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NATIONAL DAM INSPECTION PROGRAM. UNION CITY RESERVOIR DAM (NDI---ETC(U)
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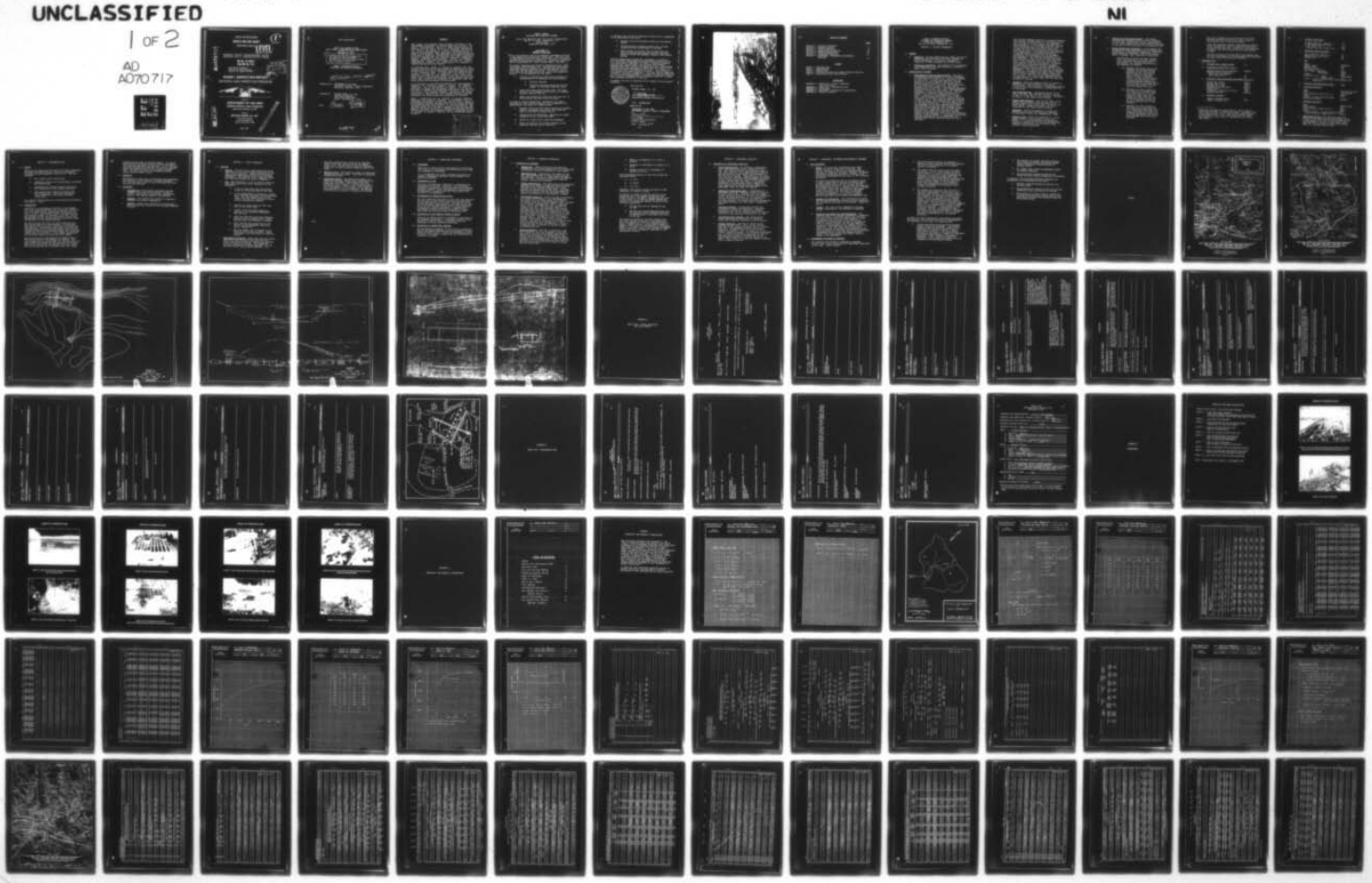

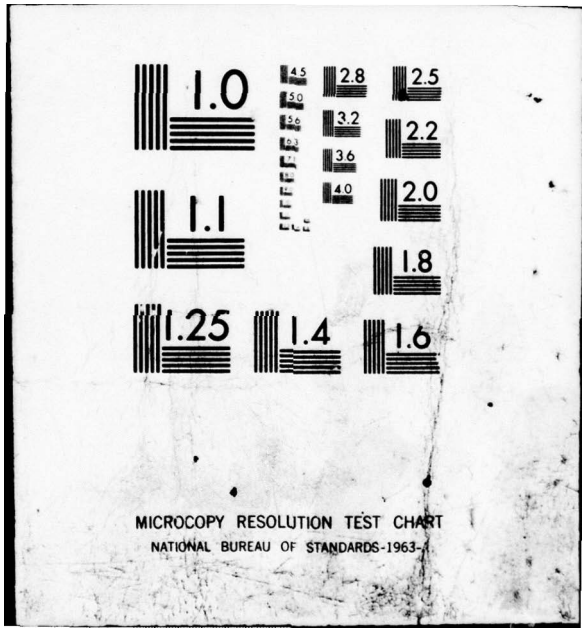
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OHIO RIVER BASIN

BENTLEY RUN, ERIE COUNTY

PENNSYLVANIA

LEVEL II

UNION CITY RESERVOIR DAM

NDI No. PA 00019
PennDER No. 25-3

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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

prepared for

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

prepared by

MICHAEL BAKER, JR., INC.
Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009

May 1979

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OHIO RIVER BASIN

UNION CITY RESERVOIR DAM
ERIE COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI No. PA 00019
PennDER No. 25-3

(6) National Dam Inspection Program. Union City Reservoir Dam (NDI-PA-00019) (PennDER-25-3), Ohio River Basin, Bentley Run, Erie County, Pennsylvania. Phase I Inspection Report.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

(15) DACW31-79-C-0011

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

Prepared by: MICHAEL BAKER, JR., INC.
Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009

Date: (11) May 1979

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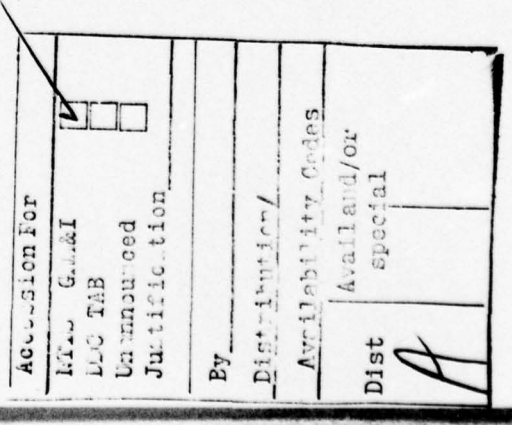
PREFACE

This report was 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. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

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



PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Union City Reservoir Dam, Erie County, Pennsylvania
NDI No. PA 00019, PennDER No. 25-3
Bentley Run
Inspected 28 November 1978

ASSESSMENT OF GENERAL CONDITIONS

Union City Reservoir Dam is an earthfill embankment dam with a clay puddle core and concrete cutoff wall. The dam, which is approximately 250 feet long and 36 feet high, is owned and operated by the Borough of Union City. Union City Reservoir Dam is categorized as a "High" hazard-"Small" size dam.

The visual inspection and review of engineering data, made in November 1978 and March 1979, indicate some deficiencies requiring remedial treatment, but the deficiencies do not constitute any emergency conditions. The dam was found to be in good overall condition at the time of the inspection. However, it is recommended that the owner:

1) Initiate an engineering study and development of recommendations as necessary for the following:

    a) Spillway capacity.

    b) Potential problems associated with the removal of the trees along the crest.

2) Remove the trees along the dam crest, and clear and grub the downstream slope area for a distance within 10 feet of the toe.

3) Repair the eroded area along the left wing wall of the principal spillway outlet structure.

In order to correct operational, maintenance and repair deficiencies, the following measures are recommended to be undertaken by the owner in a timely manner:

1) Regrade, treat and seed with an appropriate seeding mixture the exposed clay puddle core along the crest of the dam to prevent erosion.

2) Develop detailed maintenance, operation and repair schedules for all valves and gates.

3) Repair all rodent holes along the embankment.

4) Repair the spalled and cracked concrete on the principal spillway outlet structure.

In addition, the following operational measures are recommended to be undertaken by the owner:

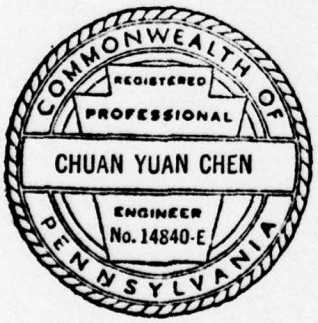
1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District of the U.S. Army Corps of Engineers for Phase I Inspection Reports, revealed that the spillways will not pass the Probable Maximum Flood (PMF) without overtopping the dam. The analysis indicated that the spillways will pass only 30 percent of the required PMF before overtopping will occur. As a result of this analysis and others noted in Section 5, the spillways are considered "seriously inadequate." The owner should immediately initiate an engineering study to evaluate the spillway capacity and to develop recommendations for remedial measures to reduce the overtopping potential of the dam.

In summary the dam is classified as an "Unsafe"-"Non-emergency" condition.



Submitted by:

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Date: 25 May 1979

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

G. K. Withers

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

Date: 16 June 1979

UNION CITY RESERVOIR DAM

Overall View

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
UNION CITY RESERVOIR DAM
NDI No. PA 00019, PennDER No. 25-3

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 of Inspection - 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. Description of Dam and Appurtenances - The Union City Reservoir Dam consists of an earth embankment 36 feet high and 250 feet long. The dam is founded on shale rock. A trench was excavated into the shale for a 12-inch concrete cutoff wall which extends above the surface of the ground and into the clay puddle core of the dam. This puddle core extends to the full height of the dam and is approximately 20 feet wide. The upstream embankment is made of rolled clay and gravel. The downstream embankment is made of similar material, with the exception of a possible greater proportion of gravel. The top of the embankment is 20 feet wide. The downstream face has a slope of 2H:1V (Horizontal to Vertical) and the upstream face has a slope of 3H:1V. The upstream slope is protected by 10-inch riprap from 3 feet above normal pool to 15 feet below normal pool. Two pipes extend under the embankment--a 14-inch diameter water supply pipe from the original dam (see paragraph 2.2), located 200 feet upstream, and a 24-inch diameter blow-off pipe. Both pipes are cast-iron and encased in a minimum of 6-inch thick concrete; several 12-inch concrete cutoff walls are installed outside of the encasement. A gate tower is provided near the upstream toe of the embankment with standard gate valves controlled from the top of the tower.

The original emergency spillway is entirely separate from the dam, although there is a spillway for low flows located at the left end of the embankment. This spillway is a 7-foot-square concrete weir box which discharges into a 30-inch cast-iron pipe (a 30-inch cast-iron pipe was placed inside the original 36-inch cast-iron pipe to stop leakage of the original pipe). The pipe passes under the end of the embankment, with concrete cutoff wall protection, and discharges into the streambed approximately 50 feet beyond the extreme toe of the embankment. The weir box controls the normal pool elevation of the reservoir 5 feet below the crest of the embankment, but will carry only a small portion of the flood discharge. Floodwater is principally discharged through a separate spillway constructed at a low point between two knolls, about 400 feet beyond the left end of the embankment. The original spillway was a reinforced concrete sill and apron with cutoff walls; however, the spillway is presently an asphalt access road with a 12-inch cast-iron pipe located underneath for low flow. The crest of the emergency spillway is approximately 1.5 feet higher than the weir box elevation at the dam.

b. Location - Union City Reservoir Dam is located on Bentley Run in Union Township, Erie County, Pennsylvania. The structure is located approximately 1.6 miles above the confluence of Bentley Run and French Creek.

c. Size Classification - The maximum height of the dam is 36 feet. The reservoir volume to the top of dam, El. 1400 feet, is 632 acre-feet. Therefore, the dam is in the "Small" size category.

d. Hazard Classification - Loss of life would likely result from a failure of the dam and serious economic impact could result from the loss of the water supply. Based on the above, the dam is classified in the "High" hazard category.

e. Ownership - Union City Reservoir is owned and operated by the Union City Municipal Authority, 12 South Main, Union City, Pennsylvania 16438.

f. Purpose of Dam - Union City Reservoir is a water supply source for the Borough of Union City. However, it is also maintained for recreational fishing in cooperation with the Pennsylvania Fish Commission and controls water flow to a fish hatchery located downstream.

g. Design and Construction History - The present structure was designed by Hill and Hill Engineers of North East, Pennsylvania and was constructed as a Civil Works Administration (CWA) project beginning in the Fall of 1933 and ending in the Spring of 1935.

h. Normal Operational Procedures - In accordance with the Water and Power Resources Board of Pennsylvania [predecessor of Pennsylvania Department of Environmental Resources (PennDER)] construction permit dated 13 December 1933, Condition 13 stipulates:

> "The Borough of Union City shall release water into Bentley Run from the reservoir to be created by the dam authorized by this permit, for supplying the Union City Fish Hatchery as follows:
>
> (a) Whenever the stream flow at the upstream line of the hatchery property is less than 150,000 gallons per day, the Borough shall release a sufficient amount of water to produce a flow of 150,000 gallons per day at said upstream line of the hatchery property whenever the water surface in the reservoir is not more than three (3.0) feet below the normal flow line.
>
> (b) Whenever the water surface in the reservoir is between three (3.0) feet and six (6.0) feet below the normal flow line, sufficient water shall be released to produce a total flow of 100,000 gallons per day at the said upstream line of the hatchery.
>
> (c) Whenever the water surface in the reservoir is more than six (6.0) feet below the normal flow line, sufficient water shall be released to produce a total flow of 50,000 gallons per day at the said upstream line of the fish hatchery."

The flow in Bentley Run is monitored by the fish hatchery personnel by means of a weir located at the property line of the fish hatchery.

Union City Municipal Authority maintenance personnel visit the dam once a week to check the trash rack on the overflow weir box. According to the operating personnel, the blow-off pipe has not been operated in years.

The pool elevation is controlled by the ungated overflow weir and except for the above-mentioned procedures, no other formal directives are followed.

1.3 PERTINENT DATA

a. Drainage Area (square miles) - 2.4

b. Discharge at Dam Site (c.f.s.) -

Maximum Known Flood at Dam Site -	Unknown
Ungated Spillway Capacity at Maximum Pool Elevation (El. 1399.2 ft.) -	800

c. Elevation [feet above Mean Sea Level* (M.S.L.)] -

Design Top of Dam -	1400.0
Average Top of Dam -	1399.5
Minimum Top of Dam -	1399.2
Emergency Spillway Crest -	1395.7
Normal Pool -	1394.0
Streambed at Centerline of Dam -	1364
Maximum Tailwater -	Unknown

d. Reservoir (miles) -

Length of Maximum Pool -	0.8
Length of Normal Pool -	0.5

---

* Elevations are based on normal pool El. 1394.0 feet as taken from the USGS 7.5 minute quadrangle. Therefore, the top of dam elevation of 90.0 feet on the design drawings is equivalent to El. 1400.0 feet (USGS) and the normal pool elevation of 85.0 feet is equivalent to El. 1394.0 feet (USGS).

e. Storage (acre-feet) -

At Top of Dam (El. 1400 ft.) -	632
At Emergency Spillway Crest (El. 1395.7 ft.) -	382
At Normal Pool (El. 1394.0 ft.) -	320

f. Reservoir Surface (acres) -

Top of Dam (El. 1400 ft.) -	75
Emergency Spillway Crest -	38
Normal Pool -	32

g. Dam -

Type -	Earthfill
Length (feet) -	250
Height (feet) -	36
Top Width (feet) -	20
Side Slopes - Upstream -	3H:1V
Downstream -	2H:1V
Zoning -	None
Impervious Core - Type -	Clay puddle
Width (feet) -	20

Cutoff - 12-inch concrete wall which extends into shale rock.

h. Diversion and Regulating Tunnel - None

i. Auxiliary Spillway -

Type -	Concrete weir box
Size -	7-ft.-square
Crest Elevation (feet M.S.L.) -	1394.0
Gates -	None
Outlet - 30-inch cast-iron pipe	
Downstream Channel -	Natural

j. Emergency Spillway -

Type -	Asphalt road
Width (feet) -	25
Crest Elevation (feet M.S.L.) -	1395.8
Gates -	None
Low Flow Outlet - 12-inch cast-iron pipe	
Invert Elevation (feet M.S.L.) -	1393.5

k. Regulating Outlets - Two cast-iron pipes are controlled by standard hand-operated gate valves located in the gate tower at the upstream toe of the embankment. One is a 14-inch water supply pipe that delivers water to Union City and the other is a 24-inch blow-off pipe.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

There were no design data available for review concerning the Union City Reservoir Dam. The only information available was from PennDER's File No. 25-3. The file included:

1) The original permit application.

2) Inspection reports and correspondence concerning the original dam.

3) Inspection and progress reports made during the construction of the present structure.

4) Post-construction inspection reports from 1935 through 1965. The latest inspection report contained in the files was dated 7 June 1965.

The original design drawings are reproduced and presented as Plates 3, 4 and 5.

2.2 CONSTRUCTION

According to correspondence contained in the PennDER file, the original structure was in very poor condition as noted during several inspections between 1919 and 1933. In 1933, the Borough of Union City applied for and received a permit to construct a new dam. The dam was designed by Hill and Hill Engineers of North East, Pennsylvania and was constructed as a CWA project under the direction of the borough engineer.

The new structure was built 200 feet downstream from the original dam and is approximately 17 feet higher than the original structure, which was not removed from the reservoir. The 14-inch water supply line from the original reservoir was incorporated into the new dam by running the line through the gate chamber and installing a gate valve at this point. A new intake was provided for the water supply line above the gate chamber.

There were only two post-construction changes made to the dam; the dates of the changes are unknown. The first change was the installation of a 30-inch cast-iron pipe inside the original 36-inch cast-iron outlet pipe which is the outlet for the concrete weir box. After the 30-inch pipe was set into place, grout was forced

between the two pipes to prevent leakage. The second post-construction change involved building an asphalt road over the emergency spillway weir. A low flow pipe was placed beneath the road with its invert at approximately the same elevation as the original concrete weir. The new road raised the emergency spillway invert elevation about 1 foot.

2.3 OPERATION

The Borough of Union City is responsible for maintenance and operation of the reservoir. Borough personnel visit the dam once a week to check the trash rack over the auxiliary spillway.

2.4 EVALUATION

a. Availability - The drawings available from the PennDER's files were not listed as "as built." However from review of the periodic construction reports, the drawings appear to be accurate.

b. Adequacy - The information available is generally adequate for a Phase I Inspection.

c. Validity - There is no indication at the present time to doubt the validity of the available engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General - The dam and its appurtenant structures were found to be in good overall condition at the time of the inspection. Noteworthy deficiencies observed are described briefly in the following paragraphs. The complete visual inspection check list and field sketch are given in Appendix A.

b. Dam - The following is a list of obvious deficiencies noted during the visual inspection of the embankment:

1) A row of large trees has been planted along the downstream edge of the crest.

2) A hole approximately 8 inches by 3 inches by 4 feet deep was found in the downstream face. The hole appears to be an old rodent hole that was surficially covered and has subsequently reopened.

3) Erosion was noted along the left wing wall of the outlet pipe.

4) Several trees and large bushes are growing on the downstream embankment near the toe.

5) Water was observed along both abutments, possibly due to surface runoff, natural springs along the abutments or seepage.

6) Small springs were noted exiting from the toe of the embankment (see field sketch, Appendix A).

7) The clay puddle core is exposed at the bottom of ruts along the crest. These ruts appear to be the result of vehicular traffic.

c. Appurtenant Structures - Minor spalling and cracking was noted along the outlet head wall and wing walls, also some pitting and cracking was observed on the 24-inch blow-off pipe. The inspection team was informed by operating personnel that the 24-inch blow-off pipe is never operated. The

emergency spillway weir could not be inspected since it had been covered over by the asphalt access road. The gate valve tower was submerged except for the metal catwalk located on top of the tower.

d. Reservoir Area - The reservoir slopes are moderately sloping and heavily wooded. There was no excessive sedimentation noted.

e. Downstream Channel - The downstream channel is a naturally occurring channel with a dense growth of trees and low bushes. Approximately 150 feet downstream from the dam is a fish hatchery and a filtration plant. Within 1 mile of the structure are an estimated 10 to 15 houses with an approximate population of 30 to 45 persons. The Borough of Union City is located 1.2 miles below the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal written instructions for operating the reservoir or evacuating the downstream area in case of an impending catastrophe.

