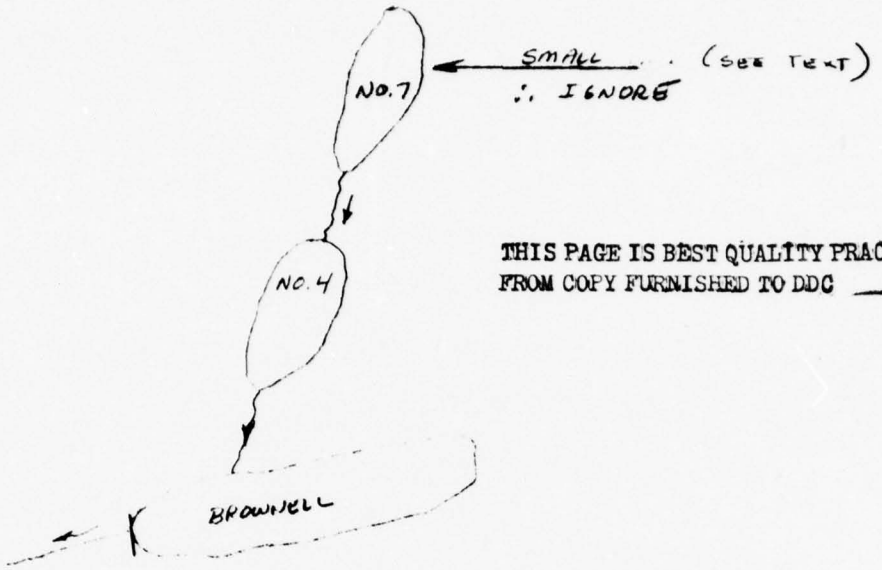
MAY 1978

APPENDIX C

HYDROLOGY AND HYDRAULICS

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT HYDRAULICS AND HYDROLOGY FILE NO.
BROWNELL SYSTEM SHEET NO. 1 OF 8 SHEETS
FOR DAM SAFETY
COMPUTED BY AMW DATE 5/11/78 CHECKED BY EFM DATE 5-24-78



PERTINENT DATA

	NO. 4	BROWNELL
DRAINAGE AREA M.²	2.3	4.0
CAPACITY AT SPILLWAY CREST 10^6 GAL	255	NOT NEEDED
" " " ACRE-FT	782.6	NOT NEEDED
SPILLWAY LENGTH (FT)	100	70 + 195
HEAD (FT)	4.1	1.1 + 3.12 (SEE NEXT SHEET)
SPILLWAY CAPACITY (CFS)	2700(1)	1864 (SEE NEXT SHEET)
AREA NORMAL POOL (ACRES)	62.1	NOT NEEDED
SPILLWAY SURCHARGE (ACRE-FT)	258(2)	396 ACRE-FT Σ = 654
TOTAL STORAGE @ TOP OF DAM	1040.6	NOT NEEDED
HT OF DAM (FT)	29	64

(1) FROM OUTLINE COMPUTATIONS C = 3.25 SEEMS SLIGHTLY HIGH BUT USE

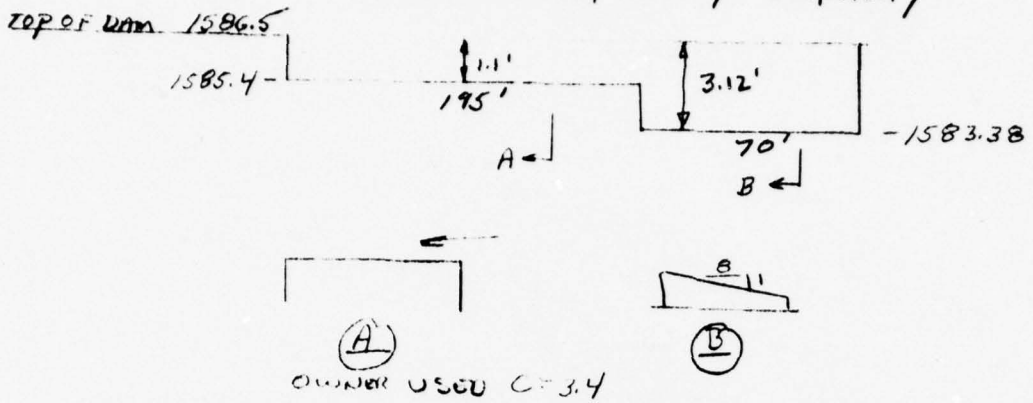
(2) EQUIVALENT RADIUS FOR 62.1 ACRES = 928'
ASSUMING 1V ON 3H SLOPES AND 4.1' FREEBOARD
EQUIVALENT RADIUS FOR 4.1' FREEBOARD = 940'
AREA 63.73 ACRES
SURCHARGE STORAGE $\frac{63.73 + 62.1}{2} \times 4.1 = 257.95 \simeq 258$ ACRE-FT

