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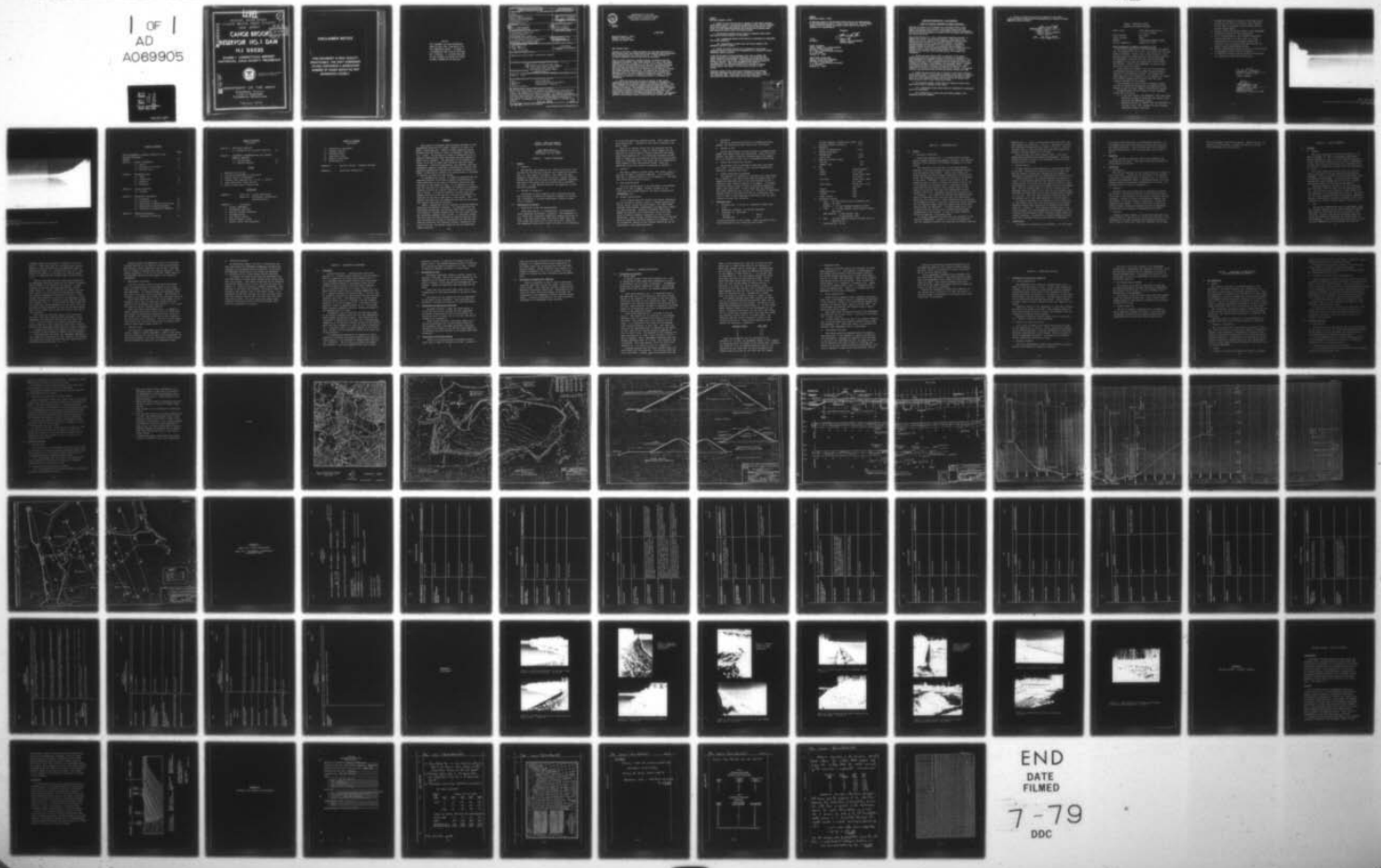

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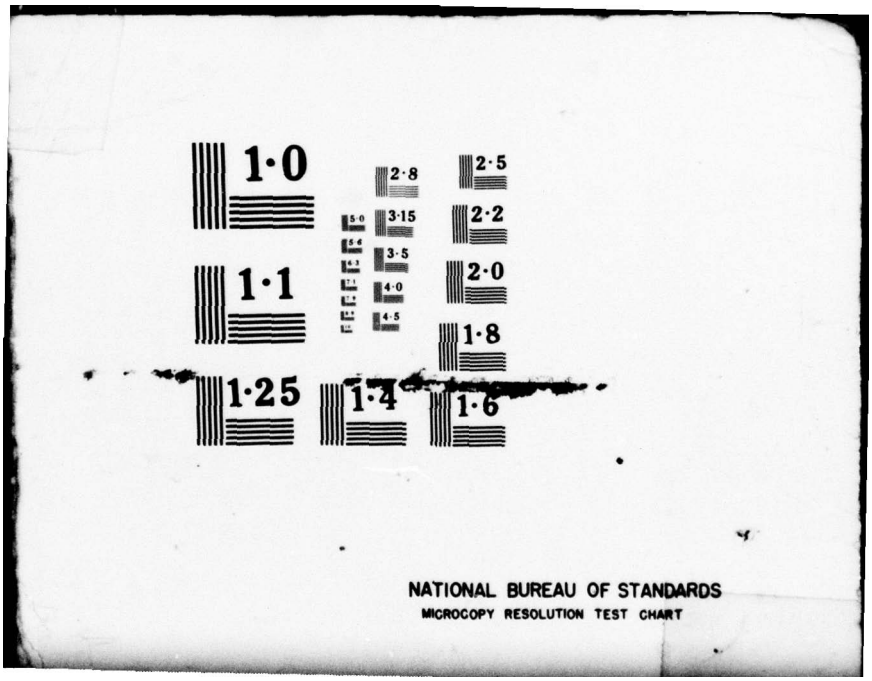
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PASSAIC RIVER BASIN
CANOE BROOK, ESSEX COUNTY
NEW JERSEY

CANOE BROOK RESERVOIR NO. 1 DAM
NJ 00525

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

February, 1979

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18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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National Dam Inspection Act Report
Canoe Brook No. 1 Dam, N.J.

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 adequacy. 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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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

30 MAY 1979

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

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Canoe Brook Reservoir No. 1 Dam in Essex 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 in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Canoe Brook Reservoir No. 1 Dam, a high hazard potential structure, is judged to be in fair to poor overall condition. Since there is no natural flow into the reservoir, the Probable Maximum Flood is simply the precipitation directly on the reservoir surface. The design freeboard capacity of the reservoir is not adequate to contain the Probable Maximum Precipitation. The reservoir has no spillway or emergency outlet, and can be completely drained only by pumping from the reservoir into the water company's distribution system. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability and seepage. The embankment crest and slopes should be surveyed to establish the present crest elevation and embankment slopes. A wave runup analysis should be performed to establish the height of a safe freeboard, in addition to the freeboard required for the PMF. Any remedial measures found necessary should be initiated within calendar year 1980.

b. Within one year from the date of approval of this report consideration should be given to constructing an emergency outlet from the reservoir. As an interim measure, the reservoir should be either operated at a lower level, or a plan established whereby the reservoir can be quickly drawn down through the owner's water distribution system.

c. The following remedial actions should be completed within thirty days from the date of approval of this report:

(1) A downstream warning system should be established in cooperation with local authorities.

(2) Irregularities, erosion scars and vehicle damage to the embankment should be repaired.

d. Within six months from the date of approval of this report vegetation should be removed from the embankment and a program of regular vegetation removal initiated.

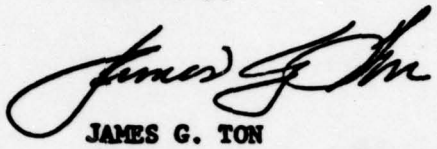
A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congresswoman Millicent Fenwick of the Fifth District. Under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

NAPEN-D
Honorable Brendan T. Byrne

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,



1 Incl
As stated

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
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P. O. Box CN029
Trenton, NJ 08625

CANOE BROOK RESERVOIR NO. 1 DAM (NJ00302)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 29 November and 16 December 1978 by Jenny-Leedshill Engineers, 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.

Canoe Brook Reservoir No. 1 Dam, a high hazard potential structure, is judged to be in fair to poor overall condition. Since there is no natural flow into the reservoir, the Probable Maximum Flood is simply the precipitation directly on the reservoir surface. The design freeboard capacity of the reservoir is not adequate to contain the Probable Maximum Precipitation. The reservoir has no spillway or emergency outlet, and can be completely drained only by pumping from the reservoir into the water company's distribution system. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability and seepage. The embankment crest and slopes should be surveyed to establish the present crest elevation and embankment slopes. A wave runup analysis should be performed to establish the height of a safe freeboard, in addition to the freeboard required for the PMF. Any remedial measures found necessary should be initiated within calendar year 1980.

b. Within one year from the date of approval of this report consideration should be given to constructing an emergency outlet from the reservoir. As an interim measure, the reservoir should be either operated at a lower level, or a plan established whereby the reservoir can be quickly drawn down through the owner's water distribution system.

c. The following remedial actions should be completed within thirty days from the date of approval of this report:

(1) A downstream warning system should be established in cooperation with local authorities.

(2) Irregularities, erosion scars and vehicle damage to the embankment should be repaired.

d. Within six months from the date of approval of this report vegetation should be removed from the embankment and a program of regular vegetation removal initiated.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 30 May 1979

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Canoe Brook Reservoir No. 1, I. D. No. NJ 00525
State Located:	New Jersey
County Located:	Essex
Stream:	(Off-stream pumped storage)
Date of Inspection:	November 29, 1978

Brief Assessment of General Condition of Dam

The visual inspection of the dam indicated the embankment to be generally fair to poor, but without any critical signs of distress. Erosion due to wave action is a continuing problem in certain areas of the in-board slope of the embankment, and there are other erosion problems and damage of the crest and slopes due to foot traffic and vehicles. Much of the embankment is heavily overgrown with trees and shrubs.

Since there is no natural flow into the reservoir, the Probable Maximum Flood is simply the precipitation directly on the reservoir surface. The design freeboard capacity of the reservoir is not adequate to contain the Probable Maximum Precipitation under the crest elevation assumed for this report.

The reservoir has no spillway or emergency outlet, and can be completely drained only by pumping from the reservoir into the water company's distribution system.

Recommendations and the urgency of their implementation are as follows:

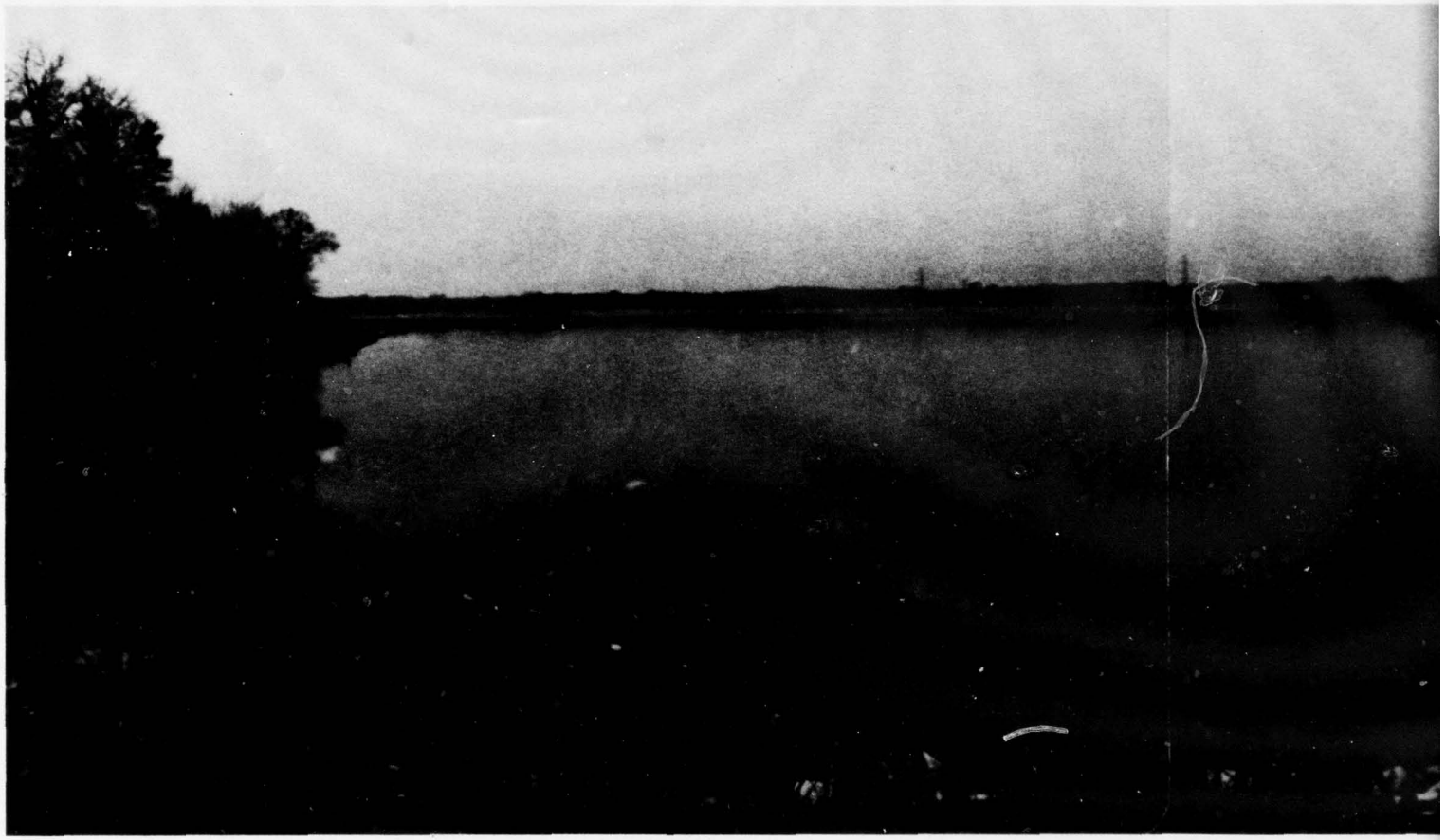
1. In the near future, the embankment crest and slopes should be surveyed to establish the present crest elevation and embankment slopes.
2. Vegetation should be removed from the embankment in the near future, and a program for more frequent vegetation removal initiated.