It is recommended that formal emergency procedures be adopted, prominently displayed, and furnished to all operating personnel.

4.2 MAINTENANCE OF DAM

The Union City Municipal Authority is responsible for maintenance of the dam. Generally, the maintenance procedures instituted by their personnel are considered adequate; however, a more conscientious program should be developed to prevent trees and large plants from growing on the embankment.

4.3 MAINTENANCE OF OPERATING FACILITIES

The only operating facilities at the Union City Reservoir Dam are the two gate valves located in the gate house at the upstream toe of the slope. The gate valve for the 14-inch water supply pipe is left open and the gate valve for the 24-inch blow-off pipe is never operated by municipal authority personnel. A preventative maintenance program should be established to ensure that these two valves are kept in operating order.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system or procedure in the event of an impending catastrophe. An emergency warning system should be installed and/or a procedure should be developed to notify residents downstream.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The maintenance procedures for the Union City Reservoir Dam are considered adequate with the exception of those items previously noted. Preventive maintenance should be done in the future to ensure that all facilities are functional if needed.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data - Design plans were obtained from PennDER and used in the preparation of the hydrologic and hydraulic analysis presented in this report.

b. Experience Data - According to the owners of the dam, the maximum depth of water flowing through the emergency spillway in recent years was approximately 1 foot. No detailed reservoir stage or rainfall records were recorded.

c. Visual Observations - The trash rack on the auxiliary spillway could become clogged with debris thereby decreasing the discharge capabilities of the spillway during periods of high flows. No other problem was observed during the field inspection that would indicate that the spillways could not operate satisfactorily in the event of a flood.

d. Overtopping Potential - Union City Dam is classified as a "High" hazard-"Small" size dam requiring evaluation for a spillway design flood (SDF) in the range of the 1/2 Probable Maximum Flood (1/2 PMF) to the Probable Maximum Flood (PMF). Since the dam is nearly "Intermediate" size, the PMF was chosen as the SDF. The spillways consist of a concrete drop-inlet and vegetated earth channel. The hydrologic and hydraulic capabilities of the reservoir and spillways were evaluated by routing the PMF through the reservoir with the aid of the U.S. Army Corps of Engineer's Flood Hydrograph Package, HEC-1. The PMF was based on a Probable Maximum Precipitation (PMP) of 21.5 inches in 6 hours. The results of the flood routing indicate that the dam would be overtopped by 2.1 feet during the PMF and that the reservoir is capable of passing about 30 percent of the PMF without overtopping the dam.

e. Spillway Adequacy - The dam, as outlined in the above analysis, would be overtopped by the PMF. The criteria for spillway adequacy determination requires an estimate of the likelihood of dam failure and an estimate of the downstream damage increase during overtopping by 1/2 PMF conditions. Therefore, the following conditions were used as the limiting criteria which are likely to cause failure of this dam:

1) Depth of overtopping of 1.0 foot or greater.

2) Duration of overtopping in excess of 1.5 hours.

3) Maximum velocity of overtopping in excess of 2 f.p.s.

The overtopping analysis of this dam yielded the following values:

1) 1.0 foot.

2) 6.0 hours.

3) 4.6 f.p.s.

Therefore, dam failure during the above 1/2 PMF conditions is likely to occur.

To assess the impact of the dam failure on the downstream area, the channel routing and dam breach options of the HEC-1 program were utilized. A flood equal to 1/2 PMF was routed through the reservoir and downstream channel for both of the following conditions:

1) The dam would not be breached by the 1/2 PMF.

2) The dam would be breached beginning when the reservoir stage reached an elevation of approximately 1 foot above the crest of the dam.

The results of these two routings indicate that the water surface elevations in the downstream area (see Appendix D) would be increased significantly, thereby causing a significant increase in damage in the event of a dam failure by overtopping. Based on the above results, the spillway is classified as "seriously inadequate" according to the recommended criteria.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - No structural inadequacies were noted during the visual inspection of the dam. The trees located on the downstream edge of the crest indicate a very unsatisfactory condition and may possibly cause leakage and contribute to the failure of the dam. Upon removal of the trees from the crest, however, another problem is created by the dying roots within the embankment which will create a large number of voids. It is therefore recommended that the owner retain a qualified consultant to evaluate the overall effects and make suggestions to prevent serious damage to the embankment after the trees are removed.

b. Design and Construction Data - Calculations of embankment slope and foundation stability were not available for review. Because of the low height of the earthfill section of the dam, its substantial width, and moderate slopes; it is inferred that the dam could be shown to meet the stability criteria required. No further stability assessments are deemed necessary for this Phase I Inspection Report.

c. Operating Records - No operating records were available for Union City Reservoir. Operating procedures, obtained by interviewing borough representatives, do not indicate cause for concern relative to the structural stability of the dam.

d. Post-Construction Changes - The modifications listed previously do not appear to adversely affect the structural stability of the structure.

e. Seismic Stability - The dam is located on the boundary between Zones 1 and 2 of the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." This is an area of low to moderate seismic activity. As indicated in paragraph 6.1.b., Union City Reservoir Dam could be shown to meet the static stability requirements of the "Recommended Guidelines for Safety Inspection of Dams." Thus, there is no need for further consideration of seismic stability.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety - No structural inadequacies were noted during the visual inspection of the dam. The overall condition of the dam and appurtenances at the time of inspection was good. However, noteworthy deficiencies have been presented in Section 3 and corrective recommendations are given in the following paragraphs.

The Union City Reservoir Dam is evaluated as being a "High" hazard-"Small" size dam and should have a hydraulic capability sufficient to pass the PMF. As presented in Section 5, the spillway and reservoir were determined to have a capacity of only 30 percent of the PMF. Based upon this analysis and others noted in Section 5, the spillway is considered "seriously inadequate." As a result of these analyses and observations, Union City Reservoir Dam is classified as an "Unsafe"-Non-emergency" dam.

b. Adequacy of Information - The information available and the observations made during the field inspection are considered sufficient for this Phase I Inspection Report.

c. Urgency - The owner should immediately initiate further investigation, as discussed in paragraph 7.1.d.

d. Necessity for Additional Data/Evaluation - The hydraulic/hydrologic analysis performed in connection with this Phase I Inspection Report has indicated the need for additional spillway capacity. It is recommended that the owner of the Union City Reservoir Dam immediately initiate an engineering study to further evaluate the spillway capacity and develop recommendations for remedial action as necessary. Also, the owner should initiate a study concerning the potential problems associated with the removal of the trees and to obtain qualified recommendations as to the best method of their removal that would produce the minimal amount of damage to the embankment.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection and review of information revealed certain items of work which should be performed immediately by the owner. These include:

1) The owner should initiate an engineering study to further evaluate the spillway capacity and develop recommendations for remedial action as necessary.

2) The trees along the crest of the dam should be removed. Prior to the removal of these trees, however, it would be advantageous for the owner to initiate a study concerning the potential problems associated with their removal and to obtain qualified recommendations as to the best method of removal that would produce minimal damage to the embankment. Also, the downstream slope area should be cleared and grubbed for a distance within 10 feet of the toe.

3) The eroded area along the left wing wall of the outlet pipe should be restored to its original configuration. Due to the height of the tailwater, an accurate assessment could not be made as to the cause of the problem. After the area is restored to its original height, local maintenance personnel should periodically check the area to determine the exact cause. If the erosion is due to backwater, then it is recommended that riprap be placed along the wing wall. If the problem is due to piping, however, an engineering study should be initiated without delay to determine the effects the piping will have on the dam and make recommendations as to possible solutions.

In order to correct operational, maintenance and repair deficiencies, the following measures are recommended to be undertaken by the owner in a timely manner:

1) A more conscientious preventive maintenance schedule should be developed. This program should include operating and repairing, as necessary, all valves and gates to ensure their proper operation. The owner should continue in the future to inspect the embankment and concrete appurtenances, and repair as necessary. Also, a periodic underwater inspection of the intake structures should be included in the maintenance program.

2) The exposed clay puddle core along the dam crest should be graded, treated and seeded with an appropriate seeding mixture to prevent erosion.

3) All rodent holes along the embankment should be properly repaired.

4) The spalled and cracked concrete on the outlet structure should be repaired as necessary.

In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

PLATES

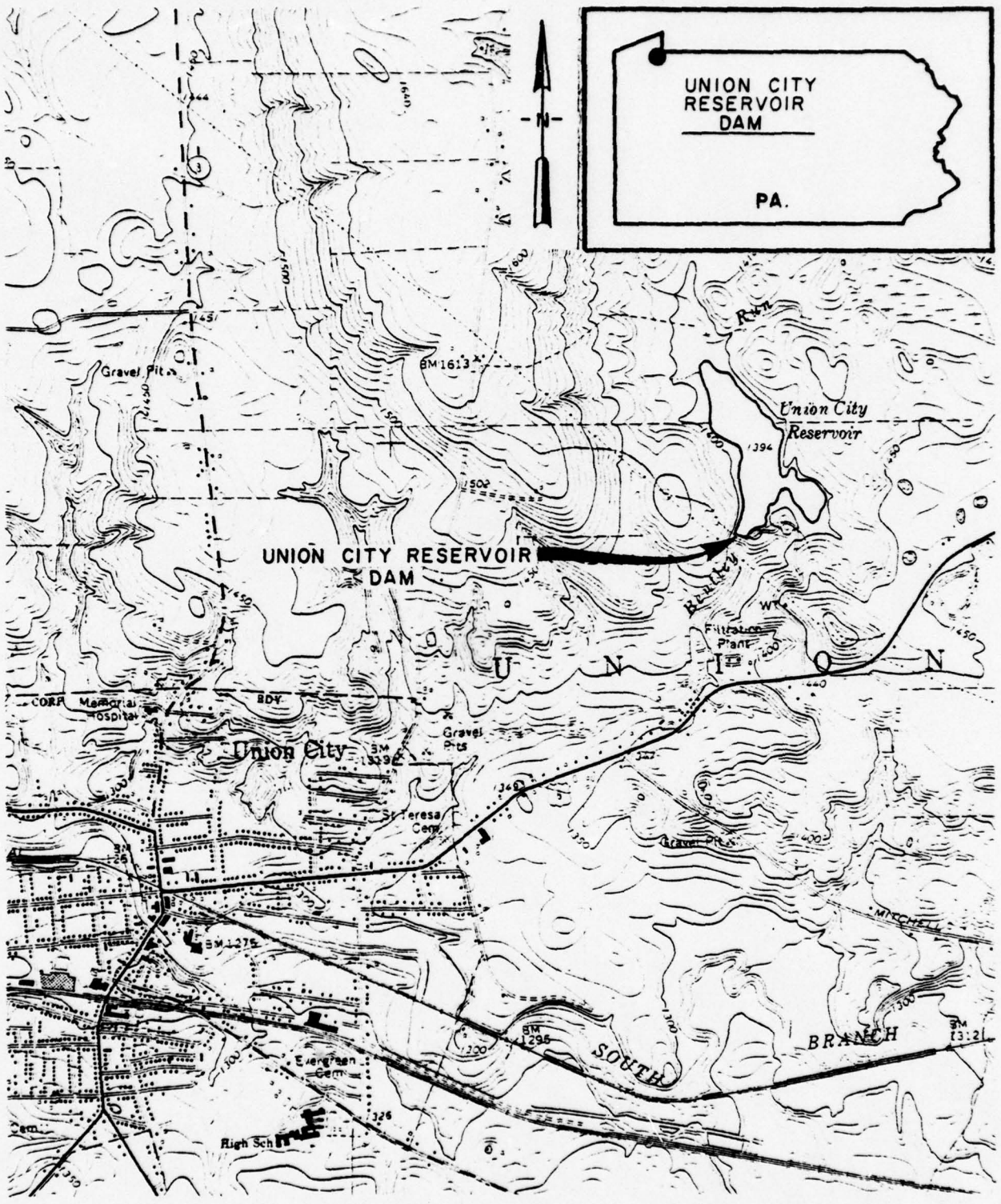
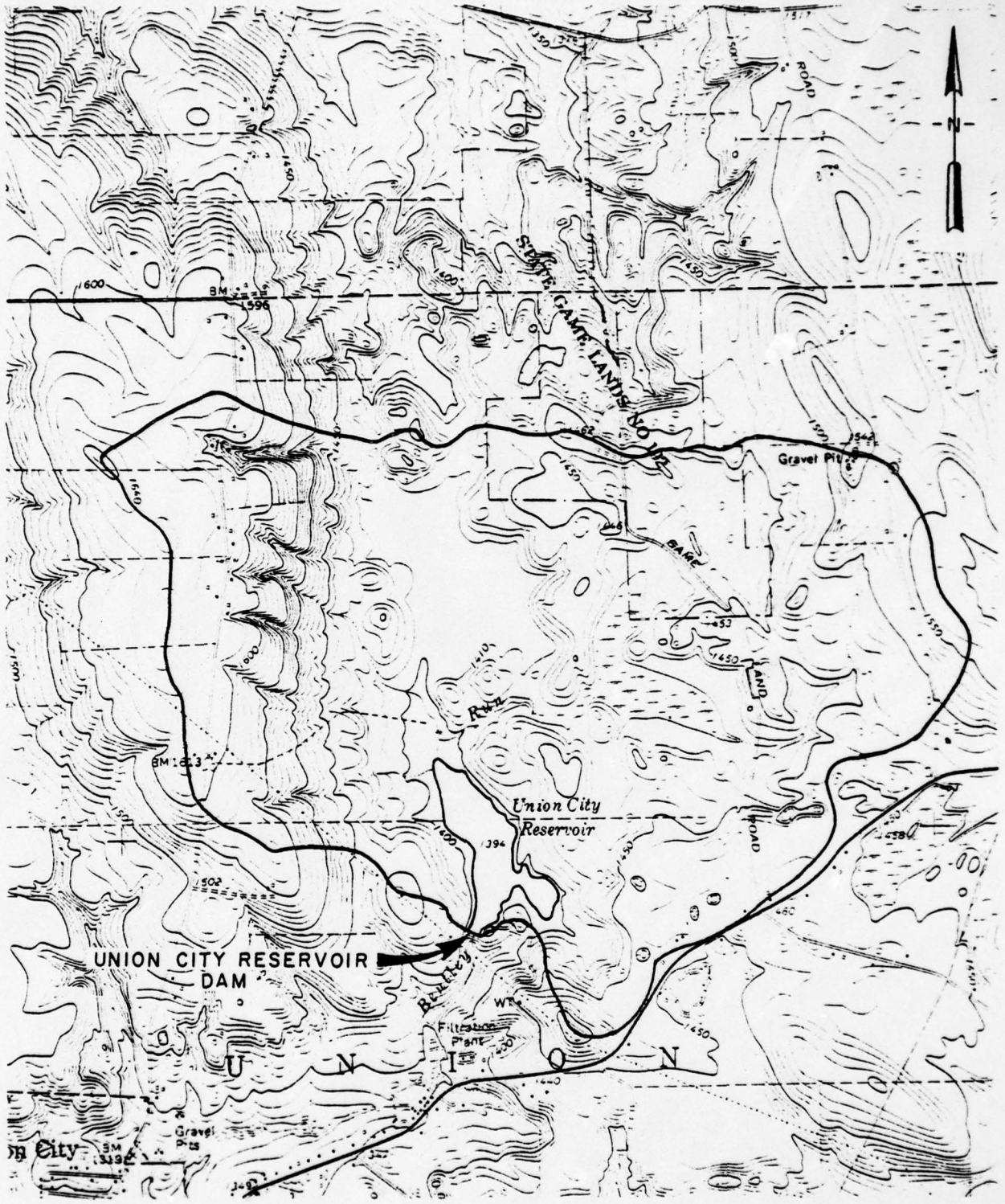


PLATE 1 LOCATION PLAN

UNION CITY RESERVOIR
DAM



SCALE 1:24000

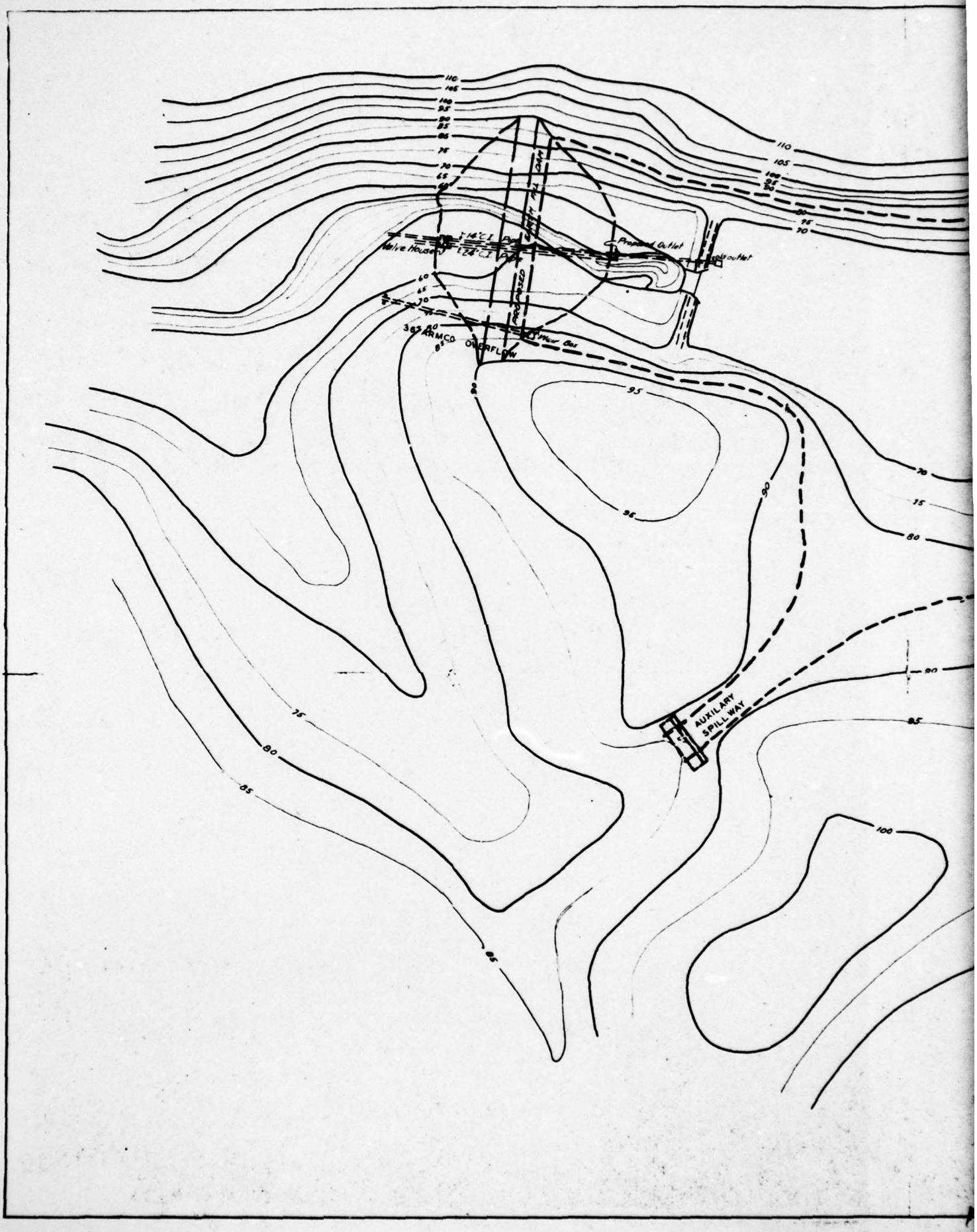
1 0 1/2 1 MILE

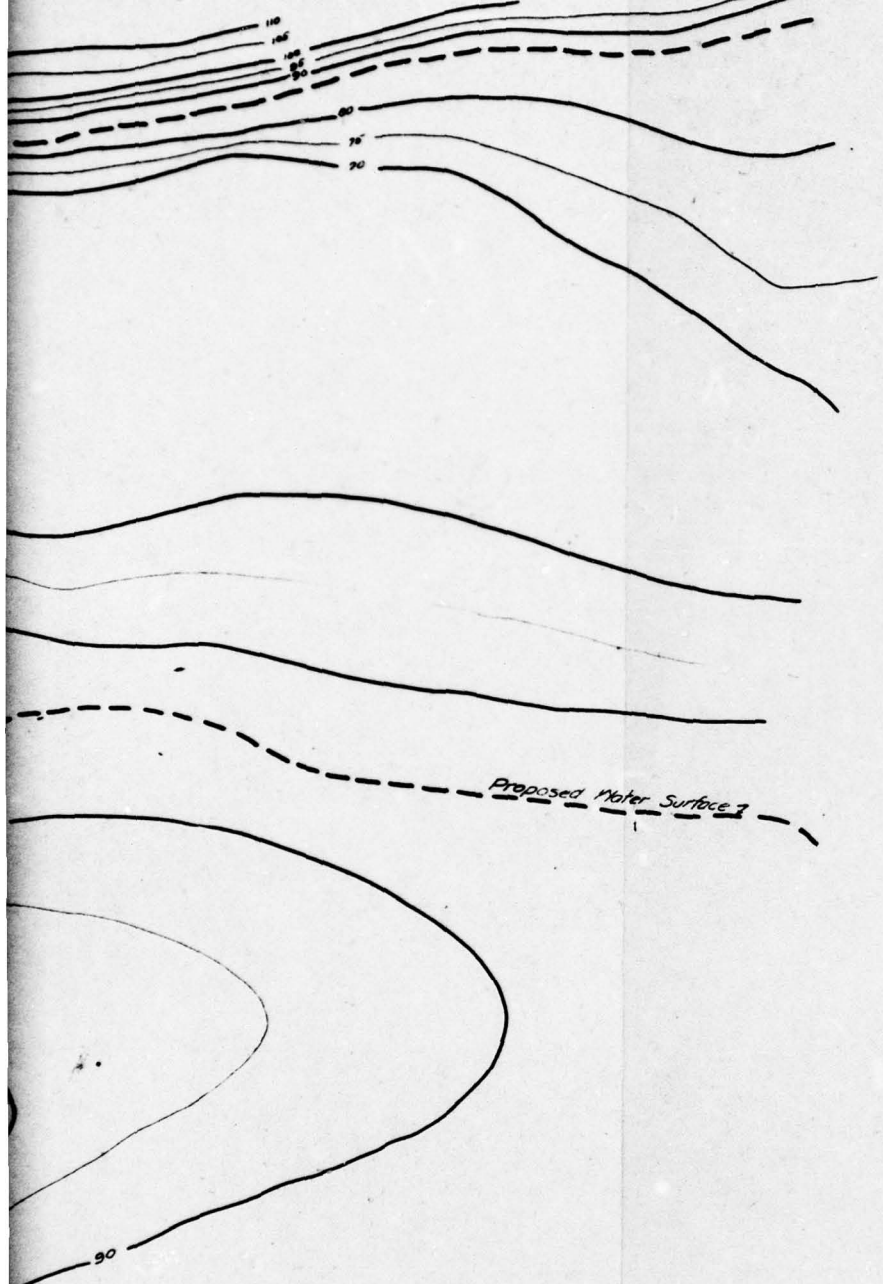
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