0313

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT HYDRAULICS AND HYDROLOGY FILE NO.
BROWNELL SYSTEM SHEET NO. 2 OF 8 SHEETS
FOR DAM SAFETY
COMPUTED BY HRW DATE 5/11/78 CHECKED BY FFM DATE 5-24-78

BROWNELL SPILLWAY CAPACITY



OWNER USED C = 3.4
USE BROAD CRESTED WEIR C = 2.68

OWNER USED C = 3.5
FROM KING "HANDBOOK OF HYDRAULICS"
C = 3.27
USE C = 3.27

$Q = 2.68 \times 195 \times (1.1)^{1.5} + 3.27 \times 70 \times (3.12)^{1.5} = 1864$ CFS

USE 1870 CFS

8313

TRANSPOSE PMF'S

NAB INSTRUCTIONS USE

LAKE AYLESWORTH & FALL BROOK PMF'S

	BROWNELL CARB. NO. 4	LAKE AYLESWORTH	FALL BROOK
DRAINAGE AREA (mi²)	4.0	2.3	6.22	4.14
Q PEAK PMF (CFS)			13,700	9,700

LAKE AYLESWORTH DERIVATION

$$Q_{PEAK\ BROWNELL} = 13\,700 \left(\frac{4}{6.22}\right)^{0.8}$$

$$= \underline{9624}\ CFS$$

FALL BROOK:

$$Q_{PEAK\ BROWNELL} = 9,700 \left(\frac{4}{4.14}\right)^{0.8}$$

$$= 9436\ CFS$$

BECAUSE OF ALMOST IDENTICAL DRAINAGE AREAS USE FALL BROOK

$Q_{PEAK\ PMF\ BROWNELL}$ = 9440 CFS

PMF FOR CARBONDALE DAM NO. 4

$$Q_{PEAK} = 9,700 \left(\frac{2.3}{4.14}\right)^{0.8} = 6061\ CFS \approx 6060\ CFS$$

COMPUTE COMPONENT OF BROWNELL PMF IN CARBONDALE NO 4 WATERSHED

$$9440 \times \left(\frac{2.3}{4}\right) = 5428\ CFS \quad \text{USE } 5430\ CFS$$

∴ PMF FLOW JUST FROM UNCONTROLLED AREA = 9440 − 5430 = 4010 CFS

TIMES OF PMF HYDROGRAPHS

FROM NAE CURVE FOR SUSQUEHANNA BASIN

	CARBONDALE No. 4	BROWNELL
DRAINAGE AREA (mi²)	2.3	4.0
TIME (HRS)	22	23.5

COMPUTE FAILURE HYDROGRAPH FOR DAM NO. 4

S = STORAGE VOLUME = $\frac{Q_{PEAK} \times TIME}{2}$

$TIME = \frac{2S}{Q_{PEAK}}$

Q_{PEAK} = 75,000 CFS (SEE NEXT SHEET)

$TIME = \frac{2 \times 1040.6 \text{ A-F} \times 43560 \text{ A/F}^2}{75{,}000 \text{ F}^3/\text{SEC}} = 1208.76 \text{ SEC}$