3. Seepage and stability analyses of the dam should be made by the owner in the near future because of the dam's high hazard classification and the locally steep slopes.
4. Erosion scars and vehicle damage to the embankment should be repaired as soon as possible.
5. As an interim measure, the reservoir should be either operated at a lower level, or a plan established as soon as possible whereby the reservoir can be quickly drawn down through the owner's water distribution system.
6. Future consideration should be given to constructing an emergency outlet from the reservoir.
7. A downstream warning system should be established in cooperation with local authorities.

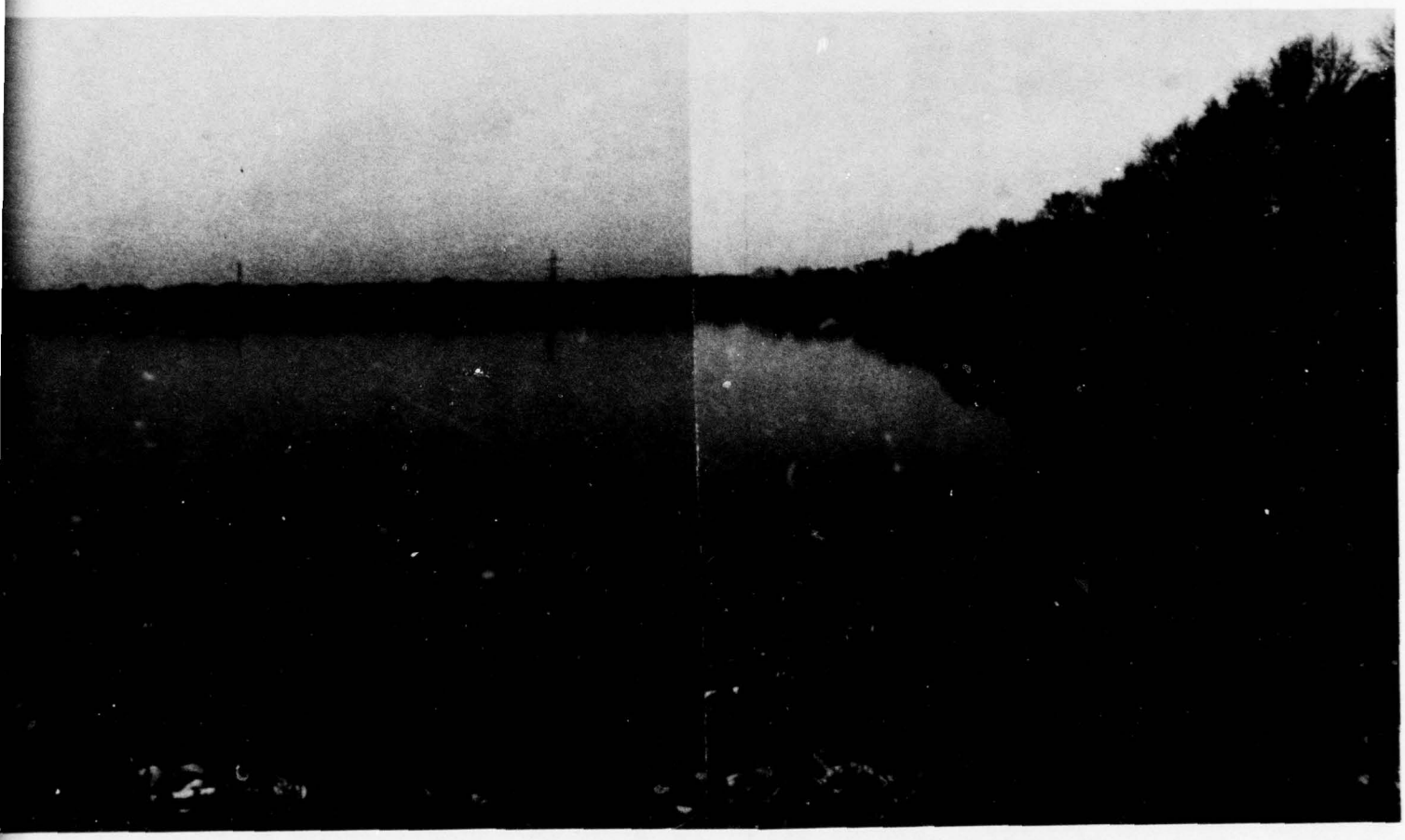
Frank L. Panuzio

Frank L. Panuzio, P. E.
Project Manager

Robert J. Jenny, P.E.
Project Director
New Jersey License No. 9878



CANOE BROOK DAM
View from northeast side of dam, showing embankment
(Nov. 29, 197



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E BROOK DAM NO. 1

embankment which completely surrounds the reservoir.
Nov. 29, 1978)

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CANOE BROOK DAM NO. 1
Federal I.D. No. NJ 00525
New Jersey I.D. No. (None)

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The National Dam Inspection Act, Public Law 92-367, 1972, provides for the National Inventory and Inspection Program by the U. S. Army Corps of Engineers. This report has been prepared in accordance with this authority, through contract between the State of New Jersey and Jenny-Leedshill Engineers. The State of New Jersey has also entered into an agreement with the U. S. Army Engineer District, Philadelphia, to have this work performed.

b. Purpose of Inspection

The purpose of this inspection was to evaluate the general structural integrity and hydraulic adequacy of the dam, and to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Description of Dam and Appurtenances

Canoe Brook Dam No. 1 is essentially a rolled earthfill levee completely surrounding a reservoir. The embankment is 2.57 miles long, irregularly shaped but roughly elliptical in plan. The crest width varies from five to eight feet, and side slopes vary from 1V:2H to less than 1V:1H. Height of the embankment varies from 4 feet to 25 feet, but is generally

10 to 20 feet above the reservoir bottom. Rock riprap covers the inboard slope. Freeboard at the time of inspection was about 7 feet.

There is no natural inflow into the reservoir and the dam contains no spillway. Water is either pumped into the reservoir or flows by gravity through pipelines from nearby Canoe Brook Reservoir No. 2 or from other secondary sources. Water is pumped from the reservoir through two 24-inch outlet pipes to a treatment plant, and thence into the Commonwealth Water Company's water distribution system. There are additional inlets and outlets as described in Section 4.

B. Location

The dam is located in Essex County, New Jersey, north of the town of Summit in Millburn Township. It is accessible from John F. Kennedy Parkway by way of Highway 24. The location of the dam is shown on Plate 1.

c. Size Classification

The size classification of the dam based on its maximum height at 25 feet is small. However, because of its 2,256 acre feet storage capacity, the dam is classified as intermediate size.

d. Hazard Classification

It is concurred that the present high hazard classification of the dam is merited, since if a breach should occur, for any reason, during non-flood season, the large volume released could develop a substantial size opening or resulting large discharge. Excessive inundation and serious damage and possible loss of more than a few lives could result in Hanover Township (population 11,000) 4 miles downstream. During floods, outflow from a breach in the dam would be reduced by tailwater effects of the Passaic, and the incremental effects of this reduced outflow may not be significant in the downstream areas.

e. Ownership

The dam is owned and maintained by Commonwealth Water Company, 233 Canoe Brook Road, Short Hills, New Jersey.

f. Purpose of Dam

The dam and reservoir provide storage of untreated water pumped from Passaic River and Canoe Brook. Along with other sources, the water is used as a potable supply for general use in an extensive service area in northeastern New Jersey.

g. Design and Construction History

The original dam is believed to have been constructed about 1900. It was raised in 1929, and has remained substantially unchanged since then.

h. Normal Operational Procedures

The reservoir is operated in conjuntion with Canoe Brook No. 2 reservoir, into which water from the Passaic River is pumped and from which most of the water entering the No. 1 reservoir either flows by gravity or is pumped. A secondary source of water at times of flood is derived by pumping directly from Canoe Brook, a small stream near the reservoir. The normal operating level of 182.5 ft. elevation is maintained whenever water is available from the No. 2 reservoir, and only in times of water shortage is the water level not maintained at or near this elevation.

1.3 Pertinent Data

a. Drainage Area - 0.32 sq. mi. (reservoir surface area only)

b. Discharge at Damsite - No natural discharge

c. Elevation (ft. above MSL)

·Top Dam	184.0*
·Maximum pool	182.5

*Elevation assumed for this report. Other information indicates elevations of 184.5 feet and 184.79 feet.

	·48-inch diameter transfer pipe invert	174.5
	·Minimum reservoir elevation	165.5
d.	Reservoir	
	·Length of maximum pool	1 mile
e.	Storage (acre-feet)	
	·Maximum pool	2,256
	·Top of dam	2,562
f.	Reservoir surface (acres)	
	·Top dam	204
	·Normal pool	204
g.	Dam	
	·Type	Rolled earthfill
	·Length	2.57 miles
	·Height	Varies from 4 feet to 25 feet
	·Top width	Varies from 5 feet to 8 feet
	·Side slopes	Varies from 1V:1H to 1V:2H
	·Zoning	None
	·Impervious core	None
	·Cutoff	None
	·Grout curtain	None

h. Regulating Outlets

1. Type: 48 inch concrete pipe to Reservoir No. 2
   Length: 780 feet
   Control: 2 - 48 inch diameter butterfly valves
2. Type: 2 - 24 inch diameter outlet pipes to treatment plant
   Pump capacity: 10 mgd nominal, each
   15 mgd maximum, each
3. Type: 36-inch diameter concrete cylinder pipe to Reservoir No. 3
   Pump capacity: 30 mgd

SECTION 2: ENGINEERING DATA

2.1 Design

a. Geological Conditions

Canoe Brook Reservoir No. 1 is located within the New Jersey Piedmont Lowland physiographic province. The regional geology of this province is discussed in Appendix C to this report.

This reservoir lies just west of the Second Watchung Mountain in the area occupied by both the Wisconsin Age glacier and Glacial Lake Passaic. Glacial Lake Passaic was formed between the Second Watchung Mountain on the east and south, the Highlands on the west and the edge of the glacier on the north. Therefore, a typical soil profile in the reservoir area is likely to consist of glacial tills on top of the bedrock, an overlying layer of relatively coarse, stratified alluvium outwash, and a topmost layer of fine sandy silt and silty fine sand which represents the fine grained "rock flour" sediments carried from the glacier as it retreated. It is these finer-grained lake deposits which form the relatively flat plain upon which the Canoe Brook Reservoirs are constructed. These sediments have a relatively low permeability which, along with a high water table, accounts for the numerous swamps, ponds and puddles seen on the flat ground around the reservoirs. In certain areas one or more of these soils may be very thin or missing while another predominates at the surface. A layer of organic deposits should be expected in the swampy areas.

No bedrock exposures were seen near the perimeter of the reservoir embankment. However, it is known by projection that the Brunswick formation of sandstones and shales underlies

Reservoir No. 1. Logs of several water wells drilled in the area between Canoe Brook No. 1 and No. 2 are shown on Plate 5 and locations of these wells are shown on Plate 6. The logs indicate soils of clay and sandy clay near the surface and bedrock at depths between 60 to 140 feet.

Since the area lies within Seismic Zone 1, only minor damage may be expected from distant earthquakes. No active faults are known to exist in the immediate vicinity nor surrounding area of the dam.

b. Design History

No data could be found pertaining to the original design of the dam. Following the raising of the dam in 1929, the dam and reservoir bottom were surveyed and are presently believed to be substantially as represented in plan on Plate 2.

Typical sections of the raised embankment are shown on Plate 3. The sections indicate that borrow material for the raised dam was to be taken from the reservoir area at a minimum distance of 30 feet from the inboard toe of the old embankment. The old inboard slope of 1V:2H was retained and new embankment material added to the crest and the outboard slope. The crest was raised two feet and the outboard slope flattened to 1V:1-1/2H. The cross section drawing indicates that the new material was to have been compacted in 8-inch layers.

No data are available on the design of any of the outlet or inlet pipes, other than the cross section of the 48-inch diameter transfer pipe connecting the reservoir with Canoe Brook No. 2 (Plate 4). This concrete transfer pipe is elevated throughout the reach between the two reservoirs, and is protected from floatation during flooding by steel straps at regular intervals. The pipe has a blowoff between the reservoirs and a butterfly valve at each reservoir embankment.

2.2 Construction

No records of construction are available. No soils tests

are known to have been made of the embankment material. It is presumed that the borrow material was derived from within the present reservoir. Logs of nearby water wells indicate the near-surface soils to be clay and sandy clay (Plates 5 and 6).

2.3 Operation

Daily records of reservoir levels and withdrawals are maintained by the owner. There are no monitoring devices or survey markers on the dam.

2.4 Evaluation

a. Availability

Data are not available on the original design or construction of the dam. Limited data are available on the raising of the dam, as described above in Section 2.1b. No data are available on subsequent repair or maintenance work, or on the present elevation and precise configuration of the dam. All available data are listed in Appendix A.

b. Adequacy

Available data are insufficient to adequately evaluate the design. Calculations relating to the structural design of the dam or the stability of the as-built structure are not available. Nothing is known of construction methods, testing methods, or as-built material properties. Foundation conditions are unknown. As-built plans are old and do not reflect present conditions regarding details of embankment configuration and locations of appurtenant structures.

c. Validity

Because no recent surveys of the dam have been made, the crest elevation of the dam is not known with precision. Data furnished by the owner indicate three different elevations, and it also is likely that there are variations in the crest

due to settlement, erosion and repairs. Because of this, the validity of calculations to assess the safety of the dam from overtopping must be qualified.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The visual inspection of Canoe Brook Dam No. 1 was made on November 29, 1978 and subsequent inspections made on December 16, 1978. The water surface elevation at the time of the inspection was 177 feet or approximately eight feet below the top of the dam. Discharge from the reservoir through the treatment plant was approximately 15 cfs.

The visual inspection did not reveal any critical signs of distress in the dam forming the man-made compoundment. Several locations were noted where wave action has damaged the embankment. Although certain remedial measures have been implemented over the years, general maintenance appears to have been rather sporadic.

Detailed inspection was made of the dam, appurtenant structures, reservoir area, and the downstream channel. Descriptions of the findings of these inspections are summarized in the paragraphs which follow. The checklist of visual inspection items is included in Appendix A. Geologic and foundation conditions observed at the time of inspection are noted in greater detail in Section 2.1-a.

b. Dam

The dam was inspected for signs of settlement, seepage, erosion, cracking and any other evidence of undesirable behavior which might affect the stability of the structure. Several locations were observed where wave action has eroded and undermined the inboard slope of the embankment. Such conditions were particularly evident along the embankment sections bounding the south and

southeast sides of the reservoir (Stations 5 to 40 on Plate 2). More often than not, the wave action erosion appears to have occurred where the embankment slope is particularly steep, i.e., steeper than 1V:1-1/2 H. This general area subject to wave action is shown on Photos 1 and 2. A steep wave-cut inboard slope is shown on Photo 3.