PLATE 2 WATERSHED MAP

UNION CITY RESERVOIR
DAM


110
105
100
95
90
85
80
75
70
65
60
Proposed Outlet
Existing outlet
Valve House
14"CI Pipe
12"CI Pipe
Proposed Earth Fill Dam
36" ARMCO
OVERFLOW
Weir
AUXILARY
SPILL WAY



Note: Approx. Half Scale

PLATE 3

CONTOUR MAP

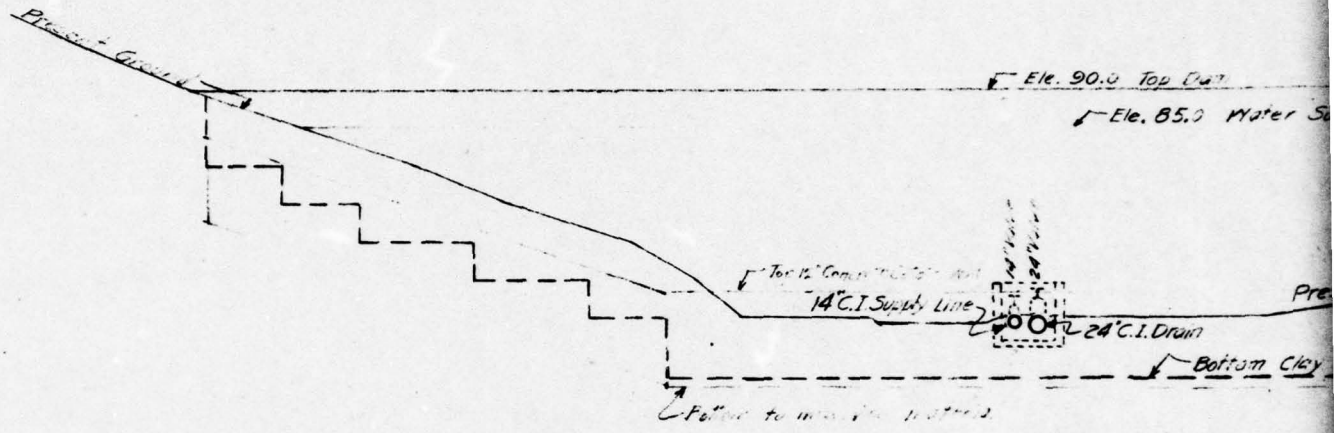
EARTH FILL DAM

UNION CITY, ERIE Co. PA.

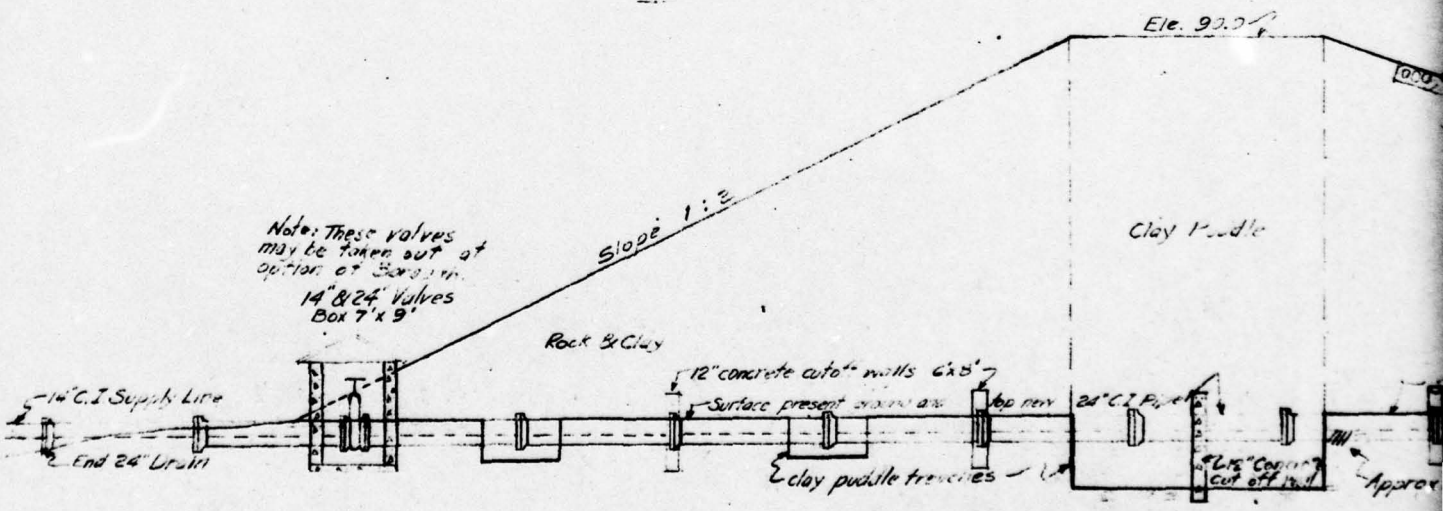
Scale 1"=50' Nov. 1933

HILL & HILL
REGISTERED ENGINEERS

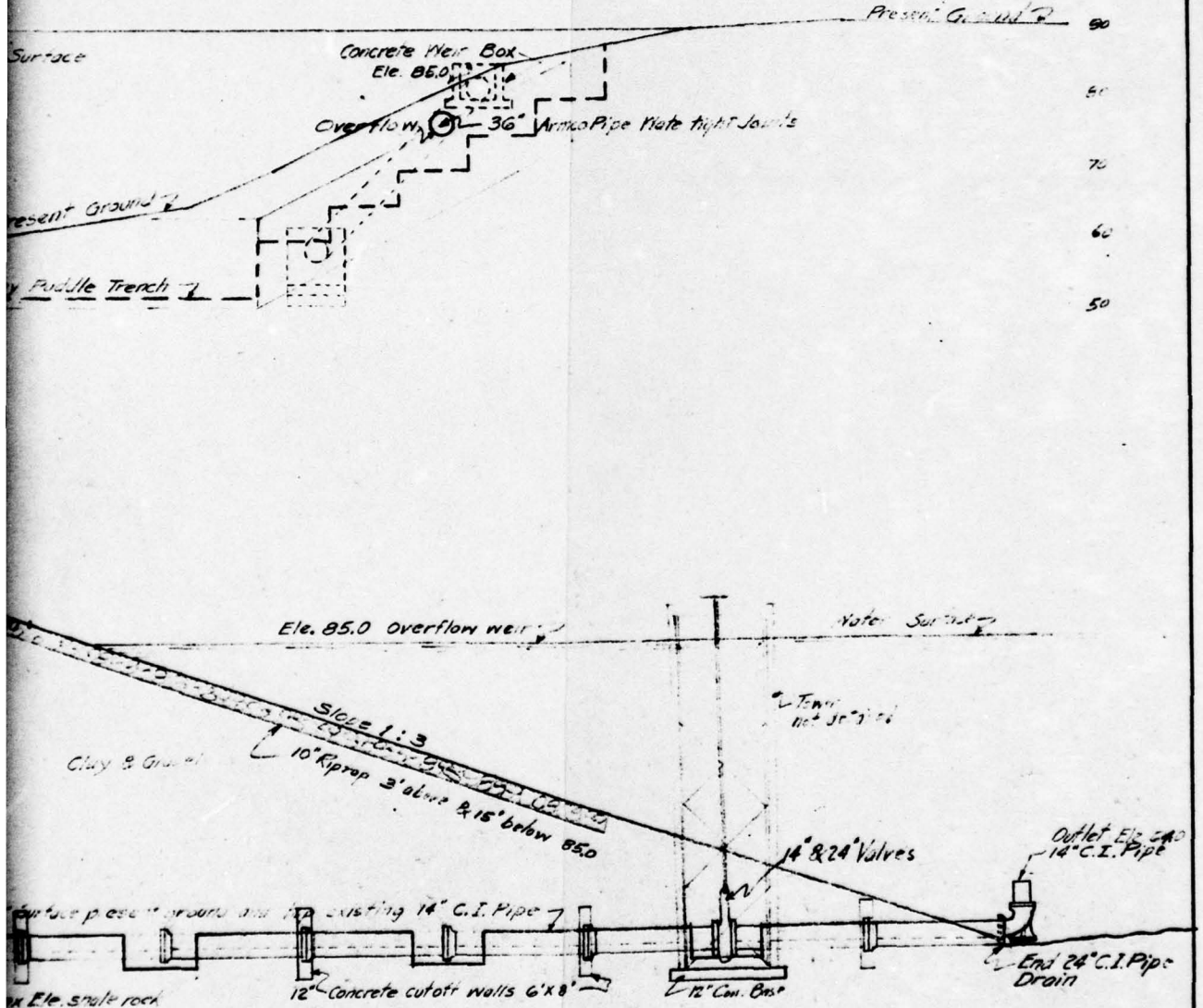
2



CROSS SECTION
ON CENTER OF
Scale 1" = 10'



CROSS SECTION
Scale 1"=6'



Note:
All Pipes to be encased in concrete 1:2:5 Mix thru dam

Note: Approx. Half Scale

PLATE 4

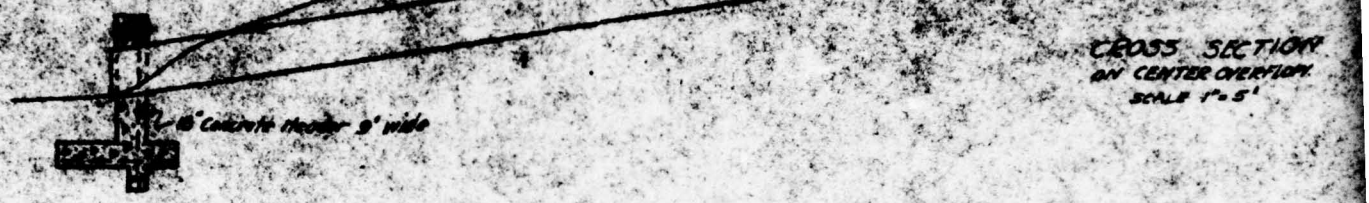
DETAILS

EARTH FILL DAM

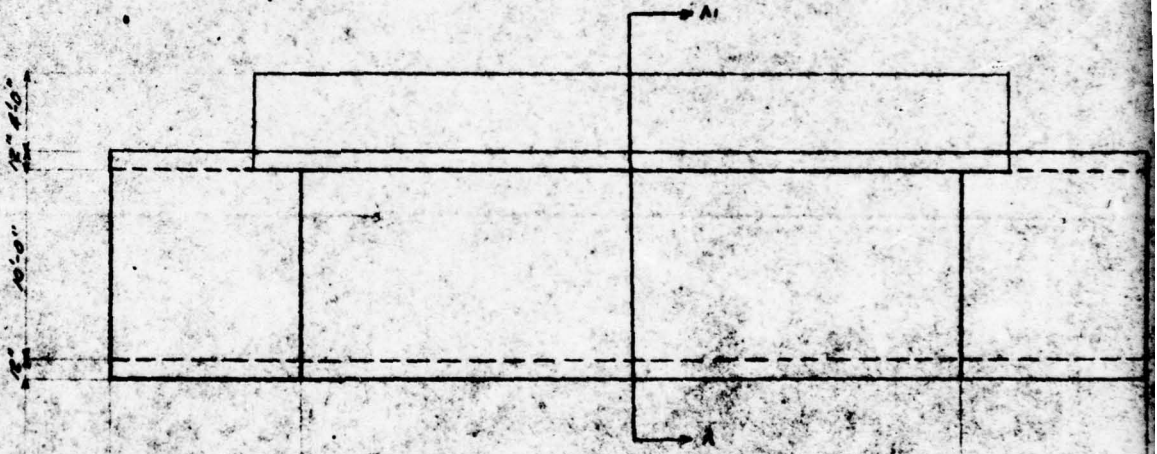
UNION CITY, ERIE CO. PA.

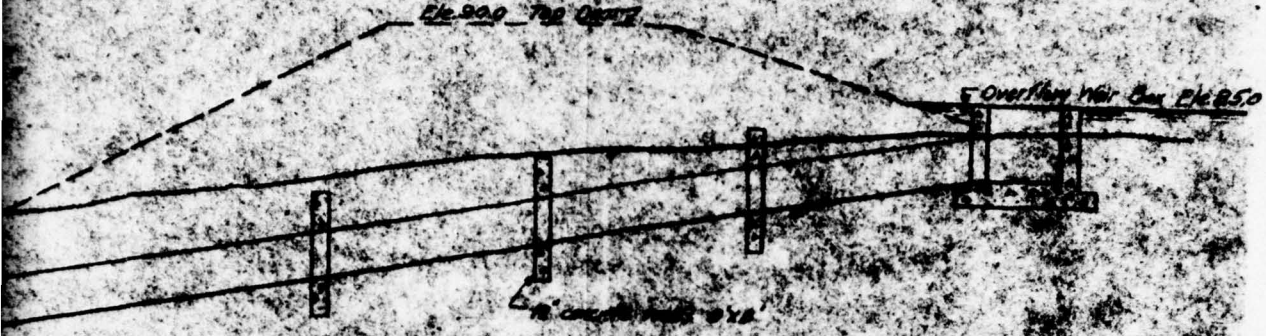
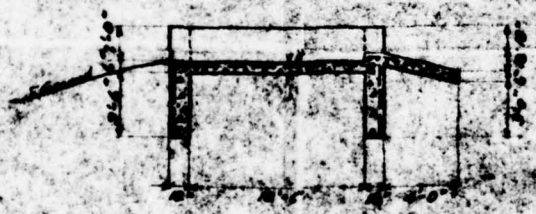
Scales as noted Mar, 1933

HILL & HILL
REGISTERED ENGINEERS



CROSS SECTION
ON CENTER OVERFLOW
SCALE 1"=5'



PLAN
AUXILARY SPILLWAY
Scale 1/8" = 1'



SECTION A-A.
AUXILIARY SPILLWAY

Note:-
Walls and paving reinforced with ½" ϕ bars, 12" ϕ both ways.

PLATE 5
DETAILS
EARTH FILL DAM
UNION [illegible] CO. PA.

APPENDIX A

CHECK LIST - VISUAL INSPECTION AND FIELD SKETCH

Check List
Visual Inspection
Phase 1

Name of Dam Union City Reservoir Dam County Erie State PA Coordinates Lat. N 41° 54.8'
NDI # PA 00019
PennDER # 25-3
Long. W 79° 48.9'

Date of Inspection 28 Nov. 1978 Weather Cold, Sunny Temperature 30°F.

Pool Elevation at Time of Inspection 1394.3 ft. M.S.L. Tailwater at Time of Inspection 1365.6 ft. M.S.L.

Datum was taken from USGS 7.5 minute quadrangle map. El. 1394.0 ft., the elevation of intake riser.

Inspection Personnel:

Michael Baker, Jr., Inc.:

James G. Ulinski
Rodney E. Holderbaum
David F. Johns

Owner's Representative
Borough of Union City:

Don Burmagin

David F. Johns Recorder

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS		
DRAINS		
WATER PASSAGES		
FOUNDATION		

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES		
STRUCTURAL CRACKING		
VERTICAL AND HORIZONTAL ALIGNMENT		
MONOLITH JOINTS		
CONSTRUCTION JOINTS		

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None were observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None were observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	1. Along the left wall of the outlet structure some erosion was noted, possibly due to piping or backwater.	1. The eroded area should be graded to its original configuration. Follow-up, periodic inspections should be made to determine the cause of the erosion. If the erosion is due to backwater, riprap should be placed. If the erosion is due to piping, an engineering study should be initiated without delay to determine the long-term effects and make recommendations as to possible solutions.
	2. Approximately 150 ft. from the right embankment and 10 ft. below the crest on the downstream slope a hole about 8 in. by 3 in. and at least 4 ft. deep was found (see field sketch). The hole appeared to be due to some species of burrowing animal.	2. The hole should be filled.
	3. Minor rutting along the crest has exposed the clay puddle core.	3. The ruts should be regraded and seeded to protect the crest and core from erosion. To prevent this problem in the future, vehicular traffic should be prohibited along the crest.

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	A row of trees is growing along the downstream edge of the crest. Several trees were also observed on the embankment above the toe and around the outlet pipe.	The trees should be removed from along the crest, the downstream slopes, and within 10 ft. of the toe.
RIPRAP FAULURES	None were observed.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Surface drainage was observed at both the left and right abutments of the downstream slope.	
ANY NOTICEABLE SEEPAGE	No seepage was noted.	
STAFF GAGE AND RECORDER	None installed	
DRAINS	None installed	

OUTLET WORKS

Name of Dam: UNION CITY RESERVOIR

NDI # PA 00019

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet conduit is cast-iron with some pitting and roughness at the exit.	
INTAKE STRUCTURE	The overflow weir was partially blocked by leaves and other minor debris.	The overflow should be kept clear of debris.
OUTLET STRUCTURE	Some minor spalling and cracking were noted on the head wall and wing walls of the 30-in. outlet pipe.	Repair as necessary.
OUTLET CHANNEL	The outlet channel is natural and fairly clear of debris and obstructions.	
EMERGENCY GATE	The blow-off pipe has a hand-operated gate valve located above the dam in the reservoir. This valve has not been operated for several years.	The operation of the gate valve should be part of routine maintenance to insure its proper operation if needed.