= 20.15 MIN

= .3358 HRS

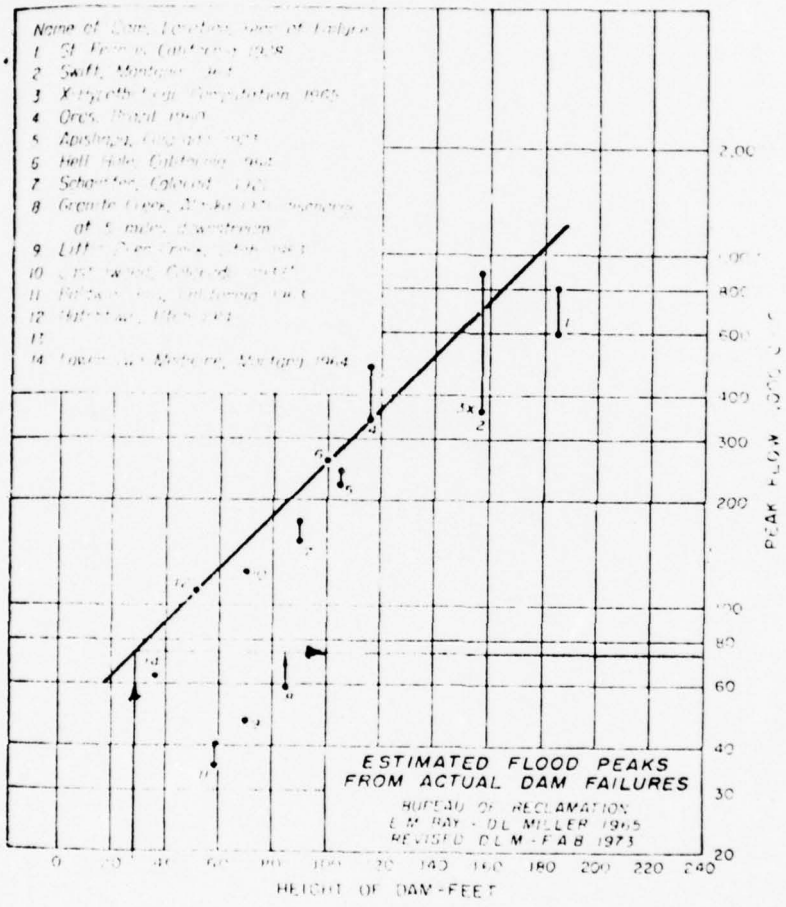


FIG. 1. ESTIMATED FLOOD PEAKS FROM ACTUAL DAM FAILURES

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT HYDRAULICS AND HYDROLOGY FILE NO.
SHEET NO. 6 OF 8 SHEETS
FOR BROWNELL SYSTEM
COMPUTED BY GMW DATE 5/19/78 CHECKED BY FFM DATE 5-24-78

PMF ON CARBONDALE NO. 4 WATERSHED

		PMF	½ PMF
QPEAK	(CFS)	6060	3030
TIME	(HRS)	22	22
$P = \frac{Q_{SPILLWAY}}{Q_{PEAK}}$		.446	.891
1-P		.554	.109
STORAGE REQ'D	(CFS-HRS)	36,930	3632.97
$= (1-P)\frac{Q_{PEAK} \times TIME}{2}$	(ACRE-FT)	3052	300
STORAGE AVAILABLE		258	258
STORAGE (REQ'D - AVAILABLE)		2794	42

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT HYDRAULICS AND HYDROLOGY FILE NO.
BROWNELL SYSTEM SHEET NO. 7 OF 8 SHEETS
FOR DAM SAFETY
COMPUTED BY GMAY DATE 3/11/78 CHECKED BY FFM DATE 5-24-78

SUSQUEHANNA REGION 2 — COMPUTE RUNOFF OVER BROWNELL WATERSHED

	PMF	½ PMF
DRAINAGE AREA	4 mi²	4 mi²
TIME (HRS)	23.5	23.5

STORM OVER DAM NO.4 PART OF WATERSHED

DRAINAGE AREA (mi²) D.A.	2.3	2.3
QPEAK = RUNOFF x D.A.	5430 CFS	2715 CFS
$P = \frac{Q_{SPILLWAY\ NO\ 4}}{Q_{PEAK}}$	.497	.994
1-P	.503	.006
REQ'D STORAGE	32,093 CFS-HRS	191 CFS-HRS
$(1-P) \times \frac{Q_{PEAK} \times TIME}{2}$	2652 ACRE-FT	.16 ACRE-FT
AVAILABLE STORAGE	258 ACRE-FT	258 ACRE-FT
STORAGE (REQ'D-AVAILABLE)	2394	-242 (∴ OK)

STORM OVER ALL BROWNELL WATERSHED

DRAINAGE AREA (D.A.) (mi²)	4.0	4.0
QPEAK RUNOFF x D.A.	9440	4720
$P = \frac{Q_{SPILLWAY\ BROWNELL}}{Q_{PEAK}}$	.198	.396
1-P	.802	.604
REQ'D STORAGE	86,958 CFS-HRS	33,498 CFS-HRS
$= (1-P) \frac{Q_{PEAK} \times TIME}{2}$	7352 ACRE-FT	2768 ACRE-FT
AVAILABLE STORAGE (BROWNELL + NO.4)	654 ACRE-FT	654
STORAGE (REQ'D-AVAILABLE)	6698 ACRE-FT	2114 (ACRE-FT)