Several locations were also noted where troughs in the embankment have been eroded by foot traffic of persons gaining access to the reservoir for fishing. At some locations riprap has been dislodged from the inboard slope (Photo 4). These troughs act as channels for rain water runoff, and with time could substantially reduce the effective embankment cross section (Photo 5). Other troughs were observed in portions of the embankment crest, and were reported to be caused by trucks used for remedial work (Photos 6 and 7). In some areas the wheel loads from the trucks have caused depressions in the crest up to two feet deep and have deformed the crest of the dam severely. Many of the troughs were filled with water at the time of the inspection.

Very thick and sometimes deeply rooted vegetation and small trees were observed almost everywhere on the embankment, including the inboard slope and crest (Photo 8). There is currently no regular maintenance program for removal of this vegetation other than a "mowing" project which reportedly takes place at five-year intervals.

A rodent problem was also reported to exist; however, no evidence of the presence of rodents could be detected.

Notwithstanding the above, the embankment appeared in fair condition, considering its age. However, its surfaces are uneven and in some locations both the inboard and outboard slopes are very steep, i.e., 1:1.

Seepage through the embankment could not be detected. A recent analysis by the owner of inflow and and outflow measurements, taking evaporation into account, indicates that no leakage is taking place from the reservoir. This appears reasonable in view of the clayey, sandy nature of the embankment materials which appear to be stiff and impermeable.

c. Appurtenant Structures

A 48-inch transfer pipeline from Canoe Brook Reservoir No 2 passes through the embankments of both reservoirs with flow through it controlled by valves located in each embankment. No seepage through the embankment along the sides of the pipe could be detected. The pipeline is elevated in the swampy area between the reservoirs (Photo 9).

Water from Canoe Brook No. 2 was being pumped into the reservoir at the time of inspection through a 16-inch pipeline which discharges into Canoe Brook No. 1 at a location near the 48-inch transfer pipeline.

Water from Canoe Brook Reservoir No. 1 is pumped to nearby treatment-filtration plants (Photo 10) after passing through a sedimentation-coagulation basin (Photo 11). The intakes were submerged at the time of the inspection, and thus could not be inspected. Just south of the coagulation basin are located the facilities for pumping water from the Canoe Brook stream (Photo 12).

d. Reservoir Area

The reservoir is man-made with its perimeter completely formed by earthen embankment. Water in the reservoir was greenish blue, and no odor could be detected. No debris was observed, other than very minor brush originating from vegetation growing on the embankment slopes.

e. Downstream Channel

No downstream channel, as such, is associated with this dam because the embankment completely surrounds the reservoir and discharges from the reservoir in the event of embankment failure would flow around the embankment in a direction of the lowest ground surface elevation.

In general the areas surrounding the embankment are flat and consist of swamp areas, wooded areas, scrub areas and a golf course. The channel downstream of the reservoir nearest the Passaic River is also very wide and very flat (Photo 13). Several structures, probably residences, were observed to the north and northwest, and some of these are located on the opposite side of the Passaic River. U.S. Geological Survey maps indicate that most of these structures are located on ground that is higher than the reservoir water surface, but other houses are further downstream on the Passaic River in Hanover Township that could be endangered by flooding.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Canoe Brook Dam No. 1 impounds water from three sources, (1) a primary source indirectly from the Passaic River via pipelines from Canoe Brook Reservoir No. 2, (2) a secondary source pumped directly from Canoe Brook, a small stream tributary to the Passaic River and (3) occasional flow by gravity from Canoe Brook Reservoir No. 3, a holding reservoir 1-1/2 miles north of No. 1. Water from the Passaic River is normally pumped into the No. 2 reservoir during the period October 1 to June 1 and is limited by minimum flow restrictions that must be maintained in the river. From Reservoir No. 2 water either flows by gravity into No. 1 through a 48-inch transfer pipeline, or it can be pumped to No. 1 through a 16-inch pipeline. Water is pumped directly to No. 1 from Canoe Brook (stream), whenever available, through two pumps at the combined rate of 20 mgd.

Withdrawals from the reservoir are made year-round to the nearby treatment plants and into the Commonwealth Water Company distribution system. The average rate of withdrawal is reported to be 20 mgd, with a maximum pump capability of 30 mgd total through the two 24-inch outlets. Water can also be pumped at a rate of 30 mgd to Reservoir No. 3, providing there is storage capacity in that reservoir, through a 36-inch pipeline located at the north end of the reservoir.

The Canoe Brook Reservoirs are operated in such a manner as to maintain the maximum possible water level in Canoe Brook No. 1 by releasing or pumping water from the No. 2 reservoir. This is done to minimize the pumping head from No. 1 into the treatment plant and to allow

capacity in the No. 2 reservoir for pumping from the Passaic River. The maximum operating level is elevation 182.5 and the minimum is elevation 175.5 feet. Records of reservoir operation are kept on a daily basis.

4.2 Maintenance of Dam

The owners reportedly conduct a monthly visual inspection of the dam. One of the primary purposes of the inspection is to observe the condition of the riprap, which is subject to wave erosion and dislodging by trespassers. Riprap has apparently been replaced over the years.

Other than the slab staff gage, there are no instrumentation or monitoring systems of the dam or reservoir.

The owners cut the vegetation from the embankment of the dam at 5-year intervals. They reportedly are planning to increase the frequency of such maintenance.

4.3 Maintenance of Operating Facilities

As shown on Plate 2, there are three drains, a 4-inch and two 24-inch, through the west embankment. The owner's representative did not know whether the drains are still in place, but in any case they may be assumed to be inoperable.

Other intake and outlet facilities appear to be regularly maintained and in good working condition. The treatment plants have been subjected to periodic flooding of the Passaic River and the lower windows of the building have been bricked in to provide some flood protection.

4.4 Description of Warning Systems

There is no warning system or emergency contingency plan in event of failure of the dam. Neither is

there any area-wide coordinated flood warning system, although it is reported that certain communities in the Passaic basin are initiating their own individual warning systems. Spring flooding of the Passaic is a frequent occurrence, and it is not unusual for flood waters to inundate the area surrounding the dam embankment.

4.5 Evaluation of Operational Adequacy

There is presently no way to lower or drain the reservoir other than through the owner's water distribution system. This condition imposes a limitation on emergency operational flexibility. Maintenance of the inlet and outlet facilities appears to be good, but maintenance of the embankment could be improved considerably. A serious shortcoming is the lack of precise knowledge of the embankment crest elevation.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

As already stated, Canoe Brook Reservoir No. 1 Dam is classified as high hazard and intermediate in size. In accordance with the Corps of Engineers', "Recommended Guidelines for Safety Inspection of Dams." the Spillway Design Flood (SDF) should be the Probable Maximum Flood (PMF).

Canoe Brook Reservoir No. 1 is contained within a man-made dike that is continuous for the entire circumference of the reservoir. The height of the dike varies from about four feet to about twenty-five feet. Water is supplied to the reservoir by pumping and controlled gravity flow, hence reservoir storage is completely controlled except for contributions that occur as precipitation directly on the reservoir surface.

Canoe Brook Reservoir No. 1 is shown in plan on Plate 2. The capacity of the reservoir at its maximum operating level is reported by the owners to be 2,256 acre-feet. The surface area of the reservoir is 204 acres. It is reported by the owner that the maximum water surface elevation is 182.5 feet. The crest elevation of the impounding dike is reported by the owners as 184.5 feet but is variously shown on drawings as 184.0 to 184.79 feet. For purposes of this analysis the more conservative, or lower, crest elevation of 184.0 feet is assumed. Hence, embankment freeboard above the maximum operating level is 1.5 feet. The reservoir has no spillway. The stage-capacity curve for Canoe Brook Reservoir No. 1 is shown on Plate D-1, Appendix D.

Drawings obtained from the owner indicate three low level drains for the reservoir: two 24-inch drains and one 4-inch drain. However, during discussions with the

owner, it was learned that there are no known low level drains and, if those drains shown on the drawings do exist they probably are not functional. Assuming there are no drains, the only means of emptying the reservoir is: via pumping to Canoe Brook No. 3: via gravity flow to Canoe Brook No. 2 or; via pumping through the treatment plant and into the distribution system. In the event that Canoe Brook Reservoirs Nos. 2 and 3 were full, the only reliable means of draining the No. 1 reservoir is to pump into the distribution system. The rate at which the reservoir can be drained by this means depends on water use which is reported to average about 60 acre-feet per day. Assuming this average rate, the reservoir could be drained in about 37 days.

The Probable Maximum Flood (PMF) entering the reservoir is the Probable Maximum Precipitation (PMP) with no reduction allowance for infiltration. The PMP was calculated using Hydrometeorological Report No. 33 with a Hops Brook reduction factor of 0.80 for misalignment of the storm. Following discussions with the Corps, PMP values for a 10 square mile drainage basin were used even though the reservoir surface area is 0.3 square miles. The cumulative PMP for various durations is shown in the following tabulation. Calculations supporting these figures are presented in Appendix E.

Duration, Hours	PMP, Feet
6	1.7
12	1.8
24	2.0
48	2.1

Under the assumption that the freeboard of the reservoir is 1.5 feet, the embankment design is only capable of containing about 70 percent of the 48-hour PMP. Assuming the reservoir is at the maximum operating level at the beginning of the 6-hour PMP, the peak overtopping discharge could be as high as 1500 cubic feet per second.

b. Experience Data

Reservoir elevation records are available for Canoe Brook Reservoir No. 1. The reservoir is maintained at its maximum water surface elevation whenever possible. This allows maximum storage space in Canoe Brook Reservoir No. 2 so that, when available, water can be diverted from Passaic River into the system. Thus, during high runoff months, No. 1 Reservoir is normally full. During low runoff in Passaic River, the No. 1 Reservoir falls below its maximum level. There is no evidence that the embankment has ever been overtopped.

c. Visual Observations

Other than the company's water treatment facilities, there are no developments around or immediately downstream of the reservoir. There is no stream channel between the reservoir and Passaic River, about 1,000 feet west. Terrain between the reservoir and Passaic River is gently sloping and heavily wooded.

Some areas along the reservoir side of the embankment are irregular due to wave action. The fetch of the reservoir is about one mile.

In some places along the top of the reservoir embankment, there are deep ruts caused by trucks driving along the embankment top. These ruts result in a narrower and possibly lower embankment crest in some areas.

d. Overtopping Potential

The design reservoir freeboard above the maximum operating level is not adequate to contain the PMP without overtopping. Assuming the reservoir can be drained at the rate of 60 acre-feet per day, the reservoir level can be lowered at the rate of about 0.3 feet per day. Except for the most intense period of precipitation, this rate is adequate to keep up with precipitation inflows.

During the period when intense precipitation has increased the reservoir level above the design operating level, there is a potential for local overtopping due to run-up of surface waves.

Actual embankment freeboard may be somewhat less than the design freeboard in some areas because of damage to the embankment crest caused by trucks traveling along the crest. This reduced freeboard along with wave run-up and higher than design reservoir stages may result in some local overtopping.

Because the freeboard of Canoe Brook Reservoir No. 1 can contain only 70 percent of the PMP, the lack of a spillway should be considered, in accordance with Corps guidelines, as Inadequate.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The embankment has a number of irregularities in the width of crest and angle of slope. Slopes, both inboard and outboard, are overly steep in some places, greatly exceeding the design slopes. Wave action on the southern and southeastern shoreline has resulted in the upper part of the slope being steeper than the lower part. Vehicles have caused ruts in the crest and have deformed some slopes. Locally there are small areas of erosion resulting from foot traffic on the slopes.

Vegetation growth on the embankment is very heavy throughout much of the length of the dam. More frequent removal of this growth should be done to protect the embankment from the formation of possible piping channels.

Embankment materials visually appear to be of good quality. Riprap is generally well-maintained.

b. Design and Construction Data

Very little is known of the design and nothing is known of the construction of the dam. Design slopes were adequate, but as stated previously, no longer represent the true cross-sectional configuration in many places. Nothing is known of as-built embankment materials. No hydraulic or hydrologic design computations are known to exist.

c. Operating Records

The daily measurements of water levels made by the owner provide a good record of reservoir operation.

The lack of any recent surveys of the embankment elevations is a deficiency that should be rectified, since the available freeboard may be inadequate to contain a probable maximum storm. Also needed are surveys of the side slopes, as some are undoubtedly too steep to assure structural stability.

d. Post-Construction Changes

The raising of the dam was done some 50 years ago and there consequently has been considerable deformation and erosion over the years, as well as changes due to maintenance of the embankment.

The various inlets and outlets have also been changed since the original construction. None of these latter changes appear to have adversely affected the structural integrity of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 1 in which it may be generally assumed that there is no hazard from earthquake, provided static stability conditions are satisfactory and conventional safety margins exist.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety

The safety of the dam is of concern because of the imprecisely known crest elevation and, consequently, the available freeboard above the maximum operating level. Until this elevation is determined for the entire 2-1/2 mile length of embankment, it must be assumed that the dam cannot contain the Probable Maximum Precipitation falling on the reservoir surface. Even if the freeboard is adequate for such a storm, there is probably insufficient freeboard to contain any appreciable wave action that might occur locally at such times.

The inordinately steep side slopes in some areas also are of some concern and are potential hazards to the structural stability. The inboard riprap protection is reasonably well maintained.

The heavy growth of vegetation on the embankment is undesirable and could lead to piping problems if unchecked.

b. Adequacy of Information

Data are insufficient to evaluate the stability of the dam, since very little is known of the design or construction methods. More importantly, information is lacking on the present elevation and configuration of the structure and its material properties. Information on the various inlets and outlets is generally adequate except for the unknown disposition of three reservoir drains indicated on the plans to be in the west embankment.

c. Urgency

A survey of the dam and seepage and stability analyses

should be performed in the near future. Vegetation removal should also be started in the near future.

Irregularities and eroded surfaces on the crest and slopes should be repaired as soon as possible.