UNGATED SPILLWAY (Emergency Spillway)

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The original concrete weir that was installed when the dam was built has been covered over by an asphalt road. A 12-in. cast-iron pipe was installed beneath the road with the invert at the approximate elevation of the original weir.	
APPROACH CHANNEL	The approach channel is grass-lined with light tree cover along the banks. The side slopes were estimated at 1.5H:1V.	
DISCHARGE CHANNEL	The discharge channel is a natural wooded channel.	
BRIDGE AND PIERS	Not Applicable	

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

GATED SPILLWAY - Not Applicable

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL		
APPROACH CHANNEL		
DISCHARGE CHANNEL		
BRIDGE AND PIERS		
GATES AND OPERATION EQUIPMENT		

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None installed	
OBSERVATION WELLS	None installed	
WEIRS	A "V"-notch weir was mounted in front of the 24-in. diameter blow-off pipe.	
PIEZOMETERS	None installed	
OTHER		

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The slopes are mild to gently sloping and are covered with heavy woods and bush-like undergrowth.	
SEDIMENTATION	No excessive sedimentation was noted.	

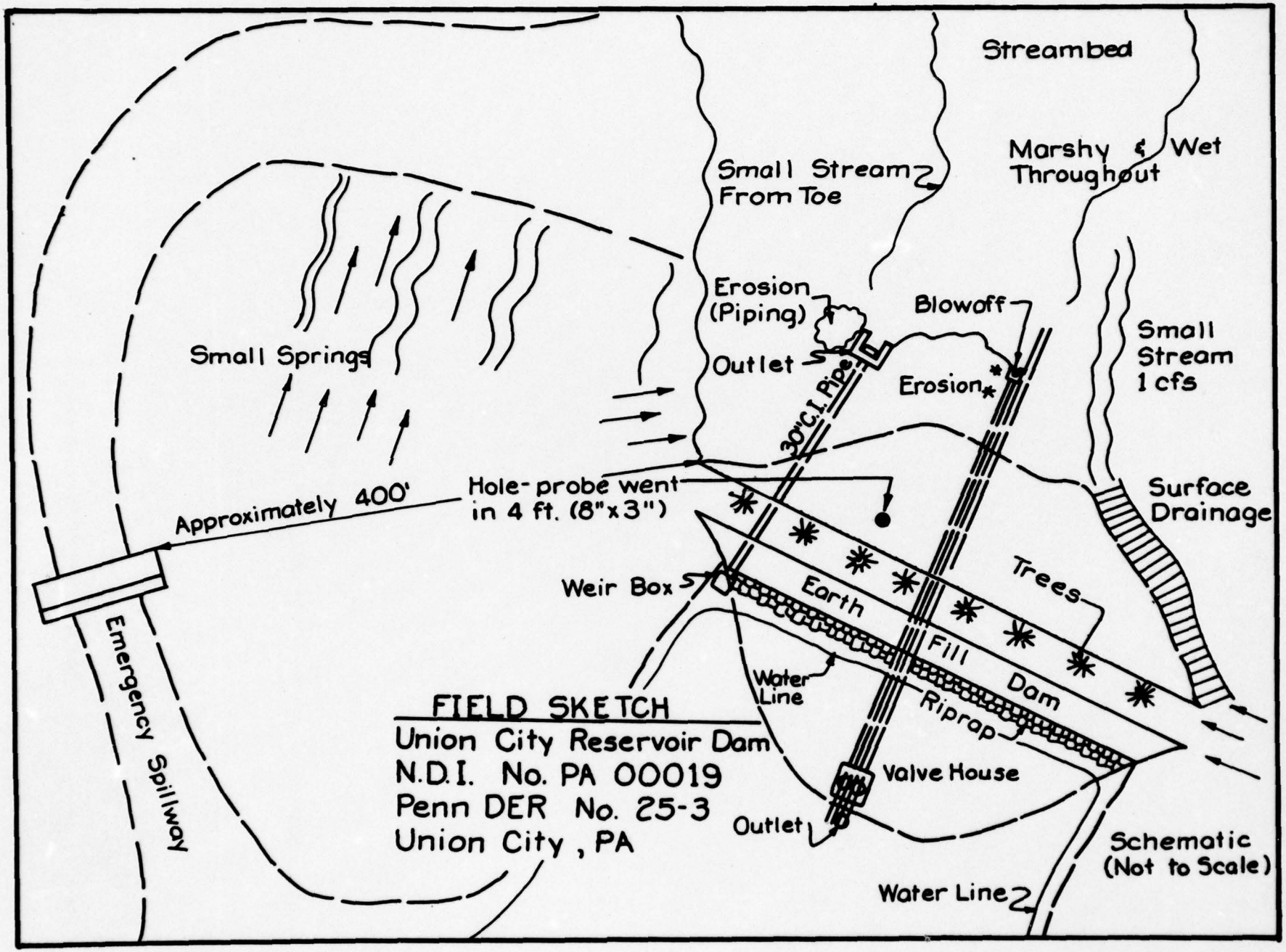
DOWNSTREAM CHANNEL

A-11

Name of Dam: UNION CITY RESERVOIR

NDI # PA 00019

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel is relatively free of debris and other obstructions.	
SLOPES	The slopes of the downstream channel (Bentley Run) from the reservoir to the Borough of Union City are moderate, avaraging approximately 1%.	
APPROXIMATE NO. OF HOMES AND POPULATION	A filtration point is located approximately 0.4 mile downstream from the dam. Approximately 10 to 15 homes are located along Bentley Run's 1.7 mile course to its mouth at the South Branch of French Creek.	


Streambed
Small Stream From Toe
Marshy & Wet Throughout
Erosion (Piping)
Blowoff
Outlet
Small Springs
30" C.I. Pipe
Erosion
Small Stream 1 cfs
Approximately 400'
Hole-probe went in 4 ft. (8"x3")
Surface Drainage
Weir Box
Earth Fill Dam
Trees
Water Line
Riprap
Emergency Spillway
Valve House
Outlet
Schematic (Not to Scale)
Water Line
FIELD SKETCH
Union City Reservoir Dam
N.D.I. No. PA 00019
Penn DER No. 25-3
Union City, PA

APPENDIX B

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

ITEM	REMARKS
PLAN OF DAM	See Plate 3, Dam Section and Plan.
REGIONAL VICINITY MAP	See Plate 1, a USGS 7.5 minute quadrangle map showing dam location with state location inset.
CONSTRUCTION HISTORY	The dam was designed by Hill and Hill Engineers of North East, Pennsylvania and was constructed as a Civil Works Administration (CWA) project from the Fall of 1933 to the Spring of 1935.
TYPICAL SECTIONS OF DAM	See Plates 4 and 5.
HYDROLOGIC/HYDRAULIC DATA	None available
OUTLETS - PLAN and DETAILS	See Plate 5.
- CONSTRAINTS	One 14-in. and one 24-in. intake to gate valve chamber in upstream toe of embankment. One 30-in. from concrete overflow weir box.
- DISCHARGE RATINGS	None available
RAINFALL/RESERVOIR RECORDS	None available

Name of Dam: UNION CITY RESERVOIR

NDI # PA 00019

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	No information available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	No information available
POST-CONSTRUCTION SURVEYS OF DAM	No information available
BORROW SOURCES	No information available

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

ITEM	REMARKS
MONITORING SYSTEMS	None installed
MODIFICATIONS	The 36-in. pipe from the overflow weir box developed several leaks and was repaired by placing a 30-in. pipe inside it and pressure grouting between the two to prevent further leakage. Also the concrete emergency spillway was covered over by an asphalt access road. It is unknown when these modifications were performed.
HIGH POOL RECORDS	No information available
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	No information available
MAINTENANCE OPERATION RECORDS	No records available

Name of Dam: UNION CITY RESERVOIR
NDI # PA 00019

ITEM	REMARKS
SPILLWAY PLAN, SECTIONS, and DETAILS	See Plate 4.
OPERATING EQUIPMENT PLANS & DETAILS	See Plate 5.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 2.4 sq.mi. (heavily wooded)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1394.0 ft. (320 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1399.2 ft. (580 ac.-ft.)

ELEVATION MAXIMUM DESIGH POOL: Unknown

ELEVATION TOP DAM: 1399.2 ft. (minimum elevation), 1399.5 ft. (average elevation)

CREST: Principal Spillway

a. Elevation 1394.0 ft.
b. Type Concrete weir box and 30 in. cast-iron conduit
c. Width 7.0 ft.
d. Length 7.0 ft.
e. Location Spillover At left end of embankment
f. Number and Type of Gates None

CREST: Emergency Spillway

a.
a. Elevation 1395.8 ft.
b. Type Asphalt road
c. Width 25 ft.
d. Length Approximately 800 ft.
e. Location Spillover Approximately 400 ft. from left end of embankment
f. Number and Type of Gates Not Applicable

OUTLET WORKS: 14-in. Water Supply Pipe, 24-in. Blow-off Pipe

a. Type 14-in. and 24-in. cast-iron, encased in concrete
b. Location Approximately 125 ft. from left embankment
c. Entrance inverts El. 1374.0 ft. (water supply), El. 1369.0 ft. (blow-off)
d. Exit inverts El. 1365.1 ft. (blow-off), El. 1366.1 (water supply)*
e. Emergency draindown facilities 24-inch blow-off pipe

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

*The exit invert for the water supply line was taken as the invert elevation at a point parallel to the blow-off pipe exit invert. In fact, the water supply line is a continuous pipe that runs to the Union City Water Treatment Plant.

APPENDIX C

PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam - View from Right Abutment

Photo 1 - View from Right Abutment
(Note Clay Puddle Core Exposed by Ruts along Top of Crest and Trees along Downstream Edge of Crest)

Photo 2 - View from Left Abutment

Photo 3 - View from Crest of Dam Looking Upstream Showing Top of Gate Valve House

Photo 4 - View of 24-inch Blow-off Pipe Showing "V"-Notch Weir

Photo 5 - View of Concrete Overflow Weir Box

Photo 6 - View of Outlet Pipe for Weir Box (Note Trees Growing Above Head Wall on Downstream Embankment)

Photo 7 - View of Outlet Head Wall (Note Erosion to Right of Wing Wall)

Photo 8 - View of Emergency Spillway Approach Channel

Photo 9 - View of 12-inch Low Flow Outlet Pipe Under Access Road Covering Emergency Spillway

Photo 10 - View from Top of Dam Looking Downstream

Note: Photographs were taken on 28 November 1978.

PHOTO 1. View from Right Abutment (Note Clay Puddle Core Exposed by Ruts along Top of Crest and Trees along Downstream Edge of Crest)

PHOTO 2. View from Left Abutment

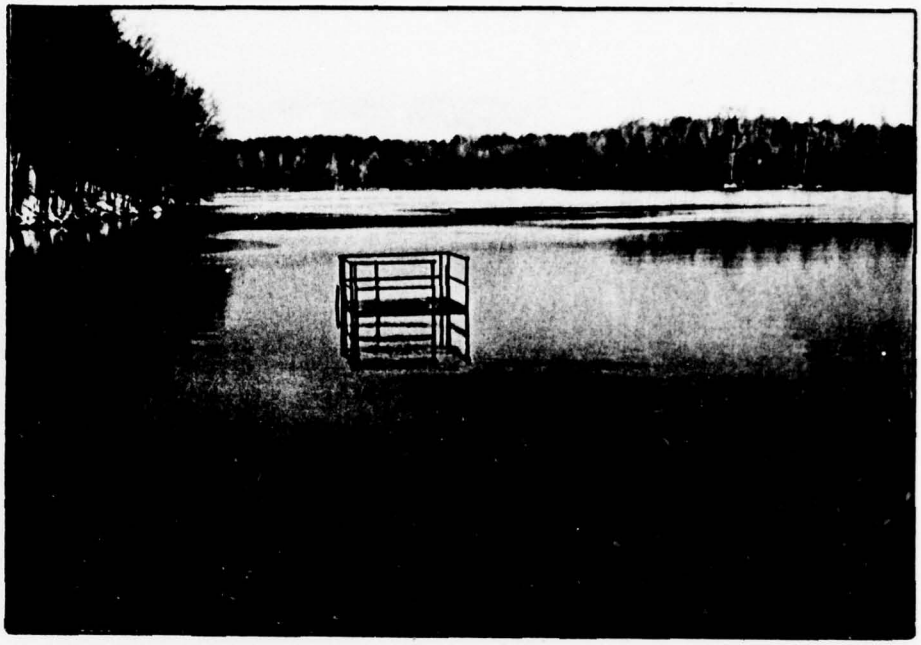


PHOTO 3. View from Crest of Dam Looking Upstream Showing Top of Gate Valve House

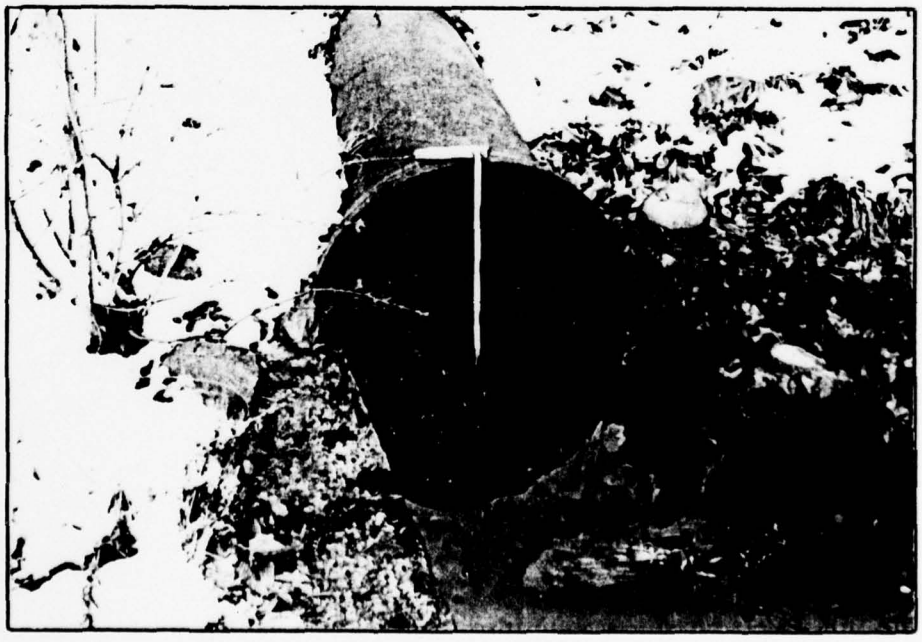


PHOTO 4. View of 24-inch Blow-off Pipe Showing "V" Notch Weir

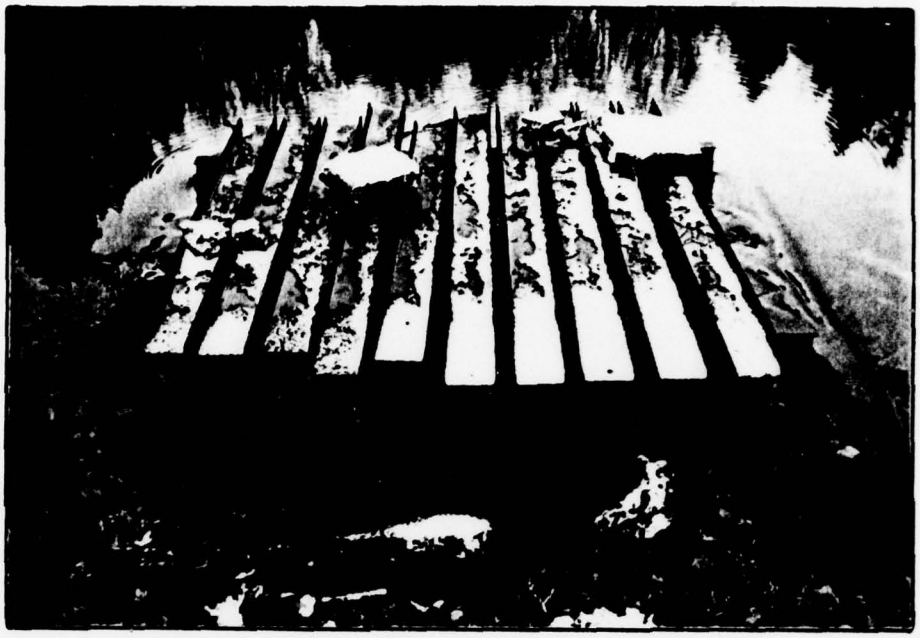


PHOTO 5. View of Concrete Overflow Weir Box

PHOTO 6. View of Outlet Pipe for Weir Box
(Note Trees Growing above Head Wall on Downstream Embankment)

PHOTO 7. View of Outlet Head Wall (Note Erosion to Right of Wing Wall)

PHOTO 8. View of Emergency Spillway Approach Channel

PHOTO 9. View of 12-inch Low Flow Outlet Pipe Under Access Road Covering Emergency Spillway

PHOTO 10. View from Top of Dam Looking Downstream

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Union City Reservoir S.O. No.

Sheet No. of

Drawing No.

Computed by Checked by Date

Table of Contents

Preface	i
Rainfall and Hydrograph Data	1
Watershed Plan	3
Principal Spillway Rating	4
Emergency Spillway Rating	6
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Flood Routing	14
Overtopping Potential	20
Dam Breach and Channel Routing Criteria	21
Map of Downstream Area	22
Dam Breach and Channel Routing Analysis	23

PREFACE

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed from coefficients determined by the Baltimore District of the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variation of watershed slopes, these coefficients may yield results of limited accuracy for this watershed. As directed, however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation and, therefore, must be addressed by the dam owner's engineering consultant during the detailed investigation as suggested in the "Assessment of General Conditions."

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS
Box 280
Beaver, Pa. 15009

Subject Union City Reservoir S.O. No.
RAINFALL AND HYDROGRAPH DATA Sheet No. 1 of 38
Drawing No.
Computed by REH Checked by 9.9.5. 8-10-79 Date 2-9-79

PMP (from H.R. - 33)

P_{24-200} = 23.0 inches (Zone 2)

P_6 = 117 % (P_{24-200})

P_{12} = 141 % (P_{24-200})

P_{24} = 141 % (P_{24-200})

P_{48} = 151 % (P_{24-200})

CDA = 2.4 sq. mi.)

Hazard and Size Classification

High hazard - small size - Evaluate for PMF since the dam is nearly intermediate in size (36 ft. high - 431 ac-ft.)

Unit Hydrograph Parameters

Sub-basin A: L = 11500 ft = 2.18 mi
L_{CA} = 4510 ft = 0.86 mi.

Sub-basin B: L = 15,010 ft = 2.48 mi.
L_{CA} = 5160 ft = 0.98 mi.

