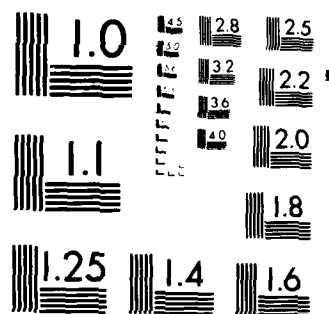


NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/6 13/13
NATIONAL DAM SAFETY PROGRAM, INGERSOLL RAND DAM (NJ00460) DELAY--ETC(U)
MAR 81 A PERERA DACW61-79-C-0011

DAEN/NAP-53842/NJ00460-81/ NL

END
DATE
FILMED
5 81
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

AD A 098 525

LEVEL

DELAWARE RIVER BASIN,
MERRILL CREEK, WARREN COUNTY,
NEW JERSEY.

NATIONAL Dam Safety Program

INGERSOLL RAND DAM

(NJ 00460)

**PHASE 1 INSPECTION REPORT-
NATIONAL DAM SAFETY PROGRAM**

Final Rept.

12/56

10 Abraham/Penn



APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

15 DHCN61-77-C-0011

**DTIC
ELECTE**

MAY 5 1981

DTIC FILE COPY

DEPARTMENT OF THE ARMY

Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

REPT. NO. *DAEN/NAP/53842/MS 00460-81/03*

11 MAR 1981

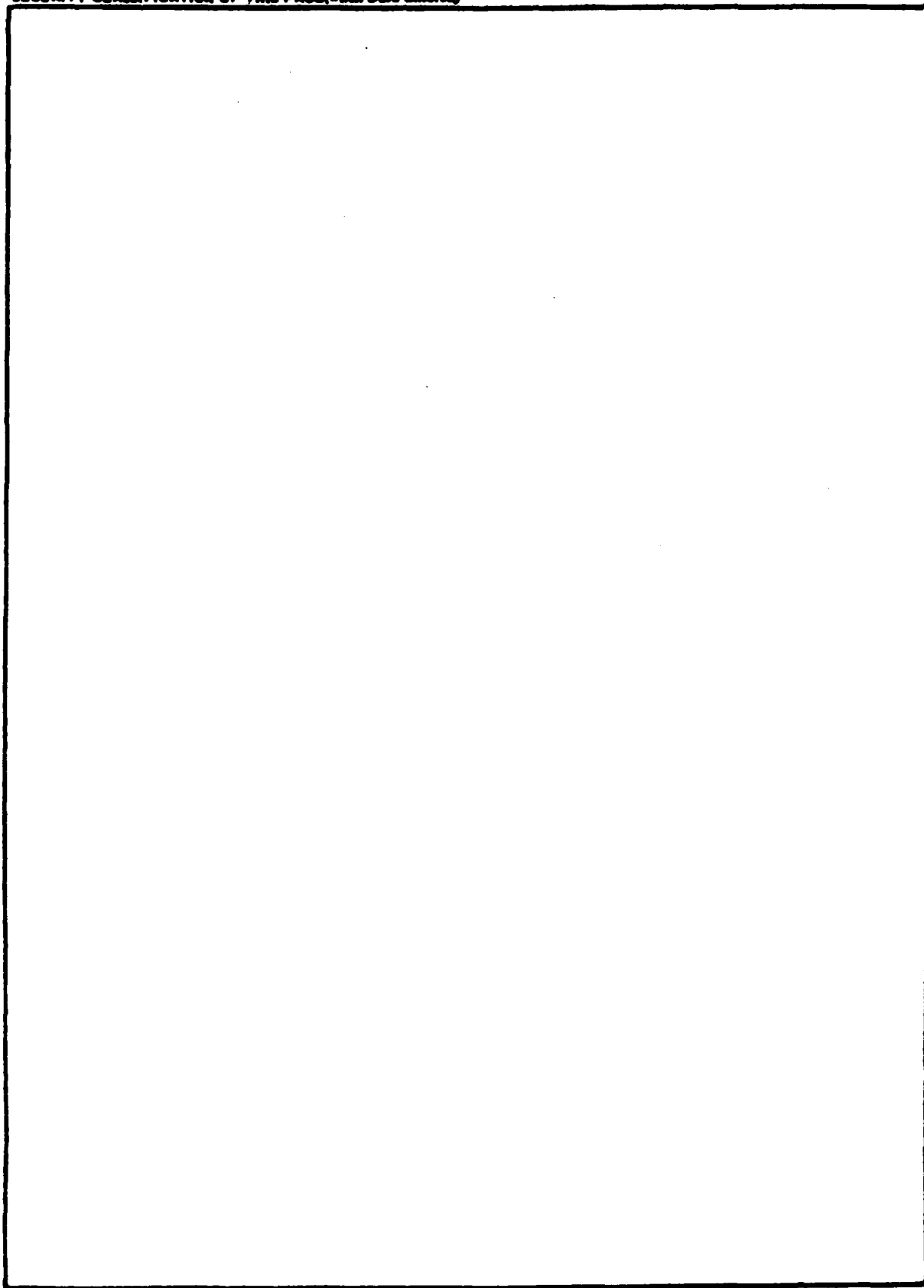
410891

81 5 04 094

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DAEN/NAP-53842/NJ00460-81/03	2. GOVT ACCESSION NO. AD-A098	3. RECIPIENT'S CATALOG NUMBER 525
4. TITLE (and Subtitle) Phase I Inspection Report National Dam Safety Program Ingersoll Rand Dam (NJ00460) Warren County, NJ	5. TYPE OF REPORT & PERIOD COVERED FINAL	
7. AUTHOR(s) Abraham Perera, L.L.	8. CONTRACT OR GRANT NUMBER(s) DACW61-79-C-0011	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Louis Berger & Associates 100 Halstead St. East Orange, NJ 07019	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	
11. CONTROLLING OFFICE NAME AND ADDRESS NJ Department of Environmental Protection Division of Water Resources P.O. Box CN029 Trenton, NJ 08625	12. REPORT DATE March, 1981	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) U.S. Army Engineer District, Philadelphia Custom House, 2d & Chestnut Streets Philadelphia, PA 19106	13. NUMBER OF PAGES 40	
	18. SECURITY CLASS. (of this report) Unclassified	
	18a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dams Embankments Visual Inspection Structural Analysis National Dam Safety Program Ingersoll Rand Dam, N.J. Spillways		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.		

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)



SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)



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

IN REPLY REFER TO