Alternative methods of draining the reservoir should be investigated in the future.

d. Necessity for Additional Data/Evaluation

Corps of Engineers Guidelines require that, in general, seepage and stability analyses should be on record for all dams in the high hazard category. Canoe Brook Dam No. 1 is so classified, and because of the steep embankment slopes, it is recommended that soil borings and laboratory tests should be performed to determine the pertinent physical properties of the embankment and foundation materials so that seepage and stability analyses can be performed.

A wave runup analysis should be performed to establish the height of a safe freeboard, in addition to the freeboard required for the PMF.

A survey of the dam, including crest elevation, side slopes and outlet locations is needed to assess the structural integrity of the dam and the danger of overtopping at low points along the crest in event of a Probable Maximum Flood.

7.2 Remedial Measures

a. Alternatives

The alternative to determining the exact crest height of the dam is to lower the normal maximum operating level of the reservoir to an elevation that would assure no overtopping during a Probable Maximum Flood.

It is recommended that the owner investigate alternative methods of draining the reservoir, including installation of an emergency outlet.

b. Operation and Maintenance Procedures

It is recommended that the owner perform the following operation and maintenance work:

should be performed in the near future. Vegetation removal should also be started in the near future.

Irregularities and eroded surfaces on the crest and slopes should be repaired as soon as possible.

Alternative methods of draining the reservoir should be investigated in the future.

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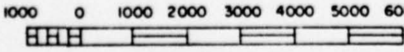
It is recommended that the owner investigate alternative methods of draining the reservoir, including installation of an emergency outlet.

b. Operation and Maintenance Procedures

It is recommended that the owner perform the following operation and maintenance work:

1. Repair any erosion scars, deformations and settlement areas as indicated by a survey of the embankment so that the embankment crest elevation and angle of slopes conform to the design drawings.
2. Remove the heavy growth of vegetation from the dam and institute a program of regular brush removal.
3. Keep records of all maintenance and operating events.
4. When the crest elevation has been determined by a survey, the maximum operating level of the reservoir should be reviewed in light of the findings of this report. As an interim measure, the reservoir should be either operated at a lower level, or a plan established as soon as possible whereby the reservoir can be quickly drawn down through the owner's water distribution system.
5. A downstream warning system should be established in cooperation with local authorities.

PLATES



QUADRANGLE LOCATION

VICINITY MAP

JENNY/LEEDSHILL DECEMBER 1978

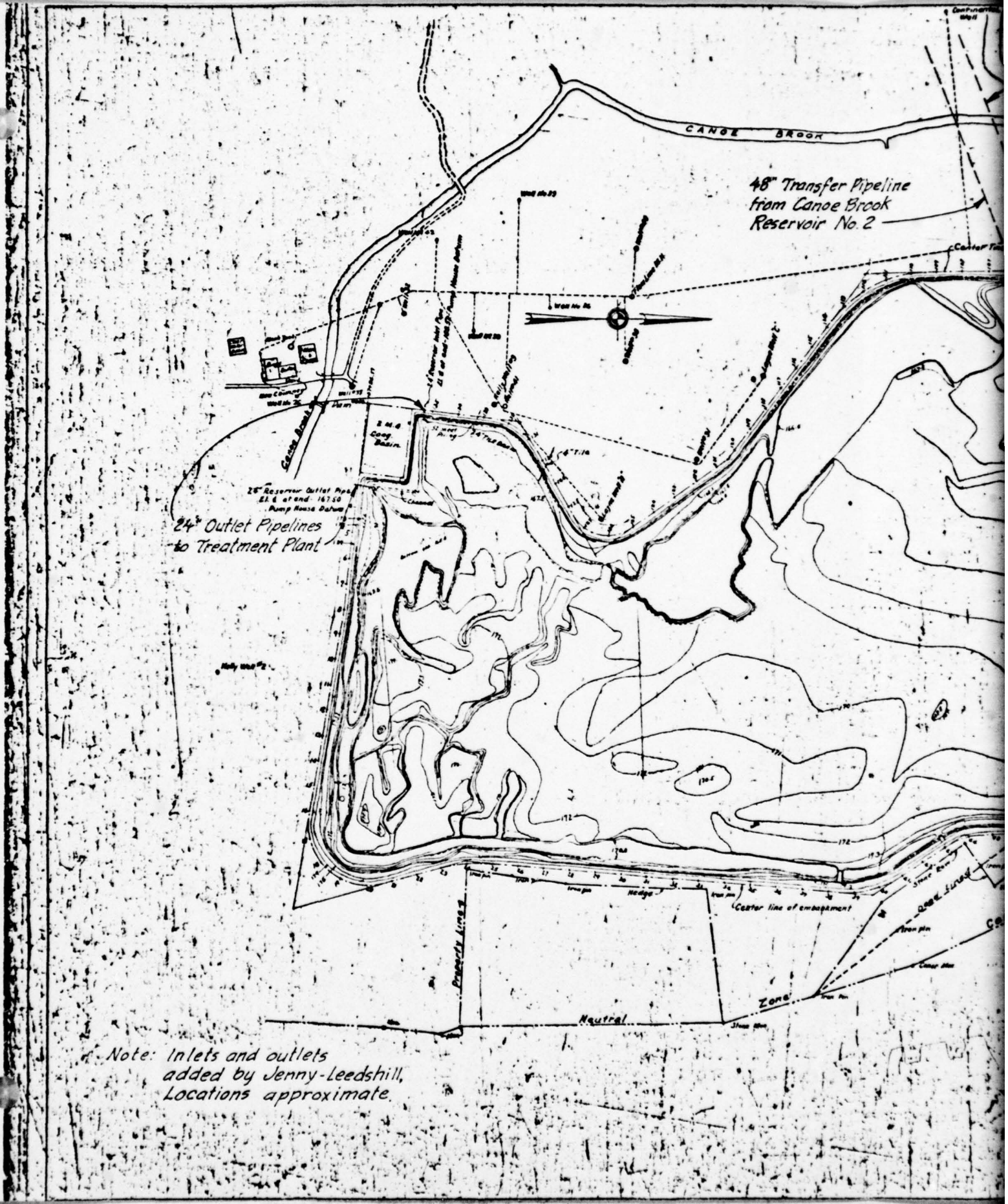
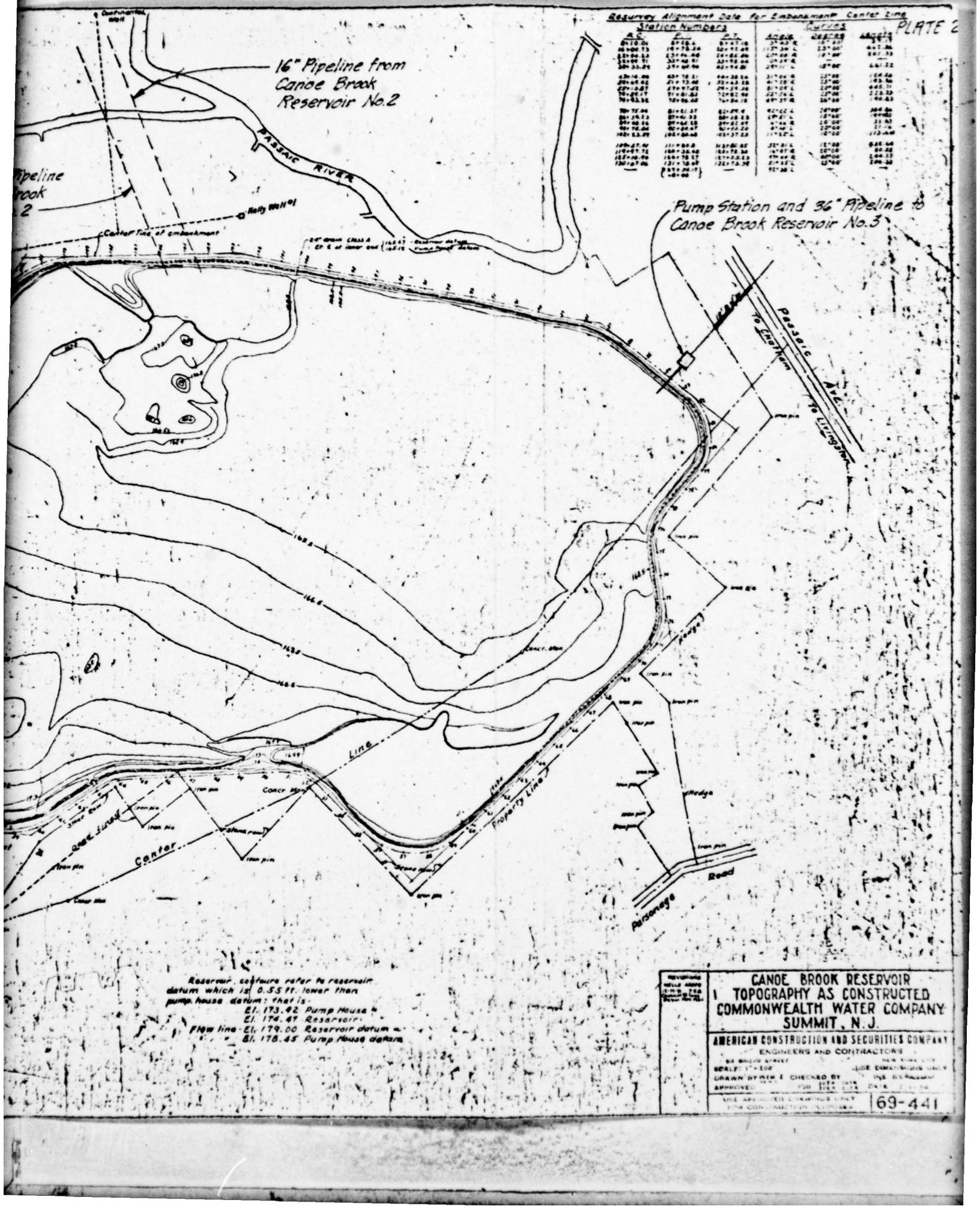

CANOE BROOK
48" Transfer Pipeline from Canoe Brook Reservoir No. 2
24" Outlet Pipelines to Treatment Plant
Neutral Zone
Note: Inlets and outlets added by Jenny-Leedshill, Locations approximate.

PLATE 2

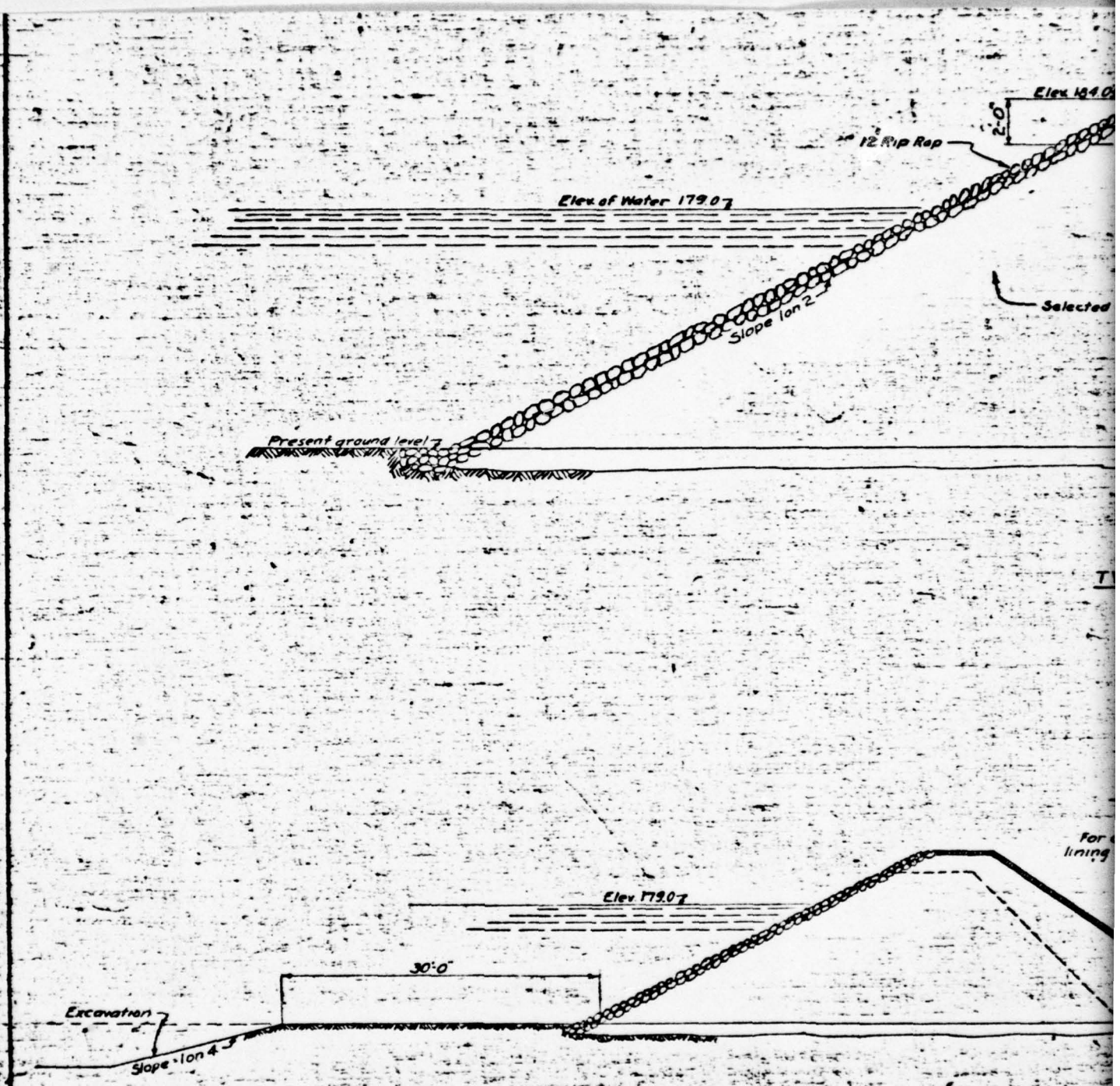


Reservoir contours refer to reservoir datum which is 0.55 ft. lower than pump house datum; that is:
El. 173.42 Pump House datum
El. 174.47 Reservoir datum
Flow line El. 179.00 Reservoir datum =
" " El. 178.45 Pump House datum

CANOE BROOK RESERVOIR
TOPOGRAPHY AS CONSTRUCTED
COMMONWEALTH WATER COMPANY
SUMMIT, N.J.