Area = 23 C_t = Plate 2 C_p = 0.55

$T_p = 3.3 (L L_{CA})^{0.3}$

T_p (A) = $3.3 (0.86 \times 2.18)^{0.3}$ = 3.98 hours

T_p (B) = $3.3 (0.98 \times 2.48)^{0.3}$ = 4.30 hours

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

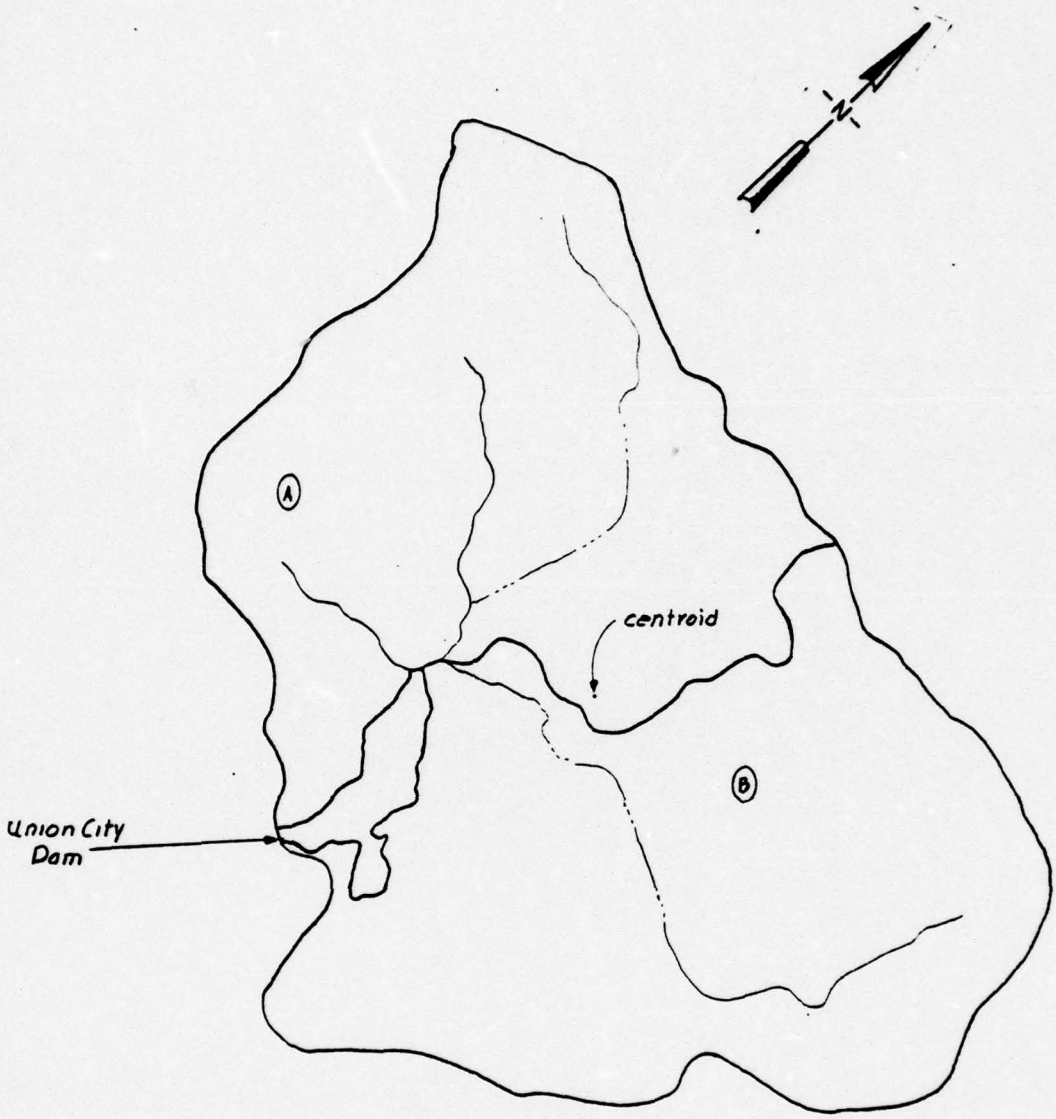
Box 280
Beaver, Pa. 15009

Subject Union City Reservoir — S.O. No.
Hydrograph Data — Sheet No. 2 of 38
Drawing No.
Computed by REH — Checked by G.G.S. 3-14-79 — Date

Adjustment to 15 min. duration:

$Tp(A) = 3.98 + 0.25\,(0.25 - 3.10/5.5) = 3.86$ hours

$Tp(B) = 4.30 + 0.25\,(0.25 - 4.30/5.5) = 4.11$ hours



Quad: Union City
A. Drainage Area = 1.10 mi.²
L = 2.18 mi. Lca = 0.86 mi.
B. Drainage Area = 1.31 mi.²
L = 2.48 mi. Lca = 0.98 mi.
Total Drainage Area = 2.41 mi.²

0 2000 4000
SCALE IN FEET

DATE: 3-29-79 q.g.s.

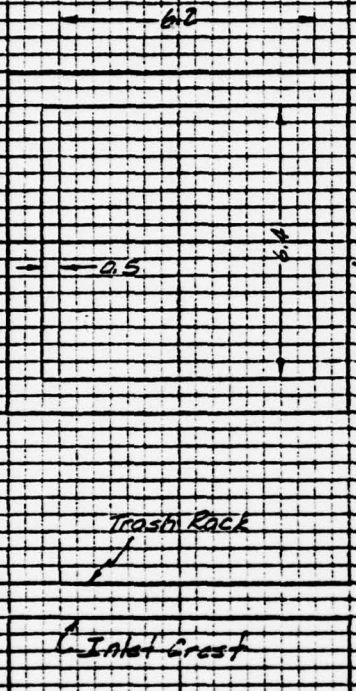
Bentley Creek Watershed
at
Union City Reservoir

MICHAEL BAKER JR. INC.
Consulting Engineers & Surveyors

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Union City Reservoir — S.O. No.
Principal Spillway Rating — Sheet No. 4 of 28
Drawing No.
Computed by REH — Checked by — Date 3-1-79



Orifice flow:

Total flow area = 6.2(2.0)(0.6) + 6.4(0.6) = 11.3 ft.²

$Q = CA\sqrt{2gh}$ (orifice flow)

h = total head

A = 11.3 ft.²

C = 0.65

g = 32.2 ft/sec.²

$Q = 0.65(11.3)\sqrt{32.2(2)}\ h^{1/2}$

$Q = 58.94\ h^{1/2}$ (datum = 1394.3 ft.)

Pipe Flow:

From Design of Small Dams - Figure B-10

L = 150 ft.

D = 30" C.I.P.

k_e = 0.2

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject UNION CITY RESERVOIR — S.O. No.
PRINCIPAL SPILLWAY RATING — Sheet No. 5 of 38
Drawing No.
Computed by REH — Checked by — Date 3-1-79

ELEV. (FEET)	H_o (FEET)	Q_o (CFS)	H_p (FEET)	Q_p (CFS)	Q_T (CFS)
1394.0					0
1395.0	0.7	49	27	122	49
1396.0	1.7	77	28	125	77
1397.0	2.7	97	29	128	97
1398.0	3.7	115	30	130	113
1399.0	4.7	128	31	132	125
1400.0	5.7	141	32	134	134
1401.0	6.7	153	33	137	147
1402.0	7.7	164	34	140	140

THIS RUN EXECUTED 02/19/79 11.00

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**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED  AUG1977
  ERROR CORR -  01,02
  MODIFICATION -  50,51,52,53, MRJ UPDATE MADE 16 JAN 5 PM
**************************************************

T1      UNION CITY RESERVOIR
T2      PENNSYLVANIA
T3      SPILLWAY RATING (EMERGENCY SPILLWAY)

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ
        0.      2.        0.        0.  -1.000000      0.0       0.0       0.        0.0       0.0

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE
    1.000       0.0    -1.000       0.0       0.0       0.0       0.0       0.0       0.0       0.0

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38.000    43.000     1.000     8.000    39.000    65.000    53.000    27.000    21.000    22.000

    28.000    54.000     4.000       0.0    38.000    39.000    42.000    33.000    40.000    41.000

     1.000    50.000    51.000    52.000     3.000    61.000    64.000       0.0       0.0       0.0

NC     0.045     0.045     0.045     0.100     0.300       0.0       0.0       0.0       0.0       0.0
QT     9.000   300.000   600.000   900.000  1200.000  1500.000  1800.000  2200.000  2600.000  3000.000

X1     1.000     7.000    25.000   320.000       0.0       0.0       0.0       0.0       0.0       0.0
GR  1404.000    25.000  1398.200    50.000  1396.400    80.000  1395.700   100.000  1395.900   120.000
GR  1397.500   150.000  1404.000   320.000       0.0       0.0       0.0       0.0       0.0       0.0

X1     2.000     6.000       0.0   247.000   115.000   115.000   115.000       0.0       0.0       0.0
GR  1404.000       0.0  1399.000    35.000  1394.100    53.000  1394.100    83.000  1399.000   102.000
GR  1404.000   247.000       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0

X1     3.000     7.000    25.000   325.000    50.000    50.000    50.000       0.0       0.0       0.0
GR  1404.000    25.000  1399.000    65.000  1394.500   100.000  1394.400   140.000  1394.300   180.000
GR  1399.000   235.000  1404.000   325.000       0.0       0.0       0.0       0.0       0.0       0.0

X1     4.000     7.000       0.0   430.000    85.000    85.000    85.000       0.0       0.0       0.0
GR  1404.000       0.0  1399.000    60.000  1390.000   170.000  1389.000   240.000  1393.000   310.000
GR  1399.000   365.000  1404.000   430.000       0.0       0.0       0.0       0.0       0.0       0.0