STORM OVER 1.7 mi² BETWEEN DAM NO.4 & BROWNELL

DRAINAGE AREA (D.A.) (mi²)	1.7	1.7
QPEAK = RUNOFF x D.A.	4010 CFS	2005 CFS
$P = \frac{Q_{SPILLWAY\ BETWEEN}}{Q_{PEAK}}$	.466	.933
1-P	.534	.067
REQ'D STORAGE	25161 CFS-HRS	1578 CFS-HRS
$= (1-P) \frac{Q_{PEAK} \times TIME}{2}$	2079 ACRE-FT	130 ACRE-FT
AVAILABLE STORAGE	396 ACRE-FT	396 ACRE-FT
STORAGE (REQ'D-AVAILABLE)	1683 ACRE-FT	-266 (∴ OK)

0313

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT HYDRAULICS AND HYDROLOGY FILE NO.
BROWNELL SYSTEM SHEET NO. 8 OF 8 SHEETS
FOR DAM SAFETY
COMPUTED BY MMW DATE 5/11/78 CHECKED BY EFM DATE 5-24-78

FAILURE OF NO. 4 DAM

TIME	.3358 hrs
Q_{PEAK}	75,000 CFS
$Q_{SPILLWAY}/Q_{PEAK} = P$	.025
$1-P$	.975
REQ'D STORAGE	12,280 CFS-HRS
$(1-P)\frac{Q_{PEAK} \times TIME}{2}$	1014.8 ACRE-FT

AVAILABLE STORAGE 296 ACRE-FT

DETERMINE CAPACITY OF BROWNELL DAM

$$S = (I-P)\frac{Q_P \times T}{2} \qquad \frac{2S}{T} = Q_P - Q_{SPILLWAY}$$

$$Q_{PEAK} = \frac{2S}{T} + Q_{SPILLWAY}$$

ASSUME STORAGE AVAILABLE = SUM OF CARBONDALE NO. 4 AND BROWNELL SURCHARGE STORAGE = 654 ACRE FT

$$Q_{PEAK} = \frac{2 \times 654 \text{ ACRE-FT}}{23.5 \text{ MIN}} + 1870 \text{ CFS}$$

$$= 673 \text{ CFS} + 1870 \text{ CFS}$$

$$= 2543 \text{ CFS} \quad \text{SAY } 2540 \text{ CFS}$$

THIS IS $\frac{2543 \times 100}{9440} = 26.9\% \approx 27\%$ OF PMF

BY ABOVE METHOD DETERMINE CAPACITY OF CARBONDALE NO. 4 DAM

$$Q_{PEAK} = \frac{2S}{T} + Q_{SPILLWAY}$$

$$= \frac{2 \times 258 \times 43560}{22 \times 60^2} + 2700$$

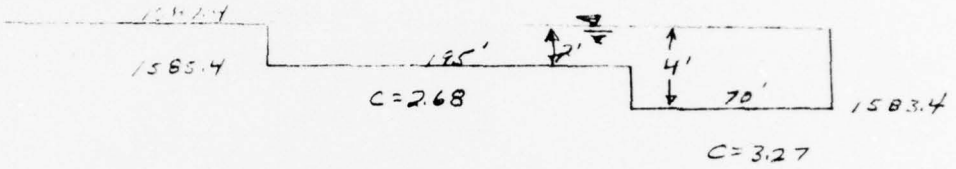
$$= 2984 \text{ CFS} \quad \text{SAY } 2980 \text{ CFS}$$

$$\frac{2180 \times 100}{6060} = 49.2\% \approx 49\%$$

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT [illegible] DAM FILE NO. _____
SHEET NO. _____ OF _____ SHEETS
FOR DAM SAFETY
COMPUTED BY [illegible] DATE 5/24/78 CHECKED BY [illegible] DATE [illegible]

MAXIMUM CAPACITY OF SPILLWAY IF EMBANKMENT RAISED TO ORIGINAL LEVEL



SURCHARGE STORAGE WITH 1.1 FEET OVER AUXILIARY SPILLWAY
= 396 ACRE-FT (129.8 ACRES)