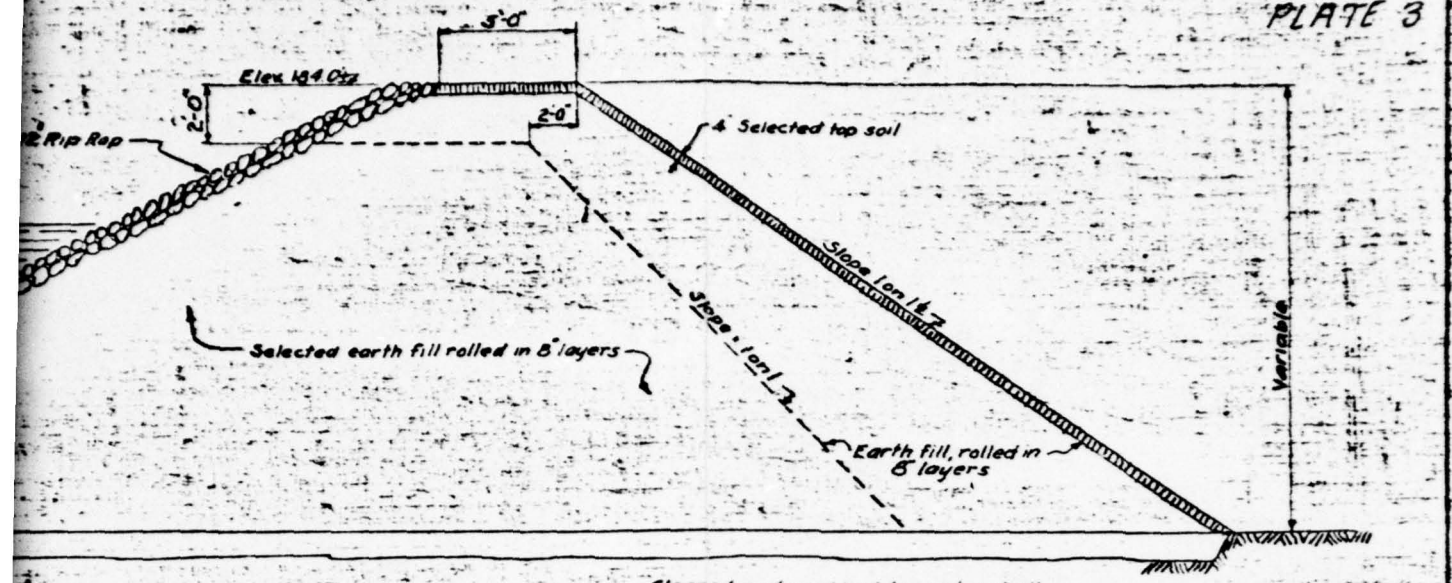
AMERICAN CONSTRUCTION AND SECURITIES COMPANY
ENGINEERS AND CONTRACTORS

69-441

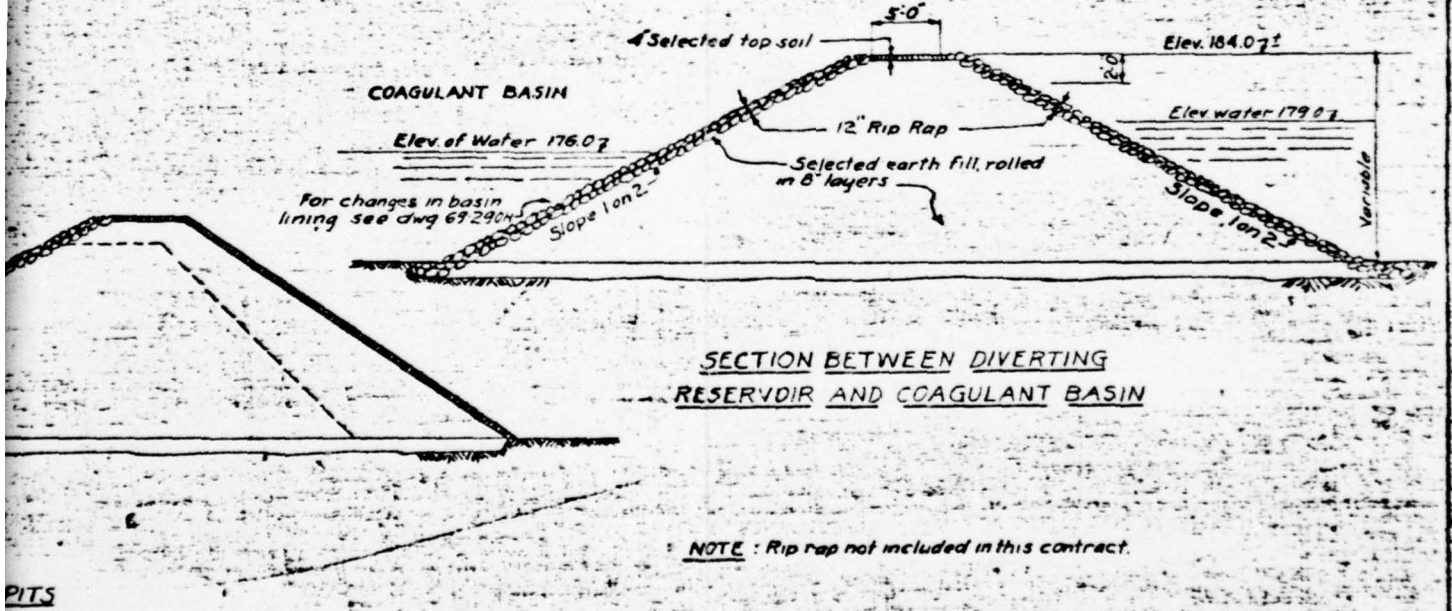


TYPICAL SECTION
SHOWING LIMITING LINE OF BORROW PITS

PLATE 3



TYPICAL SECTION



SECTION BETWEEN DIVERTING RESERVOIR AND COAGULANT BASIN

NOTE : Rip rap not included in this contract.

PITS

REVISIONS	TYPICAL SECTION OF EMBANKMENT
TRACED JJS SEPT 27, 1927	CANOE BROOK DIVERTING RESERVOIR
TRACING CHKD F.G.L. 9/27/27	FOR
	COMMONWEALTH WATER CO
	SUMMIT N.J.

AMERICAN CONSTRUCTION AND SECURITIES COMPANY
ENGINEERS AND CONTRACTORS
80 BROAD STREET — NEW YORK CITY

SCALE: ¼ & ⅛ = 1'-0" USE DIMENSIONS ONLY
DRAWN BY JCN DATE: 7-16-27 CHECKED BY
APPROVED JOB: 205A INSP. BY

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

69-188 H

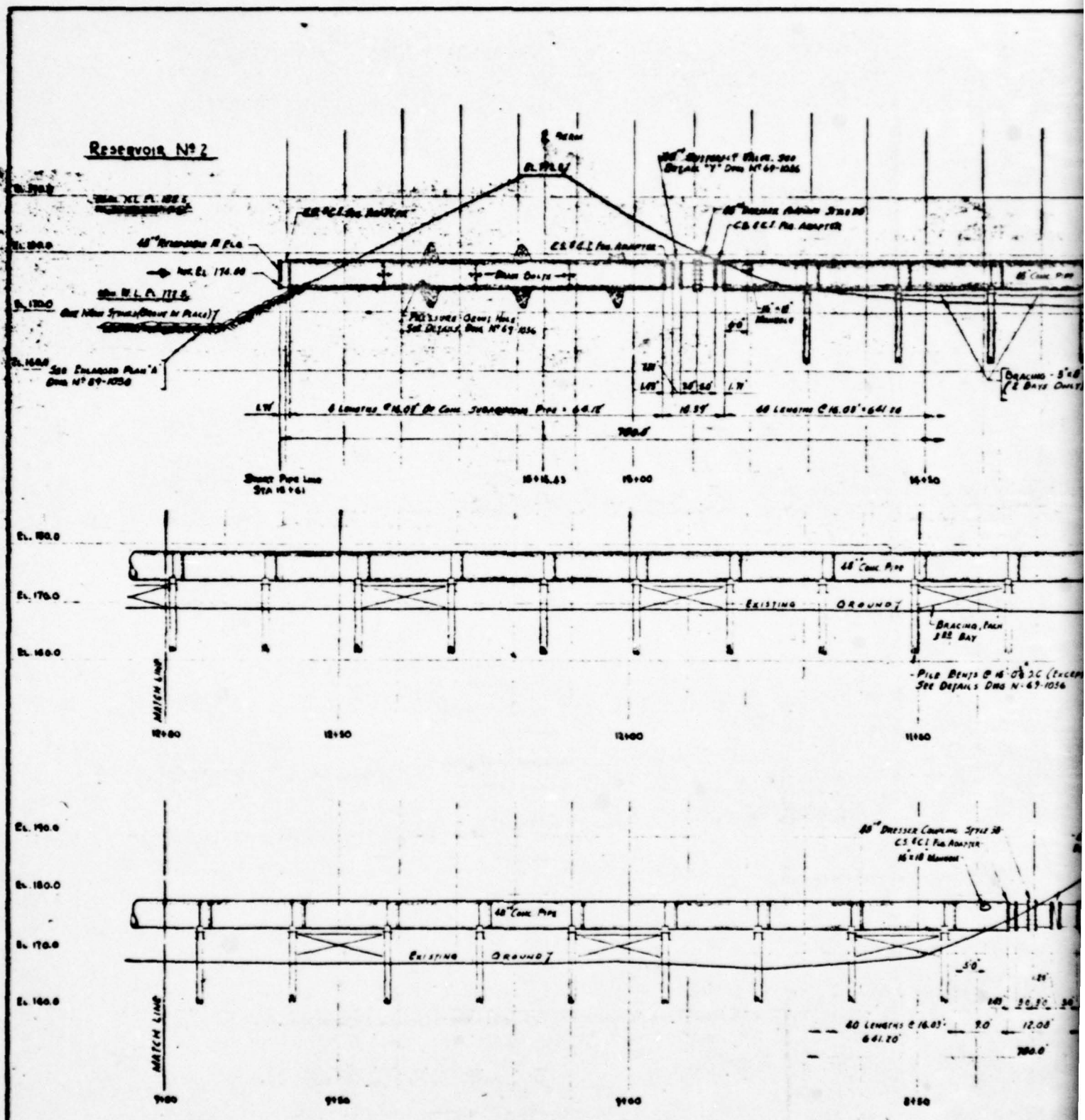
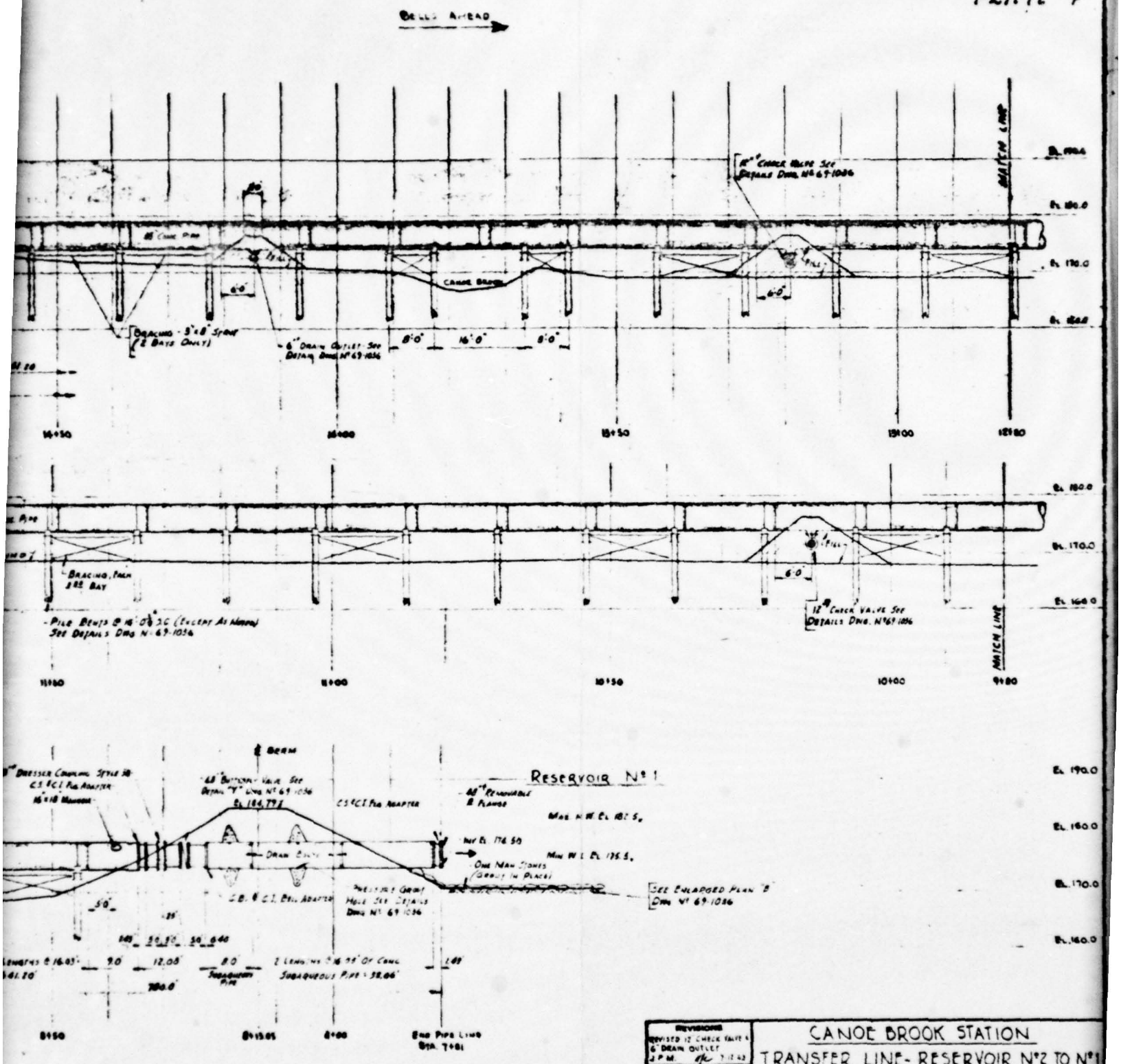

Reservoir No 2
48" Reservoir Fill Pipe
Invt. El. 174.00
Gate Valve Structure (Details on Plans)
See Enlarged Plan "A" Dwg. No 69-1056
Pile Bents Spaced as Shown See Details Dwg No 69-1056
48" C.C.E.C.I. Pipe
C.S. E.C.I. Pipe Adapter
Bracing - 5"x8" (2 Bays Only)
8 Lengths @ 16.05' = 128.40
40 Lengths @ 16.05' = 641.20
769.6
Street Pipe Line Sta 16+61
16+16.65
16+00
15+50
El. 190.0
El. 170.0
El. 160.0
Existing Ground
Bracing, Each 3 Bay
Match Line
12+80
12+50
12+00
11+50
Dresser Coupling Style 38
C.S. E.C.I. Pipe Adapter
16"x18" Manson
9.0
12.08
9+00
8+50
Notes:
1. Concrete Pipe Shown Shaded
2. Elevations Shown Are U.S.G.S. To Convert To Canada Brook Datum Subtract 8.5 Feet

PLATE 4



TO PIPE SHOWN SHADED

ELEVATIONS SHOWN ARE U.S.G.S. TO CONVERT TO CANOE BROOK DATUM SUBTRACT 0.5 FEET.