NAPEN-N

27 APR 1981

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

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Ingersoll Rand Dam in Warren County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Ingersoll Rand Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to 82 percent of the One Hundred Year Flood would cause the dam to be overtopped. However, if the proposed Merrill Creek Reservoir Project is constructed, the Ingersoll Rand Dam will be submerged. As some time will be required for the new dam's construction, it is recommended that the following remedial actions be initiated within thirty days from the date of approval of this report:

a. The owners should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

b. The owners should develop an emergency action plan, if one does not already exist, and a downstream warning system in case of an emergency at the dam.

In the event the new dam construction is delayed or postponed, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

Honorable Brendan T. Byrne

c. It is further recommended that repairs of concrete surface cracks and spalling be implemented.

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

James F. In

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

**Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625**

Accession For
NBS GRA&I
GIBB TAB
Unannounced
Classification
By
Distribution/
Availability
A

INGERSOLL RAND DAM (NJ00460)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 21 August 1980 by Louis Berger and Associates Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Ingersoll Rand Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to 82 percent of the One Hundred Year Flood would cause the dam to be overtopped. However, if the proposed Merrill Creek Reservoir Project is constructed, the Ingersoll Rand Dam will be submerged. As some time will be required for the new dam's construction, it is recommended that the following remedial actions be initiated within thirty days from the date of approval of this report:

a. The owners should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

b. The owners should develop an emergency action plan, if one does not already exist, and a downstream warning system in case of an emergency at the dam.