DEAD STORAGE $\sqrt{\text{AREA}_{\text{ft}^2}}$ = 2683' USE 1V on 3H SLOPES
ELEV = 2681 + 0.1 x 2 x 3 2688' ≅ 130.3 ACRES

$Q = 2.68 \times 165 \times 2^{3/2} + 3.27 \times 70 \times 4^{3/2} =$
$= 1478 + 1831 = 3309 \text{ CFS} \approx 3310 \text{ CFS}$

SURCHARGE STORAGE
PRINCIPAL SPILLWAY = 396 ACRE-FT
+ EMBANKMENT RAISE $\left(\frac{130.3 + 129.8}{2}\right) \times 9$ = 117 ACRE-FT
+ CHEMICAL PIT NO. 4 = 258 ACRE-FT
Σ 771 ACRE-FT

$Q_{\text{INFLOW}} = Q_{\text{SPILLWAY}} + \frac{2S}{T}$

$= 3310 + \frac{2 \times 43560 \times 771}{23.5 \text{ HRS} \times 60^2}$

$= 3310 + 794$

$= 4104 \text{ CFS} \approx \underline{4100 \text{ CFS}}$

$\frac{4100}{9440} \times 100 = 43.4\% \approx \underline{43\% \text{ OF PMF}}$

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

BROWNELL DAM

NDS ID No. 192

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MAY 1978

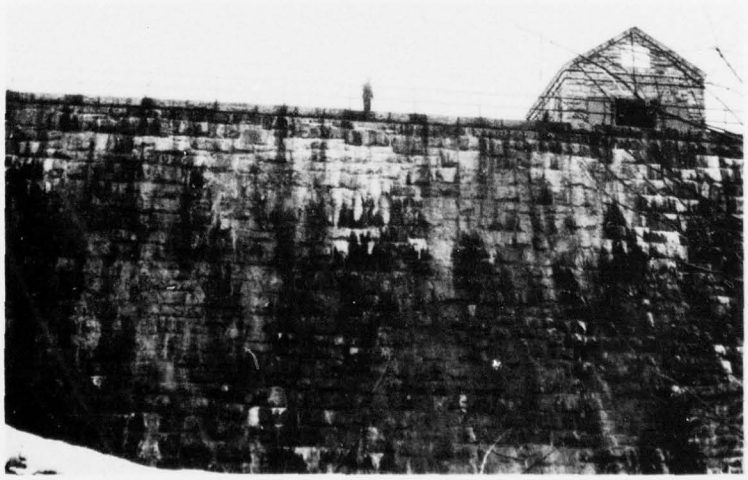
APPENDIX D

PHOTOGRAPHS

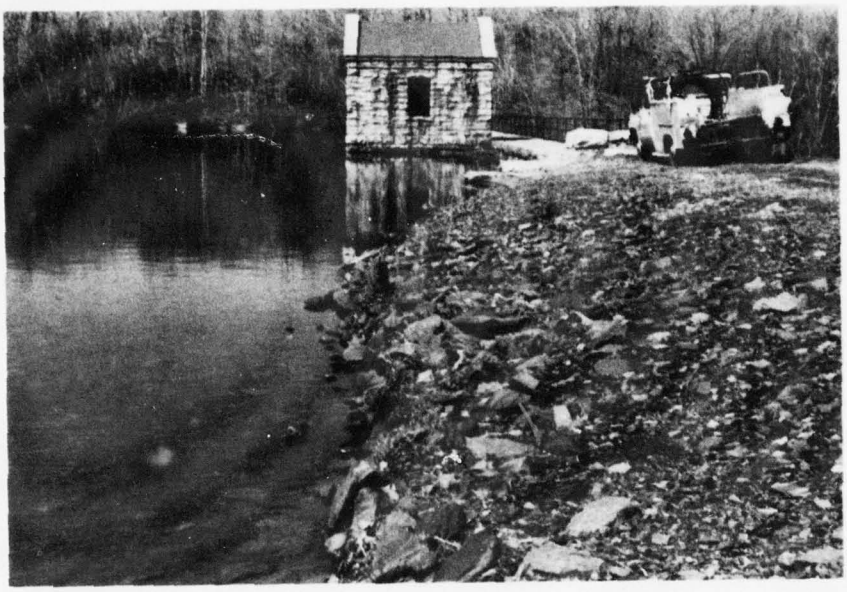
MO	OB	WI	PI	OT

BROWNELL DAM

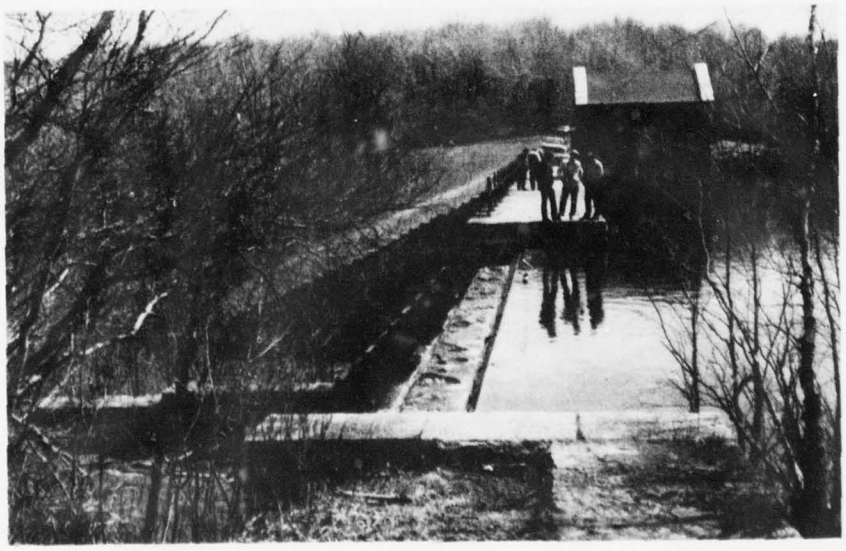
A. Masonry Gate Structure and Auxiliary Spillway



B. Downstream Face of Auxiliary Spillway



C. Masonry Gate Structure
with Right Earth Embankment in Foreground

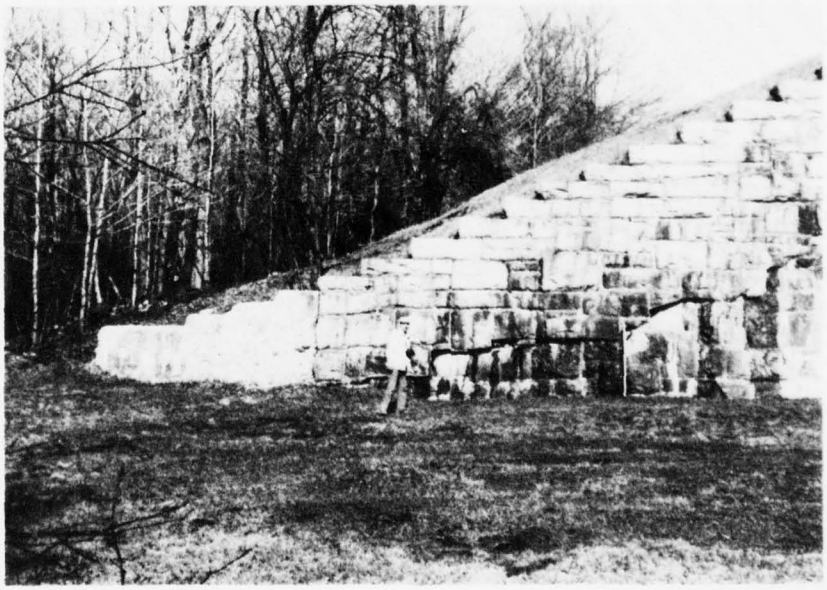


D. View from Left Abutment
Main Spillway in Foreground

E. Downstream Channel of Main Spillway

F. Main Spillway

G.



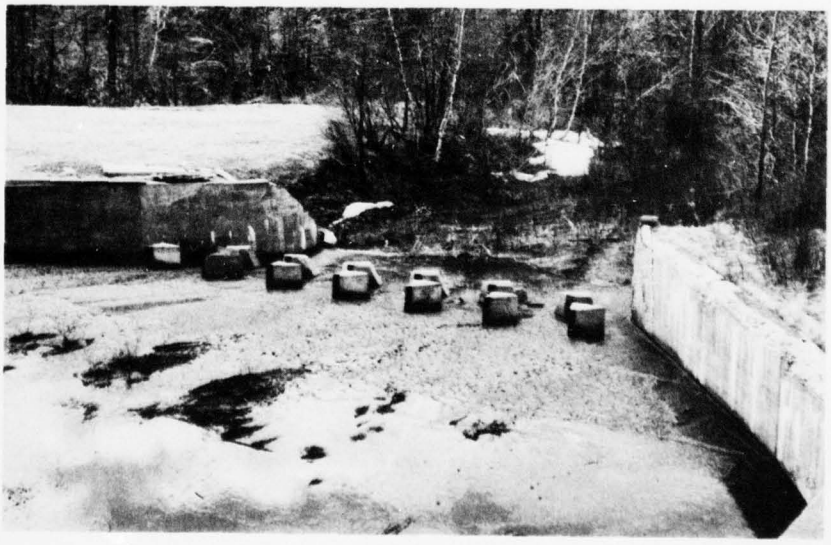
H.