REVISIONS
REVISED 12" CHECK VALVE & 6" DRAIN OUTLET J.P.M. 7-12-63
REMOVED WALKWAY J.P.M. 8-5-63

CANOE BROOK STATION
TRANSFER LINE - RESERVOIR NO. 2 TO NO. 1
PROFILE

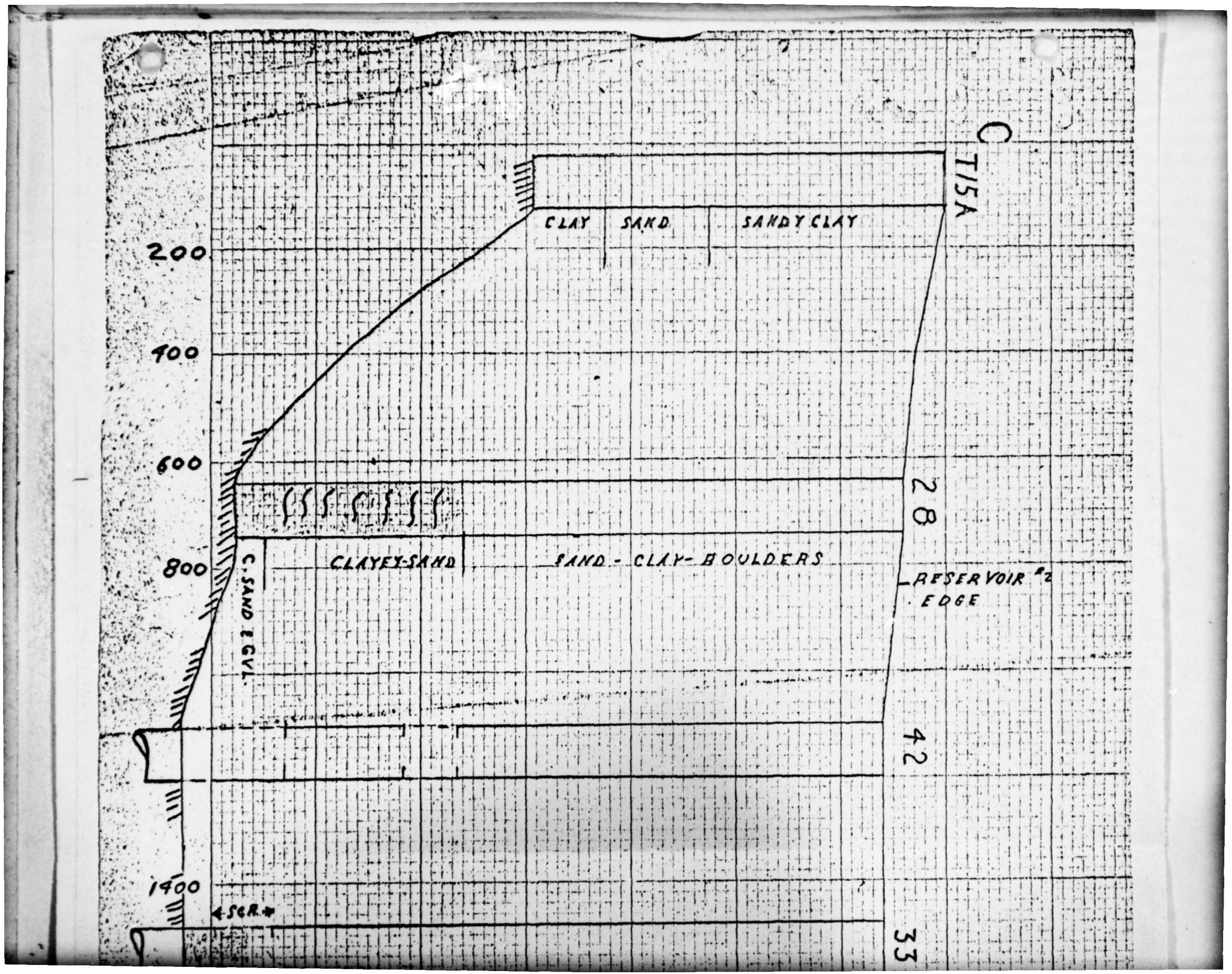
COMMONWEALTH WATER COMPANY
SUMMIT, N.J.

AMERICAN WATER WORKS SERVICE COMPANY, INC.
PHILADELPHIA, PA.

SCALE: 1" = 10'-0" | USE DIMENSIONS ONLY
DRAWN BY J.P.M. | DATE: 6-28-63 | CHECKED BY G.H.D.
APPROVED N.J.E. | PROJECT ASSISTANT ENGR. BY E.F.R.

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

69-1035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200
400
600
800
1400
CLAY
SAND
SANDY CLAY
CLAYEY-SAND
SAND - CLAY - BOULDERS
C. SAND & GVL.
SCR.
RESERVOIR #2
EDGE
28
42
33

3

41

KELLY 5

RESERVOIR N.J. EDGE

BLUE CLAY

CLAY

SANDY CLAY

CLAYEY FINE SAND

SAND, CLAY & BOULDERS

SAND-CLAY-BOULDERS

BLUE CLAY

GRAVEL

SAND & GRAVEL

SCREEN

RED CLAY-SAND & GRAVEL

10-14-48

SHALE

SANDSTONE

2000

2200

2400

2600

2800

3000

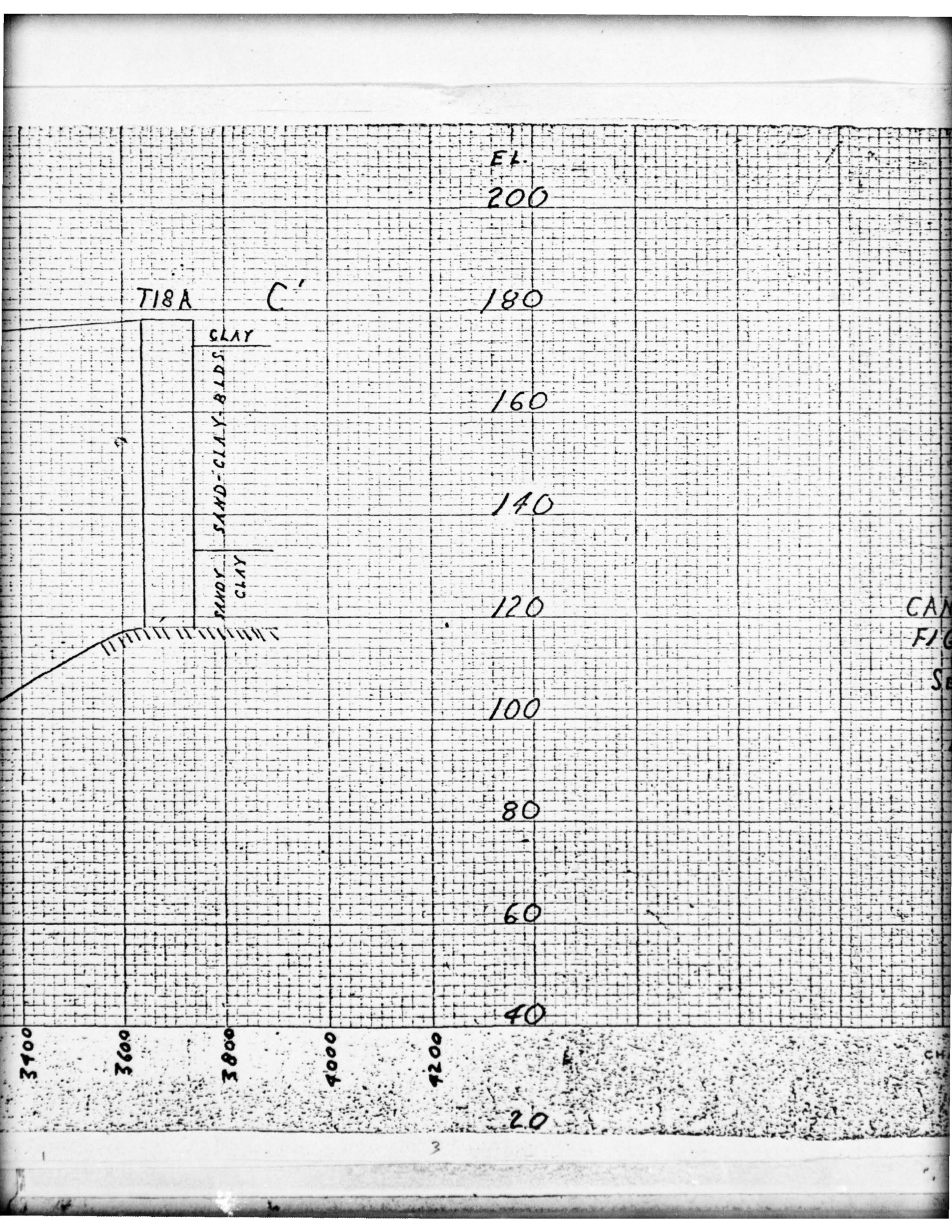
3200

CHARLES BRUNING COMPANY

CROSS SECTION 10 X 10

MADE IN U.S.A.

2


EL.
200
180
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T18A
C'
CLAY
SAND-CLAY-BLDS.
SANDY CLAY
3400
3600
3800
4000
4200

PLATE 5

CANOE BROOK WELLS

FIG. 6 - SEE FIG. 5

SECTION C-C'

HORIZONTAL SCALE 1"=200'

VERTICAL SCALE 1"=20'

69-842H

CHARLES BRUNING COMPANY
CROSS SECTION 10 x 10
PRINTED IN U.S.A.