In the event the new dam construction is delayed or postponed, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. The vertical crack near the left abutment of the dam should be closely monitored. If any signs of widening of the crack are noticed, immediate remedial work should be undertaken to implement repairs that will ensure the structural integrity of the affected portion of the dam.

c. It is further recommended that repairs of concrete surface cracks and spalling be implemented.

APPROVED: *James G. Ton*

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 21 April 1981

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Ingersoll-Rand Dam Fed ID # NJ 00460
NJ ID # 658

State Located New Jersey
County Located Warren
Coordinates Lat. 4043.8 - Long. 7506.3
Stream Merrill Creek
Date of Inspection August 21, 1980

ASSESSMENT OF
GENERAL CONDITIONS

Ingersoll-Rand Dam is assessed to be in a fair overall structural condition and it is recommended that it be downgraded to a significant hazard category. No findings were uncovered to merit further study. Although its spillway is inadequate, it can handle 81% of the design flood and overtopping by the design flood would not imperil the dam. However, a vertical crack near the left abutment should be monitored closely to detect any signs of deterioration and insure timely remedial procedures. The owners should also develop immediately written operating and maintenance procedures as well as an emergency action plan and a downstream warning system. Repairs of concrete surface cracks and spalling should be implemented but this remedial work can be waived if the proposed Merrill Creek Reservoir is constructed in the near future.


Abraham Perera P.E.
Project Manager



OVERVIEW OF INGERSOLL RAND DAM
AUGUST, 1980

OTHER DATA DE RESTORATION
FROM DATA FORWALD TO RE

TABLE OF CONTENTS

	<u>Page</u>
Assessment of General Conditions	
Overall View of Dam	
Table of Contents	
Preface	
Section 1 - Project Information	1-4
Section 2 - Engineering Data	5-6
Section 3 - Visual Inspection	7-8
Section 4 - Operational Procedures	9-10
Section 5 - Hydraulic/Hydrologic	11
Section 6 - Structural Stability	12-13
Section 7 - Assessments/Recommendations/ Remedial Actions	14-15

FIGURES

- Figure 1 - Regional Vicinity Map
- Figure 2 - Plan of Dam
- Figure 3 - Dam and Spillway Sections

APPENDIX

- Check List - Visual Inspection
 - Check List - Engineering Data
 - Photographs
 - Check List - Hydrologic and Hydraulic Data
 - Computations
- Al-Al4

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines can be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I investigations is to identify expeditiously those dams that may pose hazards to human life or property. The assessment of the general condition of the dam is based on 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 the review of this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway test flood is based on the estimated "probable maximum flood" for the region (greatest reasonable possible storm runoff) or fractions thereof. The test 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.

REPT. NO. DAEN/NAP - 53842/NJ 00460 - 8/03

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: INGERSOLL-RAND DAM FED I.D. # NJ 00460

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Ingersoll-Rand Dam and appurtenant structures and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Ingersoll-Rand Dam is a 252-foot-long concrete gravity dam constructed in 1904. Its spillway, 119 feet long and 30 feet high, has an ogee cross section. The spillway begins 29 feet from the west abutment. The top of the dam is 3.5 feet above the top of the spillway. A concrete intake structure is located behind the upstream face of the dam next to the east end of the spillway. It consists of a gate house, an intake channel, and a draw down well. The well is 10 feet by 10 feet (inside dimensions) and is 32 feet and 9 inches deep. Three cast iron drain pipes (two with an 18-inch diameter and one with a 33-inch diameter) are located 10 feet 5 inches, 21 feet 6 inches, and 32 feet 9 inches from the top of the dam. Only the valve of the low-level 33 inch diameter C.I. pipe is operable. A flow gauge is located near the bottom of the east end of the spillway and is attached to the left spillway sidewall. Another flow gauge is situated in the reservoir upstream from the dam.

b. Location

The dam is located on Merrill Creek in Harmony Township, Warren County, New Jersey and lies approximately 850 feet southeast of the intersection of Fox Farm and Bolts roads. It is also located approximately 1.35 miles north of New Jersey Route 57 and 1.42 miles east of New Jersey Route 519. It impounds the main channel of Merrill Creek.

c. Classification

The maximum height