G.&H. Auxiliary Spillway Right Retaining Wall
Showing Crack in Wall

I. Auxiliary Spillway Right Retaining Wall
Showing Bow in Wall

J. Downstream End of Auxiliary Spillway
Right Retaining Wall

K. Carbondale Dam No. 4
Upstream of Brownell Dam
View from Right Abutment



L. Carbondale Dam No. 4
Upstream of Brownell Dam
Spillway Channel Looking Downstream

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

BROWNELL DAM

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APPENDIX E

GEOLOGY

BROWNELL DAM

APPENDIX E

GEOLOGY

1. General Geology. The damsite and reservoir are located in Lackawanna County. Lackawanna County was completely covered with ice during the last continental glaciation of Pleistocene time. The general direction of ice movement was S 35°-40° W. Glacial drift covers the entire County, except where subsequent erosion has removed it. Thick deposits of glacial outwash occur in many places along the Lackawanna River, and are 50 to 100 feet thick near Dickson, Scranton, and Moosic.

The only important structural feature in Lackawanna County is the Lackawanna Syncline, which traverses the County in a southwesterly direction. The syncline enters the County at the northeast corner as a narrow shallow trough, gradually deepens and broadens toward the southwest, and reaches its maximum development in Luzerne County. The rock formations exposed range from the post-Pottsville formations (youngest) through the Pottsville, Mauch Chunk shale, Pocono sandstone to the Damascus formation of the Catskill group (oldest). The rim rocks, the Pottsville formation and Pocono sandstone, have dips that rarely exceed 10° to 20° and form a rather simple syncline. The core rocks, the post-Pottsville formations, are folded into a series of minor anticlines and synclines which trend about N 70° E. The rocks in the northwestern and southeastern parts of the County, outside of the limits of the Lackawanna Syncline, are generally horizontally stratified.

The Lackawanna River, in general, follows the axis of the Lackawanna Syncline. Southeast of the Lackawanna River, the rise in terrain is quite gradual and the crests of the high mountains are several miles from the Lackawanna River. Streams, such as Roaring Brook, Stafford Meadow Brook, and Spring Brook, have cut deep canyons through the mountains and follow a tortuous course to their confluence with the Lackawanna River near Scranton, Pennsylvania. Northwest of Lackawanna River, the mountains rise abruptly to a sharp ridge which in most places is somewhat higher than the country to the northwest. Consequently, most of the drainage in this part of the County flows westward by way of Tunkhannock Creek. A few small tributary streams, however, such as Leggetts Creek, flow eastward from this area into Lackawanna River. In the area of interest, the Lackawanna River streambed is founded in post-Pottsville formations. Proceeding uphill from the river, the older Pottsville formation, Mauch

Chunk shale, Pocono sandstone, and Catskill continental group are encountered in turn. The tributary streams, in flowing down the mountains, have generally cut through or around the hard sandstone and conglomerate members, and have eroded their streambed into the softer shales and glacial till. The Catskill continental group of rocks underlies the greater part of Lackawanna County.

2. Site Geology. The foundation conditions for Brownell Dam afforded by Racket Brook are characteristic of numerous other streams in this section of the State. The stream has cut through an outcrop of massive gray Pocono sandstone and conglomerate and, at the damsite, is flowing parallel to the interface of Pocono sandstone and Mauch Chunk shale formations. The sandstone formation forms the left abutment of the dam and extends across the valley for two-thirds of its width. The remainder of the valley bed and the right or opposite bank are described in construction reports as a combination of hardpan, fine gravel and blue clay. This was probably decomposed Mauch Chunk shale and/or glacial till. The masonry portion of the dam, including the spillways and outlet works, is all founded upon and keyed into the massive Pocono sandstone. The earthen embankment with masonry core wall rests upon the hardpan.