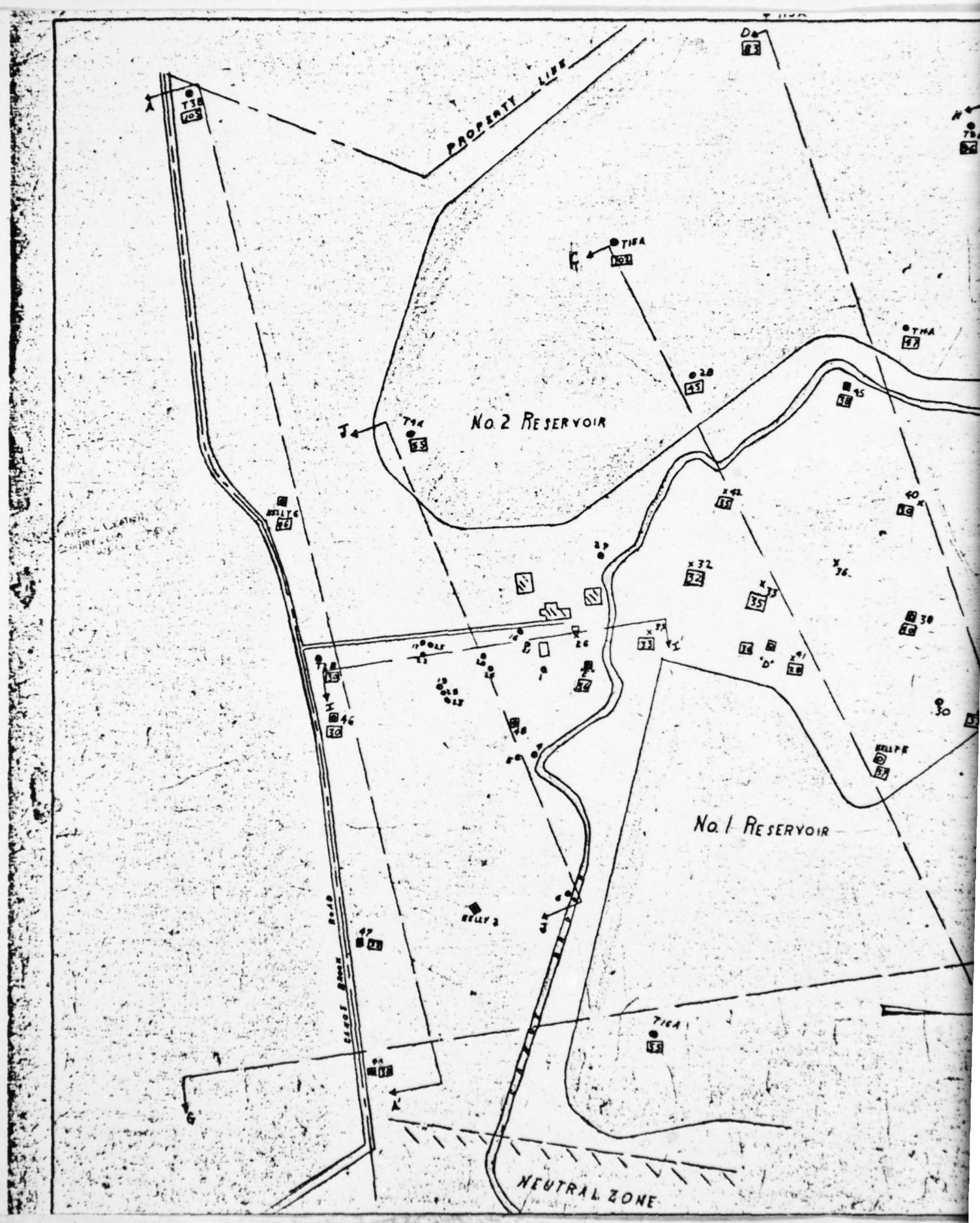
PROPERTY LINE
No. 2 RESERVOIR
No. 1 RESERVOIR
NEUTRAL ZONE
ROAD
T3A
T4A
T5A
T6A
T7A
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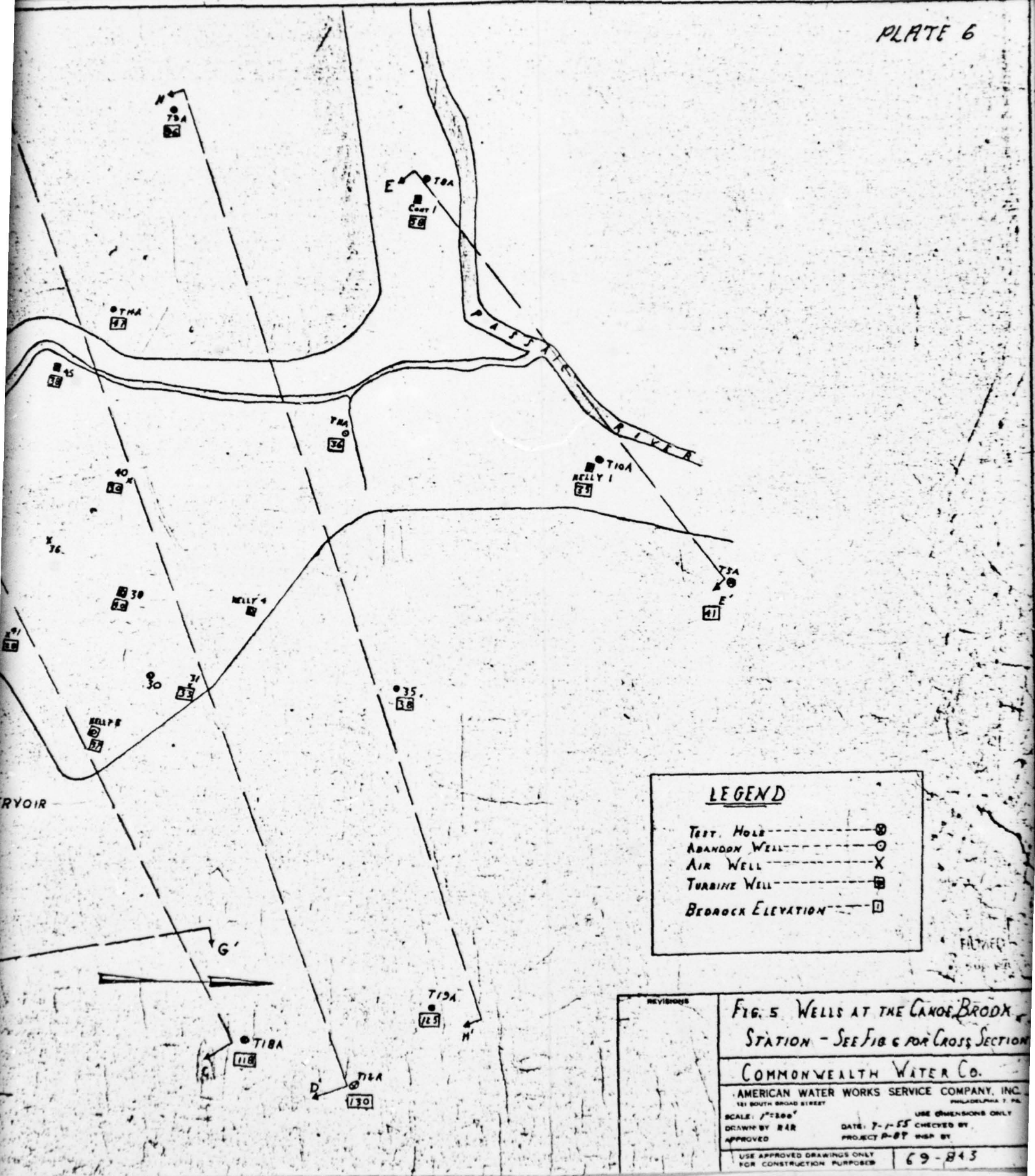
PLATE 6



LEGEND

- Test Hole
- Abandon Well
- Air Well
- Turbine Well
- Bedrock Elevation

REVISIONS

FIG. 5 WELLS AT THE CANOE BROOK STATION - SEE FIG 6 FOR CROSS SECTION

COMMONWEALTH WATER CO.

AMERICAN WATER WORKS SERVICE COMPANY, INC.
121 SOUTH BROAD STREET PHILADELPHIA 7, PA.

SCALE: 1"=200' USE DIMENSIONS ONLY
DRAWN BY R&R DATE: 7-1-55 CHECKED BY
APPROVED PROJECT P-87 INSP. BY

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

69-843

APPENDIX A

CHECK LIST - VISUAL OBSERVATIONS

CHECK LIST - ENGINEERING, CONSTRUCTION MAINTENANCE DATA

Check List
Visual Inspection
Phase 1

Name Dam Canoe Brook No. 1 County Essex State New Jersey Coordinates Lat. 40° 44' 44" N Long. 74° 21' 20" W

Date(s) Inspection Nov. 29, 1978 Dec. 16, 1978 Weather Overcast Temperature 40°F

Pool Elevation at Time of Inspection 177'+ M.S.L. Tailwater at Time of Inspection N/A M.S.L.

Inspection Personnel:

(November 29, 1978)	(December 16, 1978)	
J. A. Bischoff	D. J. Lachel	
T. C. MacDonald		
A. R. Slaughter		

Jenny-Leedshill Recorder

Owner Representative:

(November 29, 1978)

W. H. Pearce, Engineer,
Commonwealth Water Co.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEEPAGE OR LEAKAGE	Not Applicable	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Not Applicable	
DRAINS	Not Applicable	
WATER PASSAGES	Not Applicable	
FOUNDATION	Not Applicable	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not Applicable	
STRUCTURAL CRACKING	Not Applicable	
VERTICAL AND HORIZONTAL ALIGNMENT	Not Applicable	
MONOLITH JOINTS	Not Applicable	
CONSTRUCTION JOINTS	Not Applicable	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Embankment erosion is occurring along paths made by persons gaining access to reservoir for fishing. Embankment slopes are generally uneven due to continued wave action and resulting periodic remedial work.	Eroded areas should be repaired. Overly steep embankment slopes should be flattened to design angle.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Crest of dam uneven at several locations, possibly due to settlement over the years. Deep ruts caused by heavy trucks were visible at several locations (4 500-ft. sections). As a result, the width of the crest is not uniform and bulges outward in places.	Repairs are slated in 1979 by owner. A survey is needed of the crest elevation and side slope configuration.
RIPRAP FAILURES	Severe inboard slope failures at numerous locations on south and southwest side of reservoir due to wave action, and aided by very steep side slopes of <1:1.	Slopes should be returned to design angle. Continuing maintenance of riprap is necessary.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Heavy vegetation including small trees, bushes and ground cover observed throughout entire length of embankment.	All trees and brush should be removed and periodically cut.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Not Applicable.	
ANY NOTICEABLE SEEPAGE	None observed.	
STAFF GAGE AND RECORDER	Slab staff gage observed.	Owner maintains daily records of reservoir level.
DRAINS	No embankment drains.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	48-inch transfer pipeline appeared to be in good condition.	
INTAKE STRUCTURE	48-inch transfer pipeline was above level of Reservoirs 1 and 2 and thus was empty. No evidence of prior seepage around pipeline where it went through embankment. Water being pumped through 16-inch pipeline from Reservoir No. 2.	
OUTLET STRUCTURE	Both 24-inch outlets to treatment plant were submerged and could not be inspected.	
OUTLET CHANNEL	Not applicable.	
EMERGENCY GATE	None	

UNGATED SPILLWAY

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

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	
OBSERVATION WELLS	None	Owner pumps from a number of water wells in vicinity.
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Not applicable	
SEDIMENTATION	Little or no sediment inflow since reservoir is fed by pipelines from Reservoir No. 2.	
DEBRIS	Very minor	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Localized swamp areas, scrub areas, a golf course, and densely wooded areas.	
SLOPES	Area surrounding embankment is generally flat.	
APPROXIMATE NO. OF HOMES AND POPULATION	Less than 10 structures observed immediately downstream, some of which were on the opposite side of the Passaic River. Community of Hanover 4 mi. downstream contains more than 20 structures.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	"Canoe Brook Reservoir-Topography as Constructed", 2-1-1930 (Rev. Nov. 1941), Scale 1" = 200' (See Plate 2)
REGIONAL VICINITY MAP	U.S.G.S. topographic maps (See Plate 1)
CONSTRUCTION HISTORY	Little available. Owner's representatives reported the dam was constructed about 1900 and raised in 1929.
TYPICAL SECTIONS OF DAM	"Typical Sections of Embankment-Canoe Brook Diverting Reservoir", 7-16-1927 (Rev. 9-27-1932), Scale: 1/4" & 1/8" = 1' -0" (See Plate 3)
HYDROLOGIC/HYDRAULIC DATA	Elevation-capacity curve furnished by owner (See Plate D-1, Appendix D)
OUTLETS - PLAN - DETAILS -CONSTRAINTS -DISCHARGE RATINGS	"Transfer Line-Reservoir No. 2 to No. 1 Profile", 6-28-63 (Rev. 8-5-63), Scale 1" = 10' -0" (See Plate 4)
RAINFALL/RESERVOIR RECORDS	Daily reservoir levels available

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available
POST-CONSTRUCTION SURVEYS OF DAM	None since 1930
BORROW SOURCES	Borrow from reservoir excavation served as embankment materials.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
SPILLWAY-PLAN -SECTIONS -DETAILS	Not applicable
OPERATING EQUIPMENT PLANS & DETAILS	None available except for 48-inch transfer pipeline (See Plate 4)
MONITORING SYSTEMS	Staff gage only
MODIFICATIONS	Cross sections for raising of dam in 1929 (See Plate 3)
HIGH POOL RECORDS	Records available (daily basis)
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
MAINTENANCE OPERATION RECORDS	Monthly inspections of embankment by owner's personnel

APPENDIX B

Photographs

Photo 1 - Southern embankment looking east toward general area of wave erosion. (11-29-78)

Photo 2 - Southeastern shoreline, showing area of wave erosion. (11-29-78)

Photo 3 - Wave-cut southern embankment looking west. (11-29-78)

Photo 4 - Riprap on north shoreline dislodged by fishermen. (11-29-78)

Photo 5 - Erosion caused by foot traffic on west embankment.

Photo 6 - Water-filled vehicle track on west embankment crest. (11-29-78)

Photo 7 - Vehicle tracks on west embankment crest. (11-29-78)

Photo 8 - Tree stumps and new growth vegetation on east embankment. (11-29-78)

Photo 9 - 48-inch transfer pipeline to Canoe Brook Reservoir No. 2. (11-29-78)

Photo 10 - Looking south from coagulation basin toward treatment plants. (11-28-78)

Photo 11 - Coagulation basin. (11-29-78)

Photo 12 - Pumps and small dam on Canoe Brook. (11-29-78)

Photo 13 - "Downstream" area looking toward Passaic River from west embankment. (11-29-78)

APPENDIX C

REGIONAL GEOLOGY - PIEDMONT LOWLANDS

REGIONAL GEOLOGY - PIEDMONT LOWLANDS

Physiography

The Piedmont Lowlands Province of New Jersey lies northwest of a line approximately between Trenton and Perth Amboy and southeast of an approximate line between Milford on the Delaware River and Mahwah near the New York State border. Physiographically, the province is situated between the predominantly Precambrian age New Jersey Highlands Province to the northwest and the typically unconsolidated Creataceous age and younger sediments of the Coastal Plain Province to the southeast. (See Figure C-1).

Bedrock

The Piedmont Lowlands, encompassing about one-fifth of the state, is characterized by northwestward dipping bedrock composed of interbedded red shales, siltstones and sandstones of Triassic and Jurassic age and igneous basalt extrusions (lava flows) and diabase intrusions of Jurassic age. The sedimentary rocks have been eroded to a broad southeastward sloping piedmont plain. The northwest border of the province is a northeast-southwest trending fault zone (Ramapo Fault) which truncates the sedimentary beds. Total vertical displacement on the fault may reach 10,000 feet.

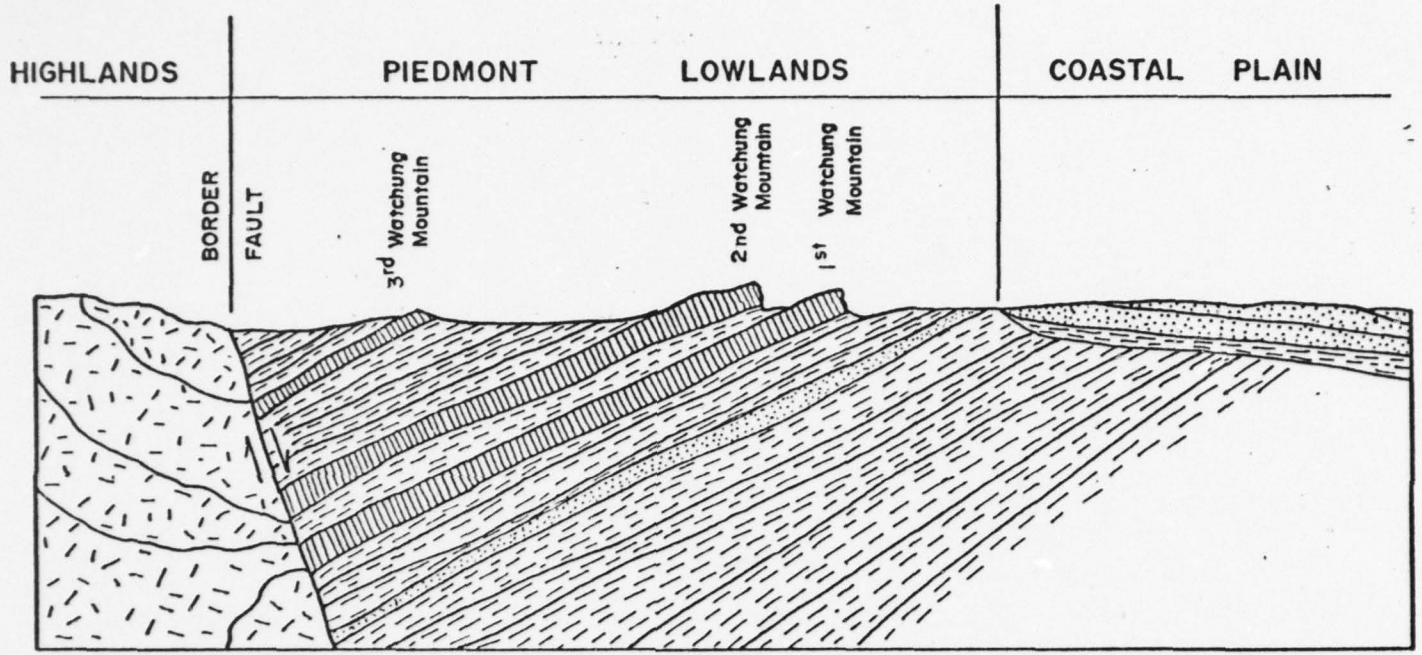
The gently rolling lowland topography of the piedmont lowlands is pierced by long asymetric ridges of hard

and resistant igneous rocks which were intruded into or on top of the sedimentary sequences. With the subsequent erosion of the softer sedimentary rocks, these igneous formations have been left standing, often in bold relief, up to 400 ft. above the surrounding plains. The igneous bodies composed of diabase and basalt form the Palisades along the Hudson River and the three Watchung Mountain ridges of the central Piedmont. The ridges are all steeper on the southeast with gentle dip slopes to the northwest.