X1     5.000     8.000       0.0   485.000   100.000   100.000   100.000       0.0       0.0       0.0
GR  1404.000       0.0  1399.000    65.000  1389.000   180.000  1384.000   215.000  1384.000   348.000
GR  1389.000   385.000  1399.000   417.000  1404.000   485.000       0.0       0.0       0.0       0.0
EJ     0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
```

Sheet 6 of 38

THIS RUN EXECUTED 02/19/79 11.07

****

HEC2 RELEASE DATED NOV 76 UPDATED AUG1977
ERROR CORR - 01,02
MODIFICATION - 50,51,52,53, MBJ UPDATE MADE 16 JAN 5 PM

****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

SPILLWAY RATING

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	DEPTH	XLCH	CUM DIS	SSTA	STENCL	STCHL	STCHR	STENCR	ENDST	TOPWID
*	1.000	300.00	1397.01	1.31	0.0	0.0	69.88	0.0	25.00	320.00	0.0	140.76	70.88
*	1.000	600.00	1397.52	1.82	0.0	0.0	61.27	0.0	25.00	320.00	0.0	150.61	89.34
*	1.000	900.00	1397.92	2.22	0.0	0.0	54.68	0.0	25.00	320.00	0.0	160.96	106.29
*	1.000	1200.00	1398.23	2.53	0.0	0.0	49.85	0.0	25.00	320.00	0.0	169.18	119.33
*	1.000	1500.00	1398.49	2.79	0.0	0.0	48.73	0.0	25.00	320.00	0.0	175.99	127.26
*	1.000	1800.00	1398.73	3.03	0.0	0.0	47.72	0.0	25.00	320.00	0.0	182.16	134.45
*	1.000	2200.00	1399.01	3.31	0.0	0.0	46.49	0.0	25.00	320.00	0.0	189.61	143.12
*	1.000	2600.00	1399.28	3.58	0.0	0.0	45.36	0.0	25.00	320.00	0.0	196.43	151.06
*	1.000	3000.00	1399.51	3.81	0.0	0.0	44.35	0.0	25.00	320.00	0.0	202.58	158.22
	2.000	300.00	1397.70	3.60	115.00	115.00	39.76	0.0	0.0	247.00	0.0	96.98	57.22
	2.000	600.00	1398.50	4.40	115.00	115.00	36.81	0.0	0.0	247.00	0.0	100.09	63.28
	2.000	900.00	1399.08	4.98	115.00	115.00	34.43	0.0	0.0	247.00	0.0	104.38	69.95
	2.000	1200.00	1399.62	5.52	115.00	115.00	30.68	0.0	0.0	247.00	0.0	119.90	89.22
	2.000	1500.00	1400.04	5.94	115.00	115.00	27.76	0.0	0.0	247.00	0.0	131.99	104.23
	2.000	1800.00	1400.40	6.30	115.00	115.00	25.27	0.0	0.0	247.00	0.0	142.30	117.03
	2.000	2200.00	1400.80	6.70	115.00	115.00	22.43	0.0	0.0	247.00	0.0	154.06	131.63
	2.000	2600.00	1401.15	7.05	115.00	115.00	19.99	0.0	0.0	247.00	0.0	164.20	144.21
	2.000	3000.00	1401.46	7.36	115.00	115.00	17.80	0.0	0.0	247.00	0.0	173.25	155.44
	3.000	300.00	1397.77	3.47	50.00	165.00	74.56	0.0	25.00	325.00	0.0	220.62	146.06
	3.000	600.00	1398.65	4.35	50.00	165.00	67.72	0.0	25.00	325.00	0.0	230.91	163.19
	3.000	900.00	1399.32	5.02	50.00	165.00	62.48	0.0	25.00	325.00	0.0	240.68	178.20
	3.000	1200.00	1399.92	5.62	50.00	165.00	57.66	0.0	25.00	325.00	0.0	251.51	193.84
	3.000	1500.00	1400.40	6.10	50.00	165.00	53.80	0.0	25.00	325.00	0.0	260.19	206.39
	3.000	1800.00	1400.80	6.50	50.00	165.00	50.57	0.0	25.00	325.00	0.0	267.48	216.91
	3.000	2200.00	1401.27	6.97	50.00	165.00	46.87	0.0	25.00	325.00	0.0	275.79	228.92
	3.000	2600.00	1401.66	7.36	50.00	165.00	43.68	0.0	25.00	325.00	0.0	282.97	239.28
	3.000	3000.00	1402.02	7.72	50.00	165.00	40.84	0.0	25.00	325.00	0.0	289.37	248.53
	4.000	300.00	1397.78	8.78	85.00	250.00	74.89	0.0	0.0	430.00	0.0	353.83	278.95
	4.000	600.00	1398.67	9.67	85.00	250.00	63.99	0.0	0.0	430.00	0.0	362.01	298.02
	4.000	900.00	1399.35	10.35	85.00	250.00	55.80	0.0	0.0	430.00	0.0	369.55	313.76
	4.000	1200.00	1399.96	10.96	85.00	250.00	48.47	0.0	0.0	430.00	0.0	377.50	329.03
	4.000	1500.00	1400.45	11.45	85.00	250.00	42.57	0.0	0.0	430.00	0.0	383.89	341.32
	4.000	1800.00	1400.87	11.87	85.00	250.00	37.59	0.0	0.0	430.00	0.0	389.28	351.69
	4.000	2200.00	1401.34	12.34	85.00	250.00	31.90	0.0	0.0	430.00	0.0	395.44	363.53
	4.000	2600.00	1401.75	12.75	85.00	250.00	26.97	0.0	0.0	430.00	0.0	400.78	373.82
	4.000	3000.00	1402.12	13.12	85.00	250.00	22.55	0.0	0.0	430.00	0.0	405.57	383.02

Sheet 7 of 38

SECNO	Q	CWSEL	DEPTH	XLCH	CUM DIS	SSTA	STENCL	STCHL	STCHR	STEMCR	ENDST	TOPWID
5.000	300.00	1397.78	13.78	100.00	350.00	78.91	0.0	0.0	485.00	0.0	413.13	334.21
5.000	600.00	1398.68	14.68	100.00	350.00	68.66	0.0	0.0	485.00	0.0	415.98	347.32
5.000	900.00	1399.35	15.35	100.00	350.00	60.31	0.0	0.0	485.00	0.0	421.90	361.59
5.000	1200.00	1399.97	15.97	100.00	350.00	52.34	0.0	0.0	485.00	0.0	430.24	377.90
5.000	1500.00	1400.46	16.46	100.00	350.00	45.92	0.0	0.0	485.00	0.0	436.96	391.05
5.000	1800.00	1400.87	16.87	100.00	350.00	40.50	0.0	0.0	485.00	0.0	442.63	402.13
5.000	2200.00	1401.35	17.35	100.00	350.00	34.44	0.0	0.0	485.00	0.0	448.97	414.53
5.000	2600.00	1401.76	17.76	100.00	350.00	29.07	0.0	0.0	485.00	0.0	454.59	425.52
5.000	3000.00	1402.13	18.13	100.00	350.00	24.25	0.0	0.0	485.00	0.0	459.63	435.37

SPILLWAY RATING

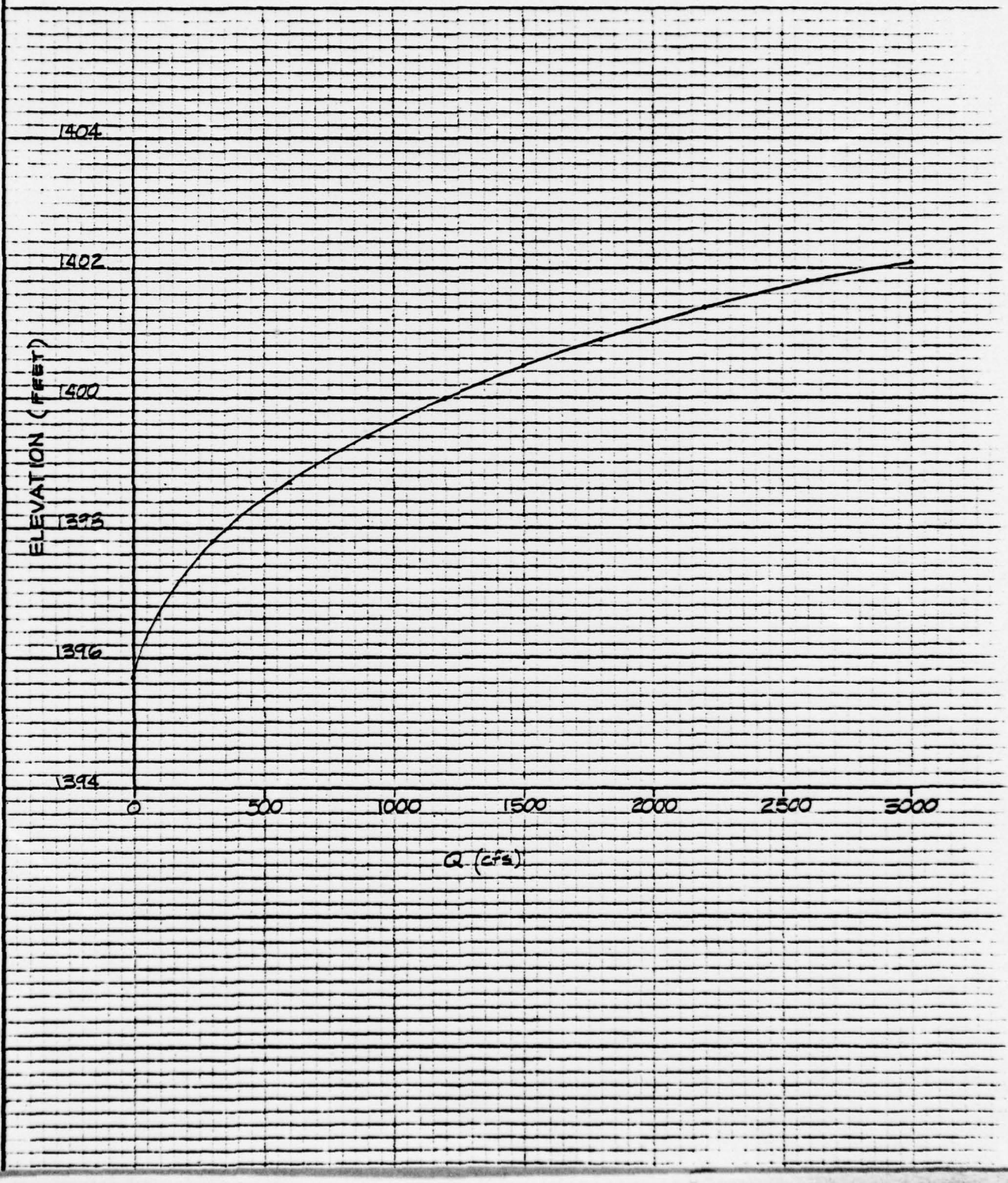
SUMMARY PRINTOUT

	SECNO	XLCH	ELMIN	K*CHSL	ELTRD	ELLC	CWSEL	DIFWSP	DIFWSX	DIFKWS	EG	DIFEG	INPUT ET
*	1.000	0.0	1395.70	0.0	0.0	0.0	1397.01	0.0	0.0	0.0	1397.42	0.0	0.0
*	1.000	0.0	1395.70	0.0	0.0	0.0	1397.52	0.52	0.0	0.0	1398.09	0.67	0.0
*	1.000	0.0	1395.70	0.0	0.0	0.0	1397.92	0.40	0.0	0.0	1398.58	1.16	0.0
*	1.000	0.0	1395.70	0.0	0.0	0.0	1398.23	0.31	0.0	0.0	1398.98	1.55	0.0
*	1.000	0.0	1395.70	0.0	0.0	0.0	1398.49	0.26	0.0	0.0	1399.32	1.90	0.0
*	1.000	0.0	1395.70	0.0	0.0	0.0	1398.73	0.24	0.0	0.0	1399.63	2.21	0.0
*	1.000	0.0	1395.70	0.0	0.0	0.0	1399.01	0.28	0.0	0.0	1400.00	2.58	0.0
*	1.000	0.0	1395.70	0.0	0.0	0.0	1399.28	0.26	0.0	0.0	1400.34	2.91	0.0
*	1.000	0.0	1395.70	0.0	0.0	0.0	1399.51	0.24	0.0	0.0	1400.65	3.22	0.0
	2.000	115.00	1394.10	-13.91	0.0	0.0	1397.70	0.0	0.70	0.0	1397.76	0.0	0.0
	2.000	115.00	1394.10	-13.91	0.0	0.0	1398.50	0.80	0.98	0.0	1398.63	0.87	0.0
	2.000	115.00	1394.10	-13.91	0.0	0.0	1399.08	0.58	1.16	0.0	1399.29	1.53	0.0
	2.000	115.00	1394.10	-13.91	0.0	0.0	1399.62	0.54	1.38	0.0	1399.89	2.13	0.0
	2.000	115.00	1394.10	-13.91	0.0	0.0	1400.04	0.43	1.55	0.0	1400.37	2.61	0.0
	2.000	115.00	1394.10	-13.91	0.0	0.0	1400.40	0.36	1.67	0.0	1400.77	3.01	0.0
	2.000	115.00	1394.10	-13.91	0.0	0.0	1400.80	0.40	1.79	0.0	1401.24	3.47	0.0
	2.000	115.00	1394.10	-13.91	0.0	0.0	1401.15	0.35	1.87	0.0	1401.64	3.87	0.0
	2.000	115.00	1394.10	-13.91	0.0	0.0	1401.46	0.31	1.95	0.0	1401.99	4.23	0.0
	3.000	50.00	1394.30	4.00	0.0	0.0	1397.77	0.0	0.07	0.0	1397.78	0.0	0.0
	3.000	50.00	1394.30	4.00	0.0	0.0	1398.65	0.88	0.15	0.0	1398.67	0.89	0.0
	3.000	50.00	1394.30	4.00	0.0	0.0	1399.32	0.66	0.24	0.0	1399.35	1.57	0.0
	3.000	50.00	1394.30	4.00	0.0	0.0	1399.92	0.60	0.30	0.0	1399.96	2.18	0.0
	3.000	50.00	1394.30	4.00	0.0	0.0	1400.40	0.48	0.36	0.0	1400.45	2.67	0.0
	3.000	50.00	1394.30	4.00	0.0	0.0	1400.80	0.41	0.41	0.0	1400.86	3.08	0.0
	3.000	50.00	1394.30	4.00	0.0	0.0	1401.27	0.46	0.46	0.0	1401.34	3.56	0.0
	3.000	50.00	1394.30	4.00	0.0	0.0	1401.66	0.40	0.52	0.0	1401.75	3.97	0.0
	3.000	50.00	1394.30	4.00	0.0	0.0	1402.02	0.36	0.56	0.0	1402.12	4.34	0.0
	4.000	85.00	1389.00	-62.35	0.0	0.0	1397.78	0.0	0.01	0.0	1397.78	0.0	0.0
	4.000	85.00	1389.00	-62.35	0.0	0.0	1398.67	0.89	0.02	0.0	1398.68	0.89	0.0
	4.000	85.00	1389.00	-62.35	0.0	0.0	1399.35	0.68	0.03	0.0	1399.35	1.57	0.0
	4.000	85.00	1389.00	-62.35	0.0	0.0	1399.96	0.61	0.04	0.0	1399.97	2.18	0.0
	4.000	85.00	1389.00	-62.35	0.0	0.0	1400.45	0.49	0.05	0.0	1400.46	2.68	0.0
	4.000	85.00	1389.00	-62.35	0.0	0.0	1400.87	0.41	0.06	0.0	1400.88	3.09	0.0
	4.000	85.00	1389.00	-62.35	0.0	0.0	1401.34	0.47	0.08	0.0	1401.35	3.57	0.0
	4.000	85.00	1389.00	-62.35	0.0	0.0	1401.75	0.41	0.09	0.0	1401.77	3.98	0.0
	4.000	85.00	1389.00	-62.35	0.0	0.0	1402.12	0.37	0.10	0.0	1402.14	4.35	0.0
	5.000	100.00	1384.00	-50.00	0.0	0.0	1397.78	0.0	0.00	0.0	1397.78	0.0	0.0
	5.000	100.00	1384.00	-50.00	0.0	0.0	1398.68	0.89	0.00	0.0	1398.68	0.89	0.0
	5.000	100.00	1384.00	-50.00	0.0	0.0	1399.35	0.68	0.00	0.0	1399.35	1.57	0.0
	5.000	100.00	1384.00	-50.00	0.0	0.0	1399.97	0.61	0.00	0.0	1399.97	2.18	0.0
	5.000	100.00	1384.00	-50.00	0.0	0.0	1400.46	0.49	0.01	0.0	1400.46	2.68	0.0
	5.000	100.00	1384.00	-50.00	0.0	0.0	1400.87	0.42	0.01	0.0	1400.88	3.09	0.0
	5.000	100.00	1384.00	-50.00	0.0	0.0	1401.35	0.48	0.01	0.0	1401.35	3.57	0.0
	5.000	100.00	1384.00	-50.00	0.0	0.0	1401.76	0.41	0.01	0.0	1401.77	3.99	0.0
	5.000	100.00	1384.00	-50.00	0.0	0.0	1402.13	0.37	0.01	0.0	1402.14	4.36	0.0

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject UNION CITY RESERVOIR S.O. No.
EMERGENCY SPILLWAY RATING Sheet No. 10 of 38
Drawing No.
Computed by SCB Checked by REH Date 2-19-79



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

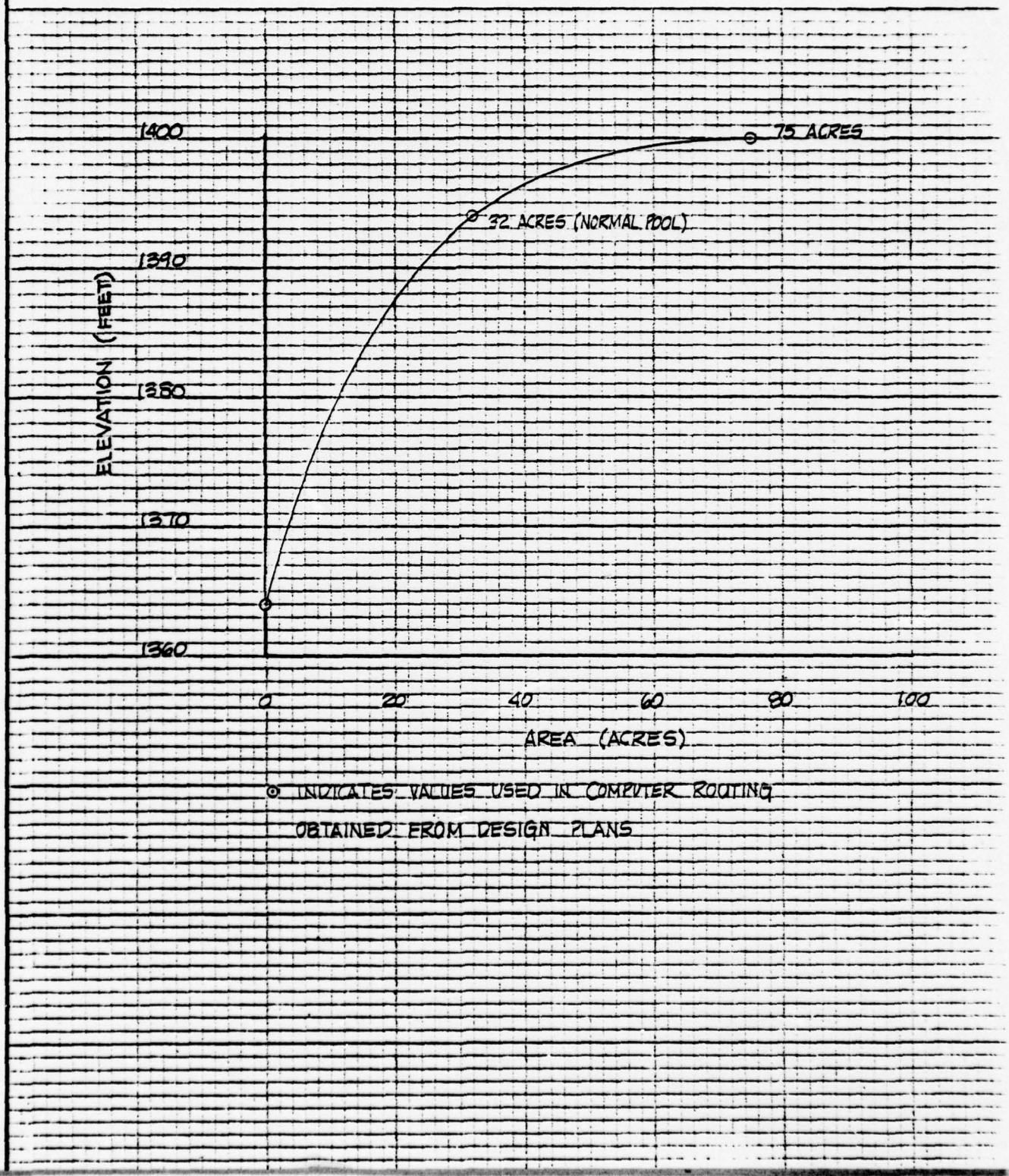
Subject UNION CITY RESERVOIR S.O. No.
STAGE VS. DISCHARGE Sheet No. 11 of 38
Drawing No.
Computed by SCB Checked by REH Date 2-19-79

ELEV. (FEET)	P.S. Q_T (cfs)	E.M.S. Q (cfs)	TOTAL (cfs)
1394.	0	0	0
1395	49	0	49
1396	77	25	102
1397	97	150	247
1398	113	360	473
1399	128	725	853
1400	134	1200	1334
1401	137	1875	2012
1402	140	2850	2990

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject UNION CITY RESERVOIR S.O. No.
STAGE VS. AREA Sheet No. 12 of 38
Drawing No.
Computed by SCB Checked by REH Date 2-15-79



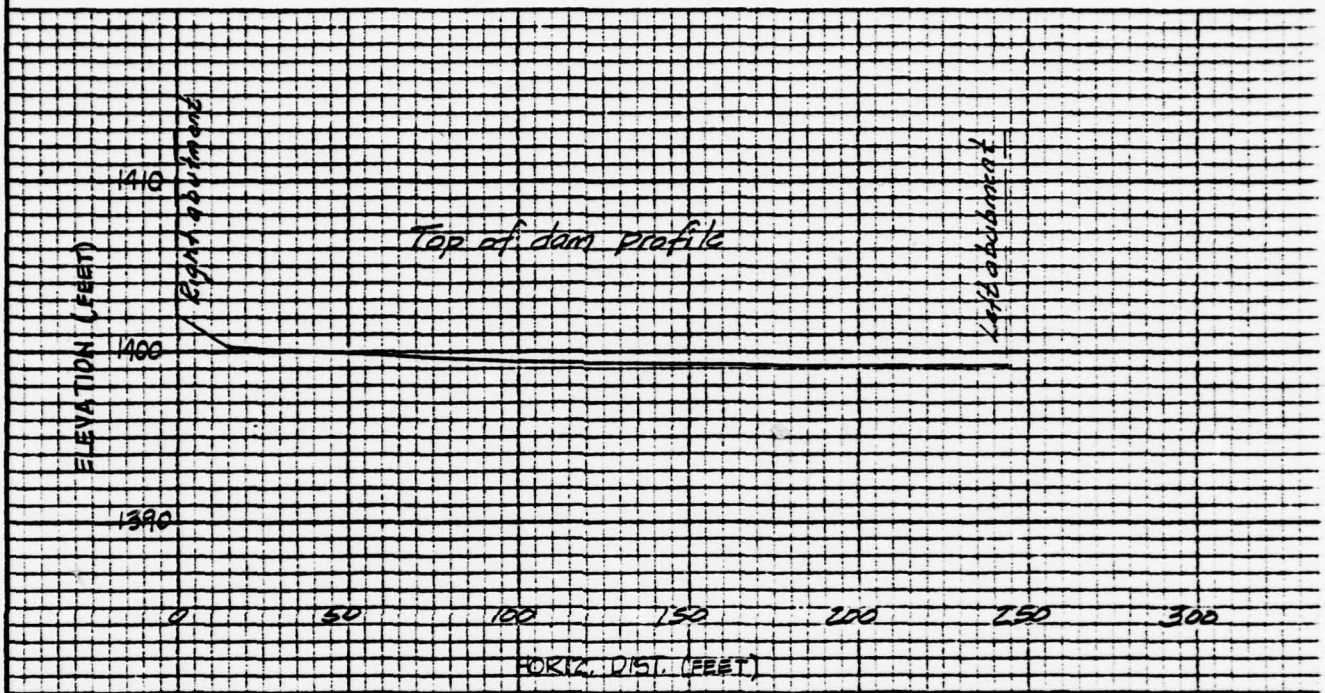
⊙ INDICATES VALUES USED IN COMPUTER ROUTING

OBTAINED FROM DESIGN PLANS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Union City Reservoir S.O. No.
TOP OF DAM PROFILE Sheet No. 13 of 38
Drawing No.
Computed by REH Checked by Date



Elev average Top of Dam = 1399.5 ft.
Elev minimum top of Dam = 1399.2 ft.
Length of dam = 244 ft.
Weir coefficient = 2.65

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  25 SEP 78
**********
     1                A1       NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
     2                A2       HYDROLOGIC AND HYDRAULIC ANALYSIS OF UNION CITY RES. MBJ  07
     3                A3       PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD
     4                B    300       0       15        0        0        0        0        0       -4        0
     5                B1     5
     6                J      1       4        1
     7                J1   1.0     0.5     0.4      0.3
     8                K          TRIB-A                                            1
     9                K1       INFLOW HYDROGRAPH FROM TRIBUTARY A
    10                M      1       1     1.10                2.41                                        1
    11                P              23      117      127      141      151
    12                T                                                        1.0     .05
    13                W   3.86     .55
    14                X   -1.5   -0.05      2.0
    15                K          TRIB-B                                            1
    16                K1       INFLOW HYDROGRAPH FROM TRIBUTARY B
    17                M      1       1     1.31                2.41                                        1
    18                P              23      117      127      141      151
    19                T                                                        1.0     .05
    20                W   4.17     .55
    21                X   -1.5   -0.05      2.0
    22                K      2   LAKE                                              1
    23                K1       COMBINE THE TWO TRIBUTARIES FOR ROUTING THROUGH THE DAM
    24                K      1    SPWY                                             1
    25                K1       ROUTING OF THE COMBINED FLOWS
    26                Y                                        1        1
    27                Y1     1                                                -1394      -1
    28                Y4  1394    1395     1396     1397     1398     1399     1400     1401     1402
    29                Y5     0      49      102      247      473      853     1334     2012     2990
    30                $A     0      32     75.0
    31                $E1364.0    1394     1400
    32                $$  1394
    33                $D1399.5    2.65      1.5      244
    34                K     99
```

SHEET 14 OF 38

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 25 SEP 78
****

RUN DATE 05/18/79
TIME 07.25

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF UNION CITY RES. MBJ 07
PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= 1.00 0.50 0.40 0.30

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FROM TRIBUTARY A

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
TRIB-A		0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.10	0.0	2.41	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.00	117.00	127.00	141.00	151.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.05	0.0	0.0

UNIT HYDROGRAPH DATA
TP= 3.86 CP=0.55 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 3.88 HOURS, CP= 0.55 VOL= 0.99

2.	6.	12.	20.	29.	38.	48.	58.	68.	78.
86.	93.	98.	102.	104.	104.	102.	97.	92.	87.
82.	78.	73.	69.	66.	62.	59.	56.	53.	50.
47.	44.	42.	40.	38.	36.	34.	32.	30.	29.
27.	26.	24.	23.	22.	20.	19.	18.	17.	16.
15.	15.	14.	13.	13.	12.	11.	10.	10.	9.

SHEET 15 OF 28

9.	8.	8.	8.	7.	7.	6.	6.	6.	5.
5.	5.	5.	4.	4.	4.	4.	3.	3.	3.
3.	3.	3.	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	1.	1.	1.	1.	1.	1.	1.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	27.78	25.35	2.43	71707.
										(706.)	(644.)	(62.)	(2030.52)

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FROM TRIBUTARY 8

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
TRIB-8	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.31	0.0	2.41	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.00	117.00	127.00	141.00	151.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.05	0.0	0.0

UNIT HYDROGRAPH DATA

TP= 4.17 CP=0.55 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 4.20 HOURS, CP= 0.55 VOL= 0.99

2.	6.	12.	20.	28.	37.	47.	57.	68.	78.
88.	96.	102.	108.	112.	114.	115.	114.	109.	104.
99.	94.	89.	84.	80.	76.	72.	69.	65.	62.
59.	56.	53.	50.	48.	46.	43.	41.	39.	37.
35.	33.	32.	30.	29.	27.	26.	25.	23.	22.
21.	20.	19.	18.	17.	16.	15.	15.	14.	13.
13.	12.	11.	11.	10.	10.	9.	9.	8.	8.
7.	7.	7.	6.	6.	6.	6.	5.	5.	5.
4.	4.	4.	4.	4.	3.	3.	3.	3.	3.
3.	3.	2.	2.	2.	2.	2.	2.	2.	2.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	27.78	25.35	2.43	85199.
										(706.)	(644.)	(62.)	(2412.57)

********** ********** ********** ********** **********

SHEET 16 OF 38

COMBINE THE TWO TRIBUTARIES FOR ROUTING THROUGH THE DAM

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	LAKE	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING OF THE COMBINED FLOWS

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	SPWY	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	-1394.	-1

STAGE	1394.00	1395.00	1396.00	1397.00	1398.00	1399.00	1400.00	1401.00	1402.00
FLOW	0.0	49.00	102.00	247.00	473.00	853.00	1334.00	2012.00	2990.00
SURFACE AREA=	0.	32.	75.						
CAPACITY=	0.	320.	632.						
ELEVATION=	1364.	1394.	1400.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1394.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1399.5	2.6	1.5	244.

PEAK OUTFLOW IS 3902. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 1871. AT TIME 44.50 HOURS

PEAK OUTFLOW IS 1412. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 973. AT TIME 45.50 HOURS

********** ********** ********** ********** **********

SHEET 17 OF 38

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 0.50	RATIO 3 0.40	RATIO 4 0.30
HYDROGRAPH AT	TRIB-A	1.10	1	1868.	934.	747.	560.
		(2.85)		(52.89)(	26.44)(	21.15)(	15.87)(
HYDROGRAPH AT	TRIB-B	1.31	1	2109.	1055.	844.	633.
		(3.39)		(59.72)(	29.86)(	23.89)(	17.92)(
2 COMBINED	LAKE	2.41	1	3969.	1985.	1588.	1191.
		(6.24)		(112.40)(	56.20)(	44.96)(	33.72)(
ROUTED TO	SPWY	2.41	1	3902.	1871.	1412.	973.
		(6.24)		(110.48)(	52.99)(	39.97)(	27.54)(

SHEET 18 OF 28

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	AVERAGE TOP OF DAM	MINIMUM TOP OF DAM
ELEVATION	1394.00	1394.00	1399.50	1399.2
STORAGE	320.	320.	596.	
OUTFLOW	0.	0.	1094.	

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	AVERAGE ~~MAXIMUM~~ DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1401.27	2.07	734.	3902.	11.50	44.00	0.0
0.50	1400.22	1.02	648.	1871.	4.00	44.50	0.0
0.40	1399.86	0.66	622.	1412.	4.00	45.00	0.0
0.30	1399.25	0.0	578.	973.	0.0	45.50	0.0

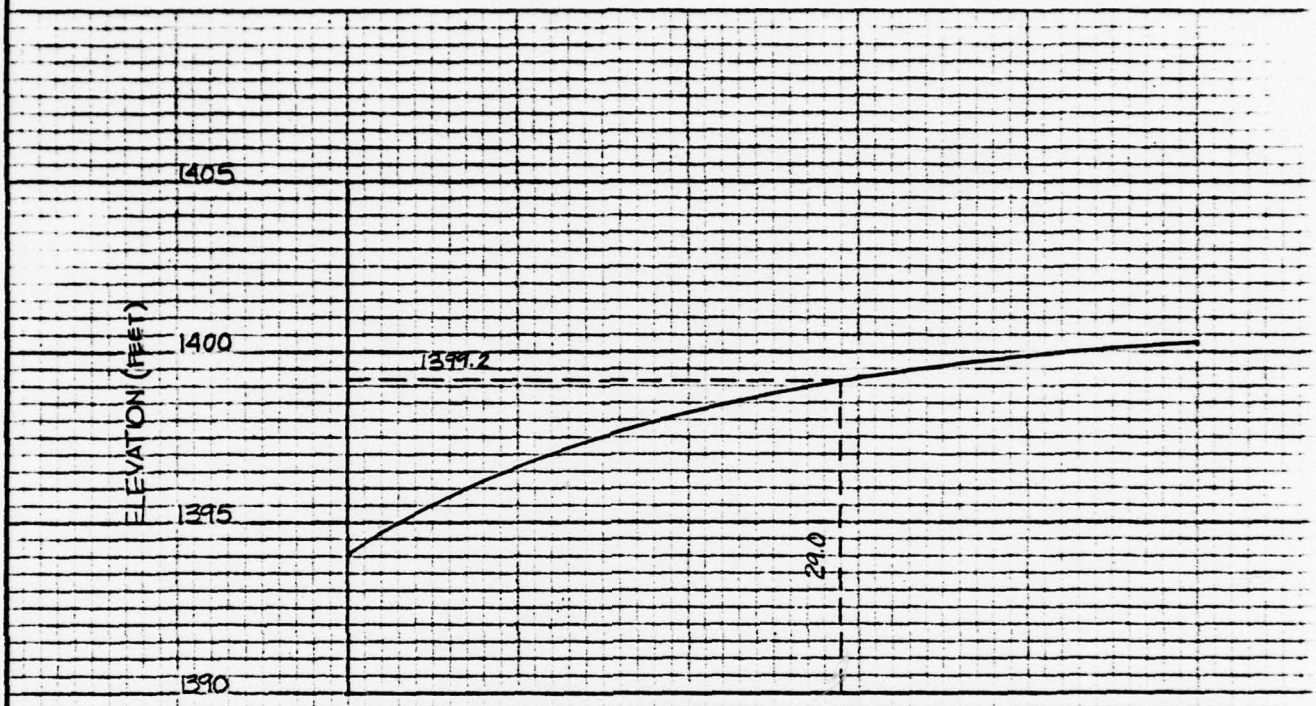
SHEET 19 OF 38

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject UNION CITY RESERVOIR
OVERTOPPING POTENTIAL

S.O. No.
Sheet No. 20 of 38
Drawing No.
Computed by SCB Checked by Date 3-14-79



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Union City Dam S.O. No.
Dam Breach and Channel Routing Criteria Sheet No. 21 of 38
Drawing No.
Computed by REH Checked by Date

Dam Breach Data

Three plans were considered in the dam breach analysis.

1. No failure of the dam
2. Total failure of the dam in 1 hour
3. Total failure of the dam in 2 hours

Other Parameters used in the analysis:

Breach width = 50 ft.

Breach Shape = trapezoidal

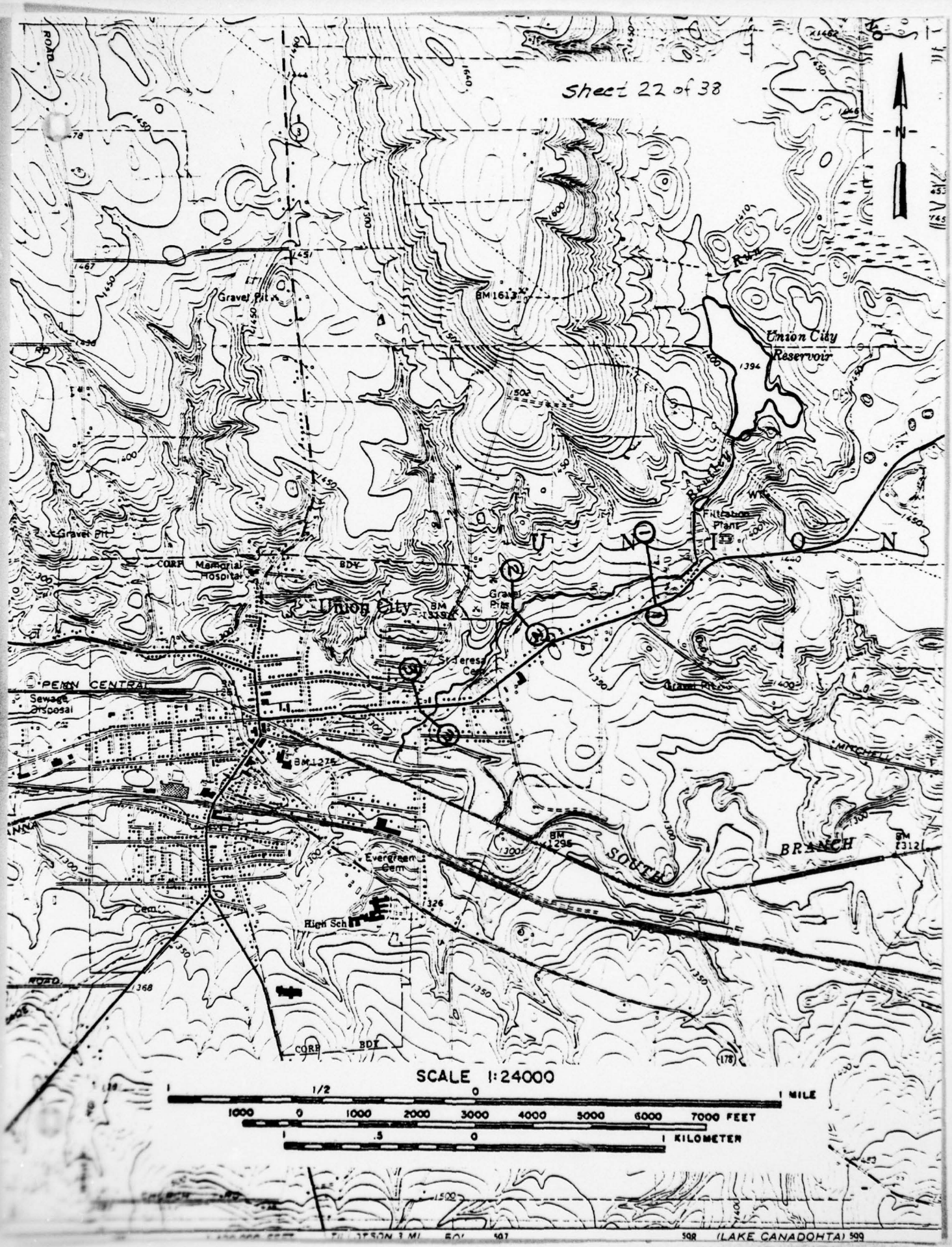
Side slope of breach = 1:1

Failure elevation = water surface elevation one foot above dam crest

Elevation breach bottom = 1364.0 feet.

Channel Routing Data

The location of cross-sections used in the routing analysis are shown on the following page.


Gravel Pit
BM 1613
Union City
Reservoir
Filtration Plant
Gravel Pit
CORP
Memorial Hospital
BDY
Union City
BM 1334
Gravel Pit
St Teresa Cem
PENN CENTRAL
Sewage Disposal
BM 1276
Evergreen Cem
Cem
High Sch
BM 1295
SOUTH
BRANCH
BM 1312
MITCHELL
ROAD
1368
CORP
BDY
SCALE 1:24000
1/2
0
1 MILE
1000
0
1000
2000
3000
4000
5000
6000
7000 FEET
.5
0
1 KILOMETER
(LAKE CANADOHTA)

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  25 SEP 78
**********
    1              A1       NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
    2              A2       HYDROLOGIC AND HYDRAULIC ANALYSIS OF UNION CITY RES. MBJ  07
    3              A3       PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD
    4              B    300       0      15       0       0       0       0       0      -4       0
    5              B1     5
    6              J      3       1       1
    7              J1   0.5
    8              K                TRIB-A                                         1
    9              K1       INFLOW HYDROGRAPH FROM TRIBUTARY A
   10              M      1       1    1.10            2.41                                      1
   11              P             23     117     127     141     151
   12              T                                                      1.0     .05
   13              W   3.86     .55
   14              X   -1.5   -0.05     2.0
   15              K                TRIB-B                                         1
   16              K1       INFLOW HYDROGRAPH FROM TRIBUTARY B
   17              M      1       1    1.31            2.41                                      1
   18              P             23     117     127     141     151
   19              T                                                      1.0     .05
   20              W   4.17     .55
   21              X   -1.5   -0.05     2.0
   22              K      2   LAKE                                               1
   23              K1       COMBINE THE TWO TRIBUTARIES FOR ROUTING THROUGH THE DAM
   24              K      1   SPWY                                               1
   25              K1       ROUTING OF THE COMBINED FLOWS
   26              Y                                1       1
   27              Y1     1                                                -1394      -1
   28              Y4  1394    1395    1396    1397    1398    1399    1400    1401    1402
   29              Y5     0      49     102     247     473     853    1334    2012    2990
   30              $A     0      32    75.0
   31              $E1364.0    1394    1400
   32              $$  1394
   33              $D1399.5    2.65     1.5     244
   34              $B    50       1    1364       1    1394    1410
   35              $B    50       1    1364       1    1394  1400.1
   36              $B    50       1    1364       2    1394  1400.1
   37              K      1       1                                               1
   38              K1       CHANNEL ROUTING MOD PULS REACH NO.1
   39              Y                                1       1
   40              Y1     1
   41              Y6  0.09    0.04    0.09    1330    1342    3070    .012
   42              Y7     0    1350     175    1340     340    1332     340    1330     360    1330
   43              Y7   360    1332     550    1340     930    1350
   44              K      1       2                                               1
   45              K1       CHANNEL ROUTING MOD PULS REACH NO.2
   46              Y                                1       1
   47              Y1     1
   48              Y6  0.09    0.04    0.09    1300    1316    2520    .012
   49              Y7     0    1320      90    1310     140    1302     140    1300     160    1300
   50              Y7   160    1302     225    1310     475    1320
```

Sheet 23 of 38

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51          K     1       3                                                  1
52          K1          CHANNEL ROUTING MOD PULS REACH NO. 3
53          Y                                          1       1
54          Y1    1
55          Y6  0.10      0.04      0.10   1277.6   1289.6     2600     .008
56          Y7     0      1300        50     1290      115   1279.6      115  1277.6      135  1277.6
57          Y7   135   1279.6       675     1290      775     1300
58          K     99
```

Sheet 24 of 38

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  25 SEP 78
**********************************

RUN  DATE 03/14/79
     TIME    12.01

                    NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
                    HYDROLOGIC AND HYDRAULIC ANALYSIS OF UNION CITY RES. MBJ  07
                    PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD

                                        JOB SPECIFICATION
                      NQ     NHR    NMIN    IDAY    IHR    IMIN   METRC    IPLT    IPRT   NSTAN
                     300       0      15       0      0       0       0       0      -4       0
                                   JOPER     NWT   LROPT   TRACE
                                       5       0       0       0

                                  MULTI-PLAN ANALYSES TO BE PERFORMED
                                      NPLAN= 3 NRTIO= 1 LRTIO= 1
                          RTIOS=   0.50

**********  **********  **********  **********  **********

                                  SUB-AREA RUNOFF COMPUTATION

                          INFLOW HYDROGRAPH FROM TRIBUTARY A

                                ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT  INAME  ISTAGE  IAUTO
                               TRIB-A       0       0       0      0      0      1       0      0

                                        HYDROGRAPH DATA
                          IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO  ISNOW  ISAME  LOCAL
                              1      1    1.10     0.0    2.41     0.0     0.0      0      1      0

                                        PRECIP DATA
                                SPFE     PMS      R6     R12     R24     R48     R72     R96
                                 0.0   23.00  117.00  127.00  141.00  151.00     0.0     0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

                                        LOSS DATA
                LROPT  STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
                    0    0.0     0.0    1.00     0.0     0.0    1.00    1.00    0.05     0.0     0.0

                                    UNIT HYDROGRAPH DATA
                                TP=  3.86    CP=0.55    NTA=  0

                                    RECESSION DATA
                                STRTQ=   -1.50    QRCSN=   -0.05    RTIOR= 2.00

          UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG=  3.88 HOURS, CP= 0.55  VOL= 0.99
      2.      6.     12.     20.     29.     38.     48.     58.     68.     78.
     86.     93.     98.    102.    104.    104.    102.     97.     92.     87.
     82.     78.     73.     69.     66.     62.     59.     56.     53.     50.
     47.     44.     42.     40.     38.     36.     34.     32.     30.     29.
```

Sheet 25 of 38

15.	15.	14.	13.	12.	12.	11.	10.	10.	9.
9.	8.	8.	8.	7.	7.	6.	6.	6.	5.
5.	5.	5.	4.	4.	4.	4.	3.	3.	3.
3.	3.	3.	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	1.	1.	1.	1.	1.	1.	1.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	27.78	25.35	2.43	71707.
										(706.1(	644.1(	62.1(	2030.52)

********** *********** ********** ********* **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FROM TRIBUTARY B

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
TRIB-B	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.31	0.0	2.41	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.00	117.00	127.00	141.00	151.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.05	0.0	0.0

UNIT HYDROGRAPH DATA

TP= 4.17 CP=0.55 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 4.20 HOURS, CP= 0.55 VOL= 0.99

2.	6.	12.	20.	28.	37.	47.	57.	68.	78.
88.	96.	102.	108.	112.	114.	115.	114.	109.	104.
99.	94.	89.	84.	80.	76.	72.	69.	65.	62.
59.	56.	53.	50.	48.	46.	43.	41.	39.	37.
35.	33.	32.	30.	29.	27.	26.	25.	23.	22.
21.	20.	19.	18.	17.	16.	15.	15.	14.	13.
13.	12.	11.	11.	10.	10.	9.	9.	8.	8.
7.	7.	7.	6.	6.	6.	6.	5.	5.	5.
4.	4.	4.	4.	4.	3.	3.	3.	3.	3.
3.	3.	2.	2.	2.	2.	2.	2.	2.	2.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	27.78	25.35	2.43	85199.
										(706.1(	644.1(	62.1(	2412.57)

********** *********** ********** ********* **********

COMBINE HYDROGRAPHS

COMBINE THE TWO TRIBUTARIES FOR ROUTING THROUGH THE DAM

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	LAKE	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING OF THE COMBINED FLOWS

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	SPWY	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	-1394.	-1

STAGE	1394.00	1395.00	1396.00	1397.00	1398.00	1399.00	1400.00	1401.00	1402.00
FLOW	0.0	49.00	102.00	247.00	473.00	853.00	1334.00	2012.00	2990.00
SURFACE AREA=	0.	32.	75.						
CAPACITY=	0.	320.	632.						
ELEVATION=	1364.	1394.	1400.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1394.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1399.5	2.6	1.5	244.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	1364.00	1.00	1394.00	1410.00

PEAK OUTFLOW IS 1871. AT TIME 44.50 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	1364.00	1.00	1394.00	1400.10

BEGIN DAM FAILURE AT 43.75 HOURS

PEAK OUTFLOW IS 14444. AT TIME 44.44 HOURS

Sheet 27 of 38

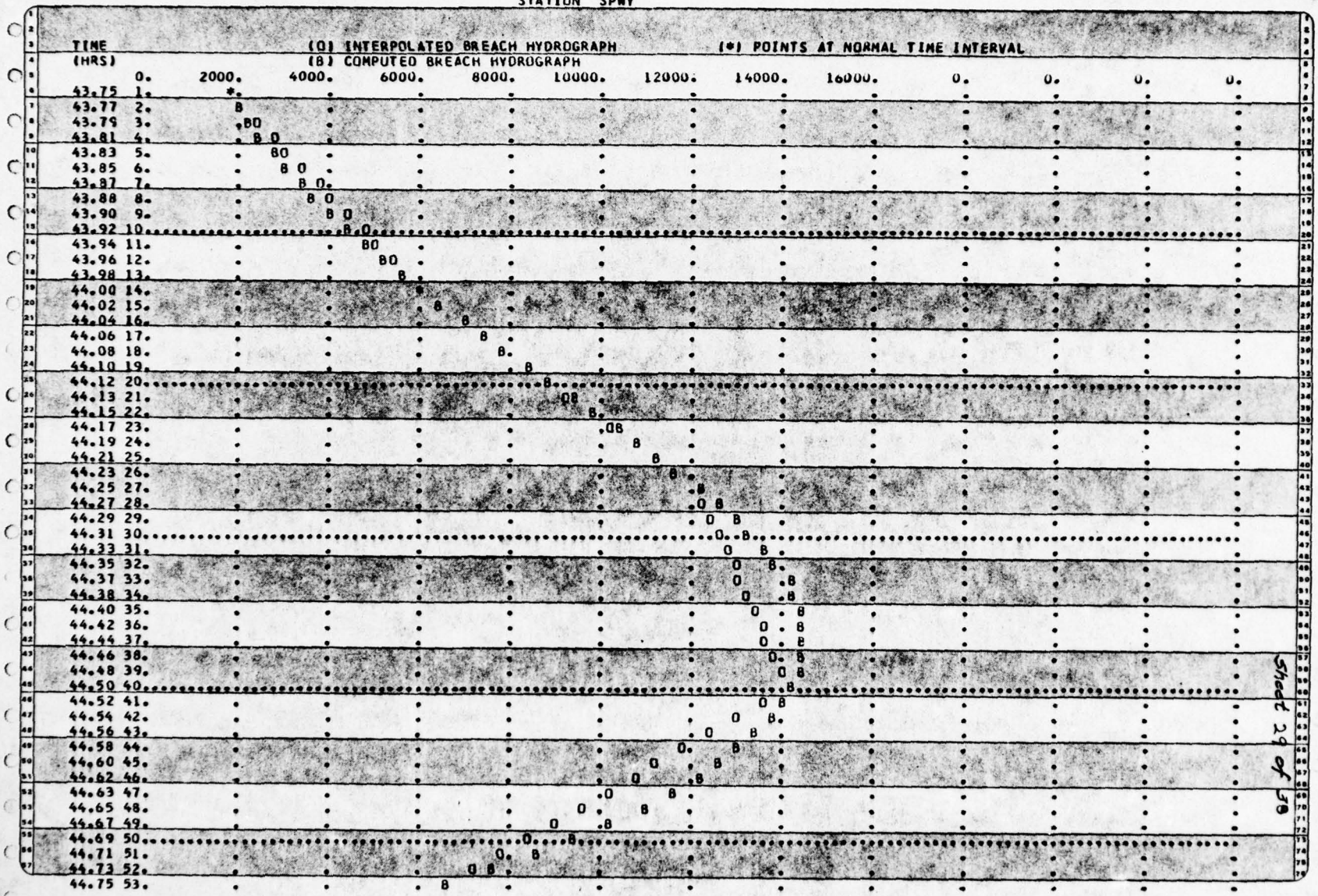
THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF 0.019 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF 0.250 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	- COMPUTED BREACH HYDROGRAPH (CFS)	= ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
43.750	0.0	1759.	1759.	0.	0.	0.
43.769	0.019	2087.	2000.	87.	87.	0.
43.788	0.038	2414.	2208.	207.	293.	0.
43.808	0.058	2742.	2450.	292.	586.	1.
43.827	0.077	3070.	2721.	349.	934.	1.
43.846	0.096	3397.	3017.	380.	1315.	2.
43.865	0.115	3725.	3333.	392.	1706.	3.
43.885	0.135	4052.	3668.	384.	2090.	3.
43.904	0.154	4380.	4019.	361.	2451.	4.
43.923	0.173	4707.	4392.	315.	2766.	4.
43.942	0.192	5035.	4780.	255.	3021.	5.
43.962	0.212	5363.	5181.	182.	3203.	5.
43.981	0.231	5690.	5593.	97.	3299.	5.
44.000	0.250	6018.	6018.	-0.	3299.	5.
44.019	0.269	6486.	6457.	29.	3329.	5.
44.038	0.288	6955.	6921.	34.	3362.	5.
44.058	0.308	7423.	7403.	20.	3382.	5.
44.077	0.327	7891.	7887.	5.	3387.	5.
44.096	0.346	8360.	8369.	-10.	3377.	5.
44.115	0.365	8828.	8857.	-29.	3348.	5.
44.135	0.385	9297.	9347.	-50.	3298.	5.
44.154	0.404	9765.	9829.	-64.	3234.	5.
44.173	0.423	10233.	10300.	-67.	3167.	5.
44.192	0.442	10702.	10757.	-55.	3112.	5.
44.212	0.462	11170.	11216.	-46.	3067.	5.
44.231	0.481	11639.	11674.	-35.	3032.	5.
44.250	0.500	12107.	12107.	-0.	3032.	5.
44.269	0.519	12266.	12512.	-246.	2786.	4.
44.288	0.538	12425.	12911.	-485.	2300.	4.
44.308	0.558	12585.	13271.	-686.	1614.	3.
44.327	0.577	12744.	13596.	-852.	762.	1.
44.346	0.596	12903.	13895.	-992.	-231.	-0.
44.365	0.615	13062.	14133.	-1070.	-1301.	-2.
44.385	0.635	13221.	14297.	-1075.	-2376.	-4.
44.404	0.654	13381.	14384.	-1004.	-3380.	-5.
44.423	0.673	13540.	14437.	-897.	-4277.	-7.
44.442	0.692	13699.	14444.	-745.	-5021.	-8.
44.462	0.712	13858.	14404.	-546.	-5568.	-9.
44.481	0.731	14017.	14316.	-299.	-5866.	-9.
44.500	0.750	14177.	14177.	0.	-5866.	-9.
44.519	0.769	13599.	13985.	-386.	-6252.	-10.
44.538	0.788	13021.	13737.	-717.	-6969.	-11.
44.558	0.808	12443.	13433.	-990.	-7959.	-13.
44.577	0.827	11865.	13069.	-1204.	-9164.	-15.
44.596	0.846	11287.	12644.	-1357.	-10520.	-17.
44.615	0.865	10709.	12154.	-1445.	-11965.	-19.
44.635	0.885	10131.	11597.	-1466.	-13431.	-21.
44.654	0.904	9553.	10971.	-1418.	-14849.	-24.
44.673	0.923	8975.	10271.	-1296.	-16145.	-26.
44.692	0.942	8398.	9495.	-1097.	-17242.	-27.
44.712	0.962	7820.	8639.	-819.	-18061.	-29.
44.731	0.981	7242.	7696.	-455.	-18516.	-29.

44.750 1.000 6664. 6664. 0. -18516. -29.

OVF

STATION SPNY



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OVN

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	1364.00	2.00	1394.00	1400.10

BEGIN DAM FAILURE AT 43.75 HOURS

PEAK OUTFLOW IS 8890. AT TIME 44.79 HOURS

sheet 30 of 38

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF 0.042 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF 0.250 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	- COMPUTED BREACH HYDROGRAPH (CFS)	= ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
43.750	0.0	1759.	1759.	0.	0.	0.
43.792	0.042	2026.	2019.	7.	7.	0.
43.833	0.083	2293.	2242.	51.	57.	0.
43.875	0.125	2560.	2495.	64.	122.	0.
43.917	0.167	2827.	2769.	57.	179.	1.
43.958	0.208	3094.	3058.	36.	214.	1.
44.000	0.250	3361.	3361.	0.	214.	1.
44.042	0.292	3710.	3681.	28.	243.	1.
44.083	0.333	4059.	4009.	50.	292.	1.
44.125	0.375	4408.	4345.	63.	356.	1.
44.167	0.417	4757.	4692.	66.	421.	1.
44.208	0.458	5106.	5067.	40.	461.	2.
44.250	0.500	5456.	5456.	-0.	461.	2.
44.292	0.542	5810.	5835.	-25.	435.	1.
44.333	0.583	6164.	6212.	-48.	388.	1.
44.375	0.625	6518.	6581.	-63.	324.	1.
44.417	0.667	6872.	6930.	-58.	267.	1.
44.458	0.708	7226.	7252.	-26.	241.	1.
44.500	0.750	7581.	7581.	0.	241.	1.
44.542	0.792	7796.	7887.	-90.	151.	1.
44.583	0.833	8012.	8152.	-140.	11.	0.
44.625	0.875	8228.	8403.	-175.	-164.	-1.
44.667	0.917	8444.	8598.	-154.	-318.	-1.
44.708	0.958	8660.	8773.	-113.	-431.	-1.
44.750	1.000	8875.	8875.	0.	-431.	-1.
44.792	1.042	8777.	8890.	-113.	-544.	-2.
44.833	1.083	8679.	8846.	-167.	-711.	-2.
44.875	1.125	8580.	8767.	-187.	-898.	-3.
44.917	1.167	8482.	8647.	-165.	-1063.	-4.
44.958	1.208	8383.	8486.	-103.	-1166.	-4.
45.000	1.250	8285.	8285.	0.	-1166.	-4.
45.042	1.292	7958.	8045.	-87.	-1253.	-4.
45.083	1.333	7631.	7768.	-136.	-1389.	-5.
45.125	1.375	7305.	7454.	-150.	-1539.	-5.
45.167	1.417	6978.	7107.	-129.	-1668.	-6.
45.208	1.458	6651.	6730.	-79.	-1747.	-6.
45.250	1.500	6324.	6324.	0.	-1747.	-6.
45.292	1.542	5868.	5895.	-27.	-1773.	-6.
45.333	1.583	5412.	5446.	-34.	-1807.	-6.
45.375	1.625	4956.	4984.	-27.	-1835.	-6.
45.417	1.667	4500.	4514.	-14.	-1848.	-6.
45.458	1.708	4044.	4045.	-1.	-1850.	-6.
45.500	1.750	3588.	3588.	0.	-1850.	-6.
45.542	1.792	3286.	3154.	132.	-1718.	-6.
45.583	1.833	2983.	2756.	228.	-1490.	-5.
45.625	1.875	2681.	2410.	271.	-1219.	-4.
45.667	1.917	2379.	2129.	250.	-969.	-3.
45.708	1.958	2076.	1919.	158.	-811.	-3.
45.750	2.000	1774.	1774.	0.	-811.	-3.

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OVF

STATION SPWY

TIME (HRS)

(O) INTERPOLATED BREACH HYDROGRAPH
(B) COMPUTED BREACH HYDROGRAPH
(*) POINTS AT NORMAL TIME INTERVAL

	1000.	2000.	3000.	4000.	5000.	6000.	7000.	8000.	9000.	0.	0.	0.	0.
43.75	1.	*											
43.79	2.	B											
43.83	3.	BO											
43.87	4.	BO											
43.92	5.	B											
43.96	6.	B											
44.00	7.	*											
44.04	8.	B											
44.08	9.	BO											
44.12	10.	BO											
44.17	11.	BO											
44.21	12.	B											
44.25	13.	B											
44.29	14.	B											
44.33	15.	B											
44.37	16.	OB											
44.42	17.	B											
44.46	18.	OB											
44.50	19.	B											
44.54	20.	OB											
44.58	21.	O B											
44.62	22.	O B											
44.67	23.	O B											
44.71	24.	OB											
44.75	25.	B											
44.79	26.	OB											
44.83	27.	OB											
44.87	28.	O B											
44.92	29.	OB											
44.96	30.	OB											
45.00	31.	B											
45.04	32.	B											
45.08	33.	O B											
45.12	34.	O B											
45.17	35.	OB											
45.21	36.	B											
45.25	37.	B											
45.29	38.	B											
45.33	39.	B											
45.37	40.	B											
45.42	41.	B											
45.46	42.	B											
45.50	43.	B											
45.54	44.	BO											
45.58	45.	B O											
45.62	46.	B O											
45.67	47.	B O											
45.71	48.	B O											
45.75	49.	B											

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OVN

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HYDROGRAPH ROUTING

CHANNEL ROUTING MOD PULS REACH NO.1

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	IAAME	ISTAGE	IAUTO
1	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0900	0.0400	0.0900	1330.0	1342.0	3070.	0.01200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.0 1350.00 175.00 1340.00 340.00 1332.00 340.00 1330.00 360.00 1330.00
360.00 1332.00 550.00 1340.00 930.00 1350.00

STORAGE	0.0	0.89	1.78	2.67	3.99	6.54	10.34	15.38	21.67	29.21
	37.99	48.02	59.30	71.82	85.59	100.61	116.88	134.59	153.87	174.70
OUTFLOW	0.0	36.40	111.21	210.79	343.01	528.28	784.58	1127.38	1570.48	2126.56
	2807.54	3624.71	4588.87	5710.41	6999.38	8465.47	10104.70	11881.24	13883.51	16121.70
STAGE	1330.00	1330.63	1331.26	1331.89	1332.53	1333.16	1333.79	1334.42	1335.05	1335.68
	1336.31	1336.94	1337.58	1338.21	1338.84	1339.47	1340.10	1340.73	1341.36	1342.00
FLOW	0.0	36.40	111.21	210.79	343.01	528.28	784.58	1127.38	1570.48	2126.56
	2807.54	3624.71	4588.87	5710.41	6999.38	8465.47	10104.70	11881.24	13883.51	16121.70

MAXIMUM STAGE IS 1335.4

MAXIMUM STAGE IS 1341.2

MAXIMUM STAGE IS 1339.5

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HYDROGRAPH ROUTING

CHANNEL ROUTING MOD PULS REACH NO.2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0900	0.0400	0.0900	1300.0	1316.0	2520.	0.01200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.0 1320.00 90.00 1310.00 140.00 1302.00 140.00 1300.00 160.00 1300.00
160.00 1302.00 225.00 1310.00 475.00 1320.00

STORAGE	0.0	0.97	1.95	3.04	4.68	6.90	9.72	13.13	17.12	21.71
	26.88	32.65	39.01	46.46	55.30	65.53	77.16	90.19	104.61	120.42
OUTFLOW	0.0	58.06	175.37	340.09	565.77	860.97	1234.99	1696.24	2252.62	2911.62
	3680.46	4566.07	5551.38	6547.01	7755.47	9182.24	10839.76	12742.89	14907.28	17348.73
STAGE	1300.00	1300.84	1301.68	1302.53	1303.37	1304.21	1305.05	1305.89	1306.74	1307.58
	1308.42	1309.26	1310.10	1310.95	1311.79	1312.63	1313.47	1314.31	1315.16	1316.00
FLOW	0.0	58.06	175.37	340.09	565.77	860.97	1234.99	1696.24	2252.62	2911.62
	3680.46	4566.07	5551.38	6547.01	7755.47	9182.24	10839.76	12742.89	14907.28	17348.73

MAXIMUM STAGE IS 1306.1

MAXIMUM STAGE IS 1313.9

MAXIMUM STAGE IS 1312.3

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HYDROGRAPH ROUTING

CHANNEL ROUTING MCD PULS REACH NO. 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	0.	0

Sheet 34 of 38

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.1000	0.0400	0.1000	1277.6	1289.6	2600.	0.00800

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.0 1300.00 50.00 1290.00 115.00 1279.60 115.00 1277.60 135.00 1277.60
135.00 1279.60 675.00 1290.00 775.00 1300.00

STORAGE	0.0	0.75	1.51	2.26	3.49	6.09	10.07	15.44	22.19	30.32
	39.84	50.74	63.03	76.69	91.75	108.19	126.01	145.21	165.80	187.78
OUTFLOW	0.0	29.72	90.80	172.11	280.74	436.81	658.08	959.65	1354.95	1856.31
	2475.32	3222.95	4109.67	5145.57	6340.35	7703.47	9244.07	10971.06	12893.14	15018.84
STAGE	1277.60	1278.23	1278.86	1279.49	1280.13	1280.76	1281.39	1282.02	1282.65	1283.28
	1283.91	1284.54	1285.18	1285.81	1286.44	1287.07	1287.70	1288.33	1288.96	1289.60
FLOW	0.0	29.72	90.80	172.11	280.74	436.81	658.08	959.65	1354.95	1856.31
	2475.32	3222.95	4109.67	5145.57	6340.35	7703.47	9244.07	10971.06	12893.14	15018.84

MAXIMUM STAGE IS 1283.3

MAXIMUM STAGE IS 1288.6

MAXIMUM STAGE IS 1287.3

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Sheet 35 of 38

AD-A070 717 BAKER (MICHAEL) JR INC BEAVER PA F/G 13/2
NATIONAL DAM INSPECTION PROGRAM. UNION CITY RESERVOIR DAM (NDI---ETC(U)
MAY 79 DACW31-79-C-0011

UNCLASSIFIED NI

2 OF 2
AD
A070717

END
DATE
FILMED
8-79
DDC

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.50
HYDROGRAPH AT	TRIB-A	1.10 (2.85)	1	934. (26.44)(
			2	934. (26.44)(
			3	934. (26.44)(
HYDROGRAPH AT	TRIB-B	1.31 (3.39)	1	1055. (29.86)(
			2	1055. (29.86)(
			3	1055. (29.86)(
2 COMBINED	LAKE	2.41 (6.24)	1	1989. (56.20)(
			2	1985. (56.20)(
			3	1985. (56.20)(
ROUTED TO	SPWY	2.41 (6.24)	1	1871. (52.99)(
			2	14177. (401.44)(
			3	8875. (251.32)(
ROUTED TO	1	2.41 (6.24)	1	1865. (52.81)(
			2	13242. (374.96)(
			3	8584. (243.06)(
ROUTED TO	2	2.41 (6.24)	1	1865. (52.82)(
			2	11863. (335.91)(
			3	8548. (242.05)(
ROUTED TO	3	2.41 (6.24)	1	1858. (52.61)(
			2	11728. (332.10)(
			3	8176. (231.51)(

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SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE	SPILLWAY CREST	AVERAGE TOP OF DAM	MINIMUM TOP OF DAM
	ELEVATION	1394.00	1394.00	1399.50	1399.2
	STORAGE	320.	320.	596.	
	OUTFLOW	0.	0.	1094.	

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	AVERAGE DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	1400.22	0.72	648.	1871.	6.00	44.50	0.0

PLAN 2		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	1394.00	1394.00	1399.50
	STORAGE	320.	320.	596.
	OUTFLOW	0.	0.	1094.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	AVERAGE DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	1400.14	0.64	643.	14444.	1.52	44.44	43.75

PLAN 3		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	1394.00	1394.00	1399.50
	STORAGE	320.	320.	596.
	OUTFLOW	0.	0.	1094.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	AVERAGE DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	1400.14	0.64	643.	8890.	1.67	44.79	43.75

PLAN 1 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	1865.	1335.4	44.75

PLAN 2 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	13242.	1341.2	44.50

PLAN 3 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS

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0.50	8584.	1339.5	45.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	1865.	1306.1	44.75

PLAN 2 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	11863.	1313.9	44.50

PLAN 3 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	8568.	1312.3	45.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	1858.	1283.3	45.00

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	11728.	1288.6	44.75

PLAN 3 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	8176.	1287.3	45.25

86 to 88 73945

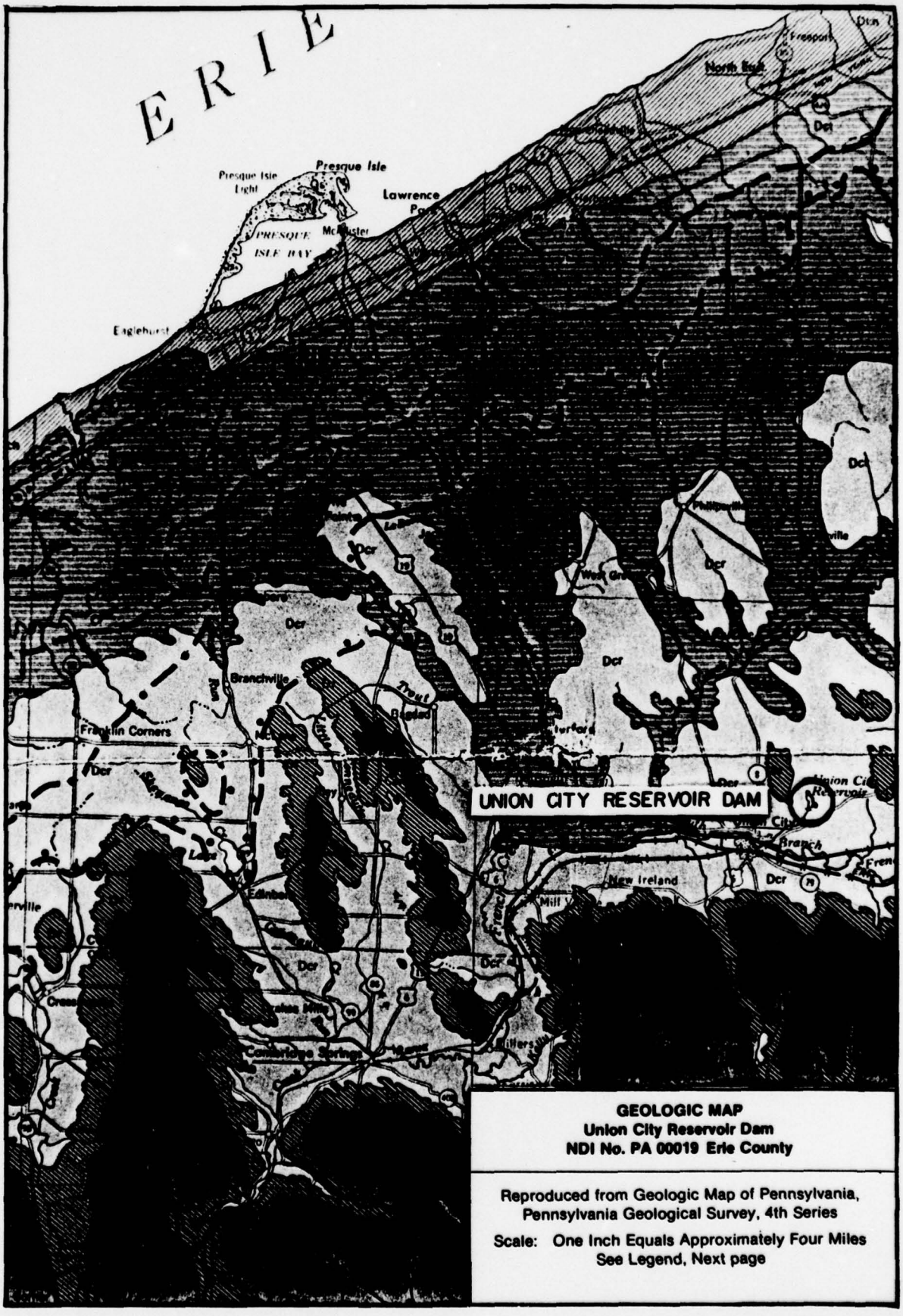
APPENDIX E

REGIONAL GEOLOGY

UNION CITY RESERVOIR DAM
NDI No. PA 00019, PennDER No. 25-3

REGIONAL GEOLOGY

Union City Reservoir is located in the glaciated section of the Appalachian Plateaus physiographic province. Although the region is overlain by deposits of Wisconsin drift of varying thickness, soils at the dam site are primarily alluvium. Photographs taken in 1934 during construction show shale bedrock in the cutoff trench beneath a thin cover of soil. This shale unit is a member of the Cattaraugus formation, Upper Devonian system. From the photographs, it appears that bedding is approximately horizontal with near vertical joints striking parallel with the axis of the valley.



GEOLOGIC MAP
Union City Reservoir Dam
NDI No. PA 00019 Erie County

Reproduced from Geologic Map of Pennsylvania, Pennsylvania Geological Survey, 4th Series

Scale: One Inch Equals Approximately Four Miles
See Legend, Next page

LEGEND

PERMIAN

Greene Formation

Cyclic sequences of sandstone, shale, red beds, limestone and coal; base at the top of the Upper Washington Limestone.

PERMIAN AND PENNSYLVANIAN

Washington Formation

Cyclic sequences of sandstone, shale, limestone and coal; some red shale; some mineable coal; base at the top of the Waynesburg Coal.

PENNSYLVANIAN

APPALACHIAN PLATEAU

Monongahela Formation

Cyclic sequences of sandstone, shale, limestone and coal; limestone prominent in northern outcrop areas; shale and sandstone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal.

Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections; Brush Creek Limestone in lower part of section.

Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestones thicken westward; Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations.

Pottsville Group

Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.

ANTHRACITE REGION

Post-Pottsville Formations

Brown or gray sandstones and shales with some conglomerate and numerous mineable coals.

Pottsville Group

Light gray to white, coarse grained sandstones and conglomerates with some mineable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

MISSISSIPPIAN

Mauch Chunk Formation

Red shales with brown to greenish gray flaggy sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties; Loyalhanna Limestone at the base in southwestern Pennsylvania.

Pocono Group

Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Cassewago, Corry, and Knapp Formations; includes part of "Oswayo" of M. L. Fuller in Potter and Tioga counties.

DEVONIAN

UPPER

WESTERN PENNSYLVANIA

Oswayo Formation

Greenish gray to gray shales, siltstones and sandstones becoming increasingly shaly westward; considered equivalent to type Oswayo. Riceville Formation Dr in Erie and Crawford Counties; probably not distinguishable north of Corry.

Cattaraugus Formation

Red, gray and brown shale and sandstone with the proportion of red decreasing westward; includes Venango sands of drillers and Salamanca sandstone and conglomerate; some limestone in Crawford and Erie counties.

Conneaut Group

Alternating gray, brown, greenish and purplish shales and siltstones; includes "pink rock" of drillers and "Chemung" and "Girard" Formations of northwestern Pennsylvania.

Canadaway Formation

Alternating brown shales and sandstones; includes "Portage" Formation of northwestern Pennsylvania.