Overburden

The Pleistocene Age Wisconsin continental glacier has smoothed and filled approximately the northern half of the province. The terminal moraine of the glacier extends from Perth Amboy to Summit then northwestward to Morris Plains. North of the morainal line the soils characteristically consist of glacial tills overlying the bedrock with scattered overlying stratified outwash deposits. At least three large glacial lakes occupied portions of the area north of the moraine at different periods, resulting in a relatively flat topography composed predominantly of silts and clays.

South of the terminal moraine, most of the overburden consists of alluvial deposits overlying a more highly developed weathered transition zone on top of the bedrock. Some highly weathered tills of pre-Wisconsin glaciation can be found on the top of intervalley ridges. Much of the alluvium is glacial outwash.



SCHEMATIC CROSS-SECTION OF
NEW JERSEY PIEDMONT LOWLANDS
PHYSIOGRAPHIC PROVINCE

JENNY / LEEDSHILL
JANUARY 1979

FIGURE C-1

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Reservoir Surface Only

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 182.5 feet (2256 AF)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): ~~none~~ N/A

ELEVATION MAXIMUM DESIGN POOL: 182.5 feet

ELEVATION TOP DAM: 184 feet (assumed)

CREST:

a. Elevation 184 feet (assumed
b. Type earth
c. Width 5 to 8 feet
d. Length 2.57 miles
e. Location Spillover none
f. Number and Type of Gates none

OUTLET WORKS:

a. Type 2 - 24" Dia. water supply outlets, 1-48" Dia and 1-36" Dia transfer outlets
b. Location SW corner of res., W side of res., NW corner
c. Entrance inverts 167.5', 169.52, 174.5', UNK
d. Exit inverts UNK, UNK, 174.68', UNK
e. Emergency draindown facilities None or Non Functional

HYDROMETEOROLOGICAL GAGES: Not Known.
a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: Not Applicable

(1) Canoe Brook No. 1 is near boundary between Zone 1 and Zone 6. Use average of the precipitation values for the two zones.✓

(2) Drainage basin area is 0.3 square miles. Use precipitation values for a 10-square mile basin✓.

(3) Precipitation values from HMR #33 - see sheet 2

ALL SEASON ENVELOPES

200 mi², 24 HR Ppt.	ZONE	PERCENT FOR 10 mi² BASIN 6 HR	12 HR	24 HR	48 HR
22.4"	6	113	123	132	142
	1	111	122	133	142
	Avg.	112	123	133	142

ZONES 1 & 6 AVERAGE PMP VALUES FOR CANOE BROOK No. 1:

Duration, HRS	6	12	24	48
PMP	25.1"	27.6"	29.8"	31.8"
PMP reduced by Hops Brook factor (0.80)✓	20.1" (1.7')	22.0" (1.8')	23.8" (2.0')	25.4" (2.1')

✓ As instructed by COE

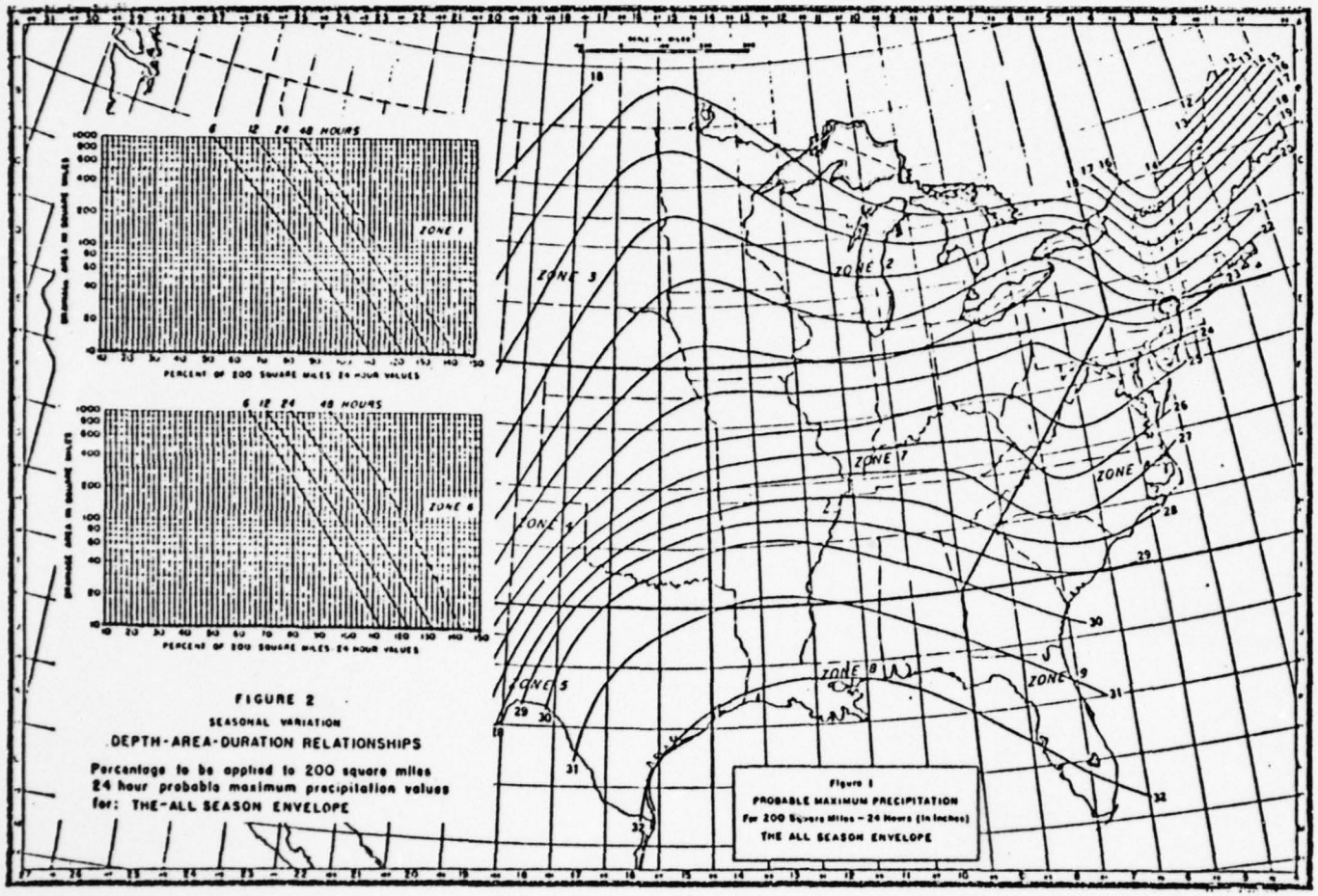


FIGURE 2

SEASONAL VARIATION

DEPTH-AREA-DURATION RELATIONSHIPS

Percentage to be applied to 200 square miles 24 hour probable maximum precipitation values for: THE-ALL SEASON ENVELOPE

The 78124 | Canoe Brook No. 1

Drawdown

Assuming Water Use = Average Water Use

= 20 MGD = 61.38 AF/day

Storage @ Design Level = 2256 AF

DRAWDOWN Time = 2256/61.38 = 36.75 days

say 37 days

Source: Users Manual, HEC-1 DB, Sept 1978

TABLE 1

DISTRIBUTION OF MAXIMUM 6 HOUR

SPS OR PMP IN PERCENT OF 6 HOUR AMOUNT

Duration Hours	EM 1110-2-1411 Criteria (Default)	Southwestern Division Criteria (Optional)
1	10	4
2	12	8
3	15	19
4	38	50
5	14	11
6	11	8

TABLE 2

DISTRIBUTION OF MAXIMUM 1 HOUR

SPS OR PMP (1)

Duration Minutes	Percent of Maximum 1 hour Precipitation In Each Time Interval	Accumulated Percent of Precipitation
5	2	2
10	4	6
15	4	10
20	6	16
25	7	23
30	17	40
35	28	68
40	11	79
45	7	86
50	6	92
55	4	96
60	4	100

(1) Distribution obtained from NOAA Technical Memorandum NWS Hydro - 35.

Assume reservoir is at maximum operating level when the 6-hour PMP begins and during the 6-hour PMP the water use out of the reservoir is negligible. 6-hr. PMP = 20.1"

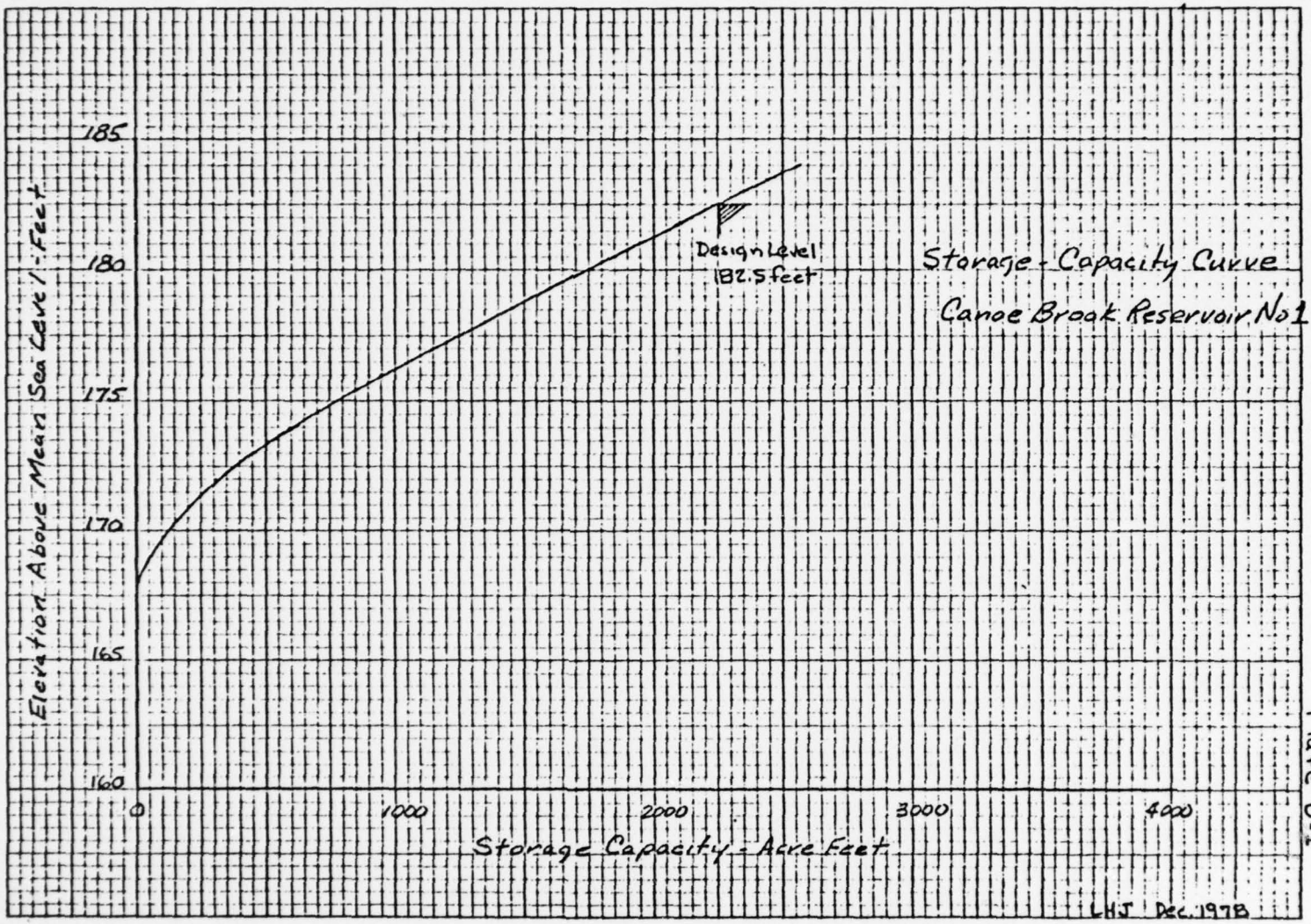
Duration HRS	% Dur. INTERVAL	PPT inch	Cum PPT
1	10	2.01	2.01
2	12	2.41	4.42
3	15	3.02	7.44
4	34	7.64	15.08
5	14	2.81	17.89
6	11	2.21	20.10

Freeboard = 18 inches, therefore overtopping will occur near the beginning of the 6th hour. Assuming the distribution of precipitation during the 6th hour is similar to the distribution during the peak hour (shown on p D-5) the a maximum of 28% of the 6th precipitation could occur in a 5-minute interval. This would result in a peak overtopping discharge of:

$$2.21'' \times 0.28 \times \tfrac{1}{12}\tfrac{ft}{in} \times 204\,Ac \times 43560\,ft^2/Ac \times \tfrac{1}{5} \times \tfrac{1}{60} = 1527\ cfs.$$

If the average rate of precipitation during the 6th hour is used, the peak overtopping discharge is:

$$2.21 \times \tfrac{1}{12} \times 204 \times 43560 \times \tfrac{1}{60} \times \tfrac{1}{60} = 454\ cfs$$



Storage - Capacity Curve

Canoe Brook Reservoir No 1

Plate D-1

LHJ Dec. 1978

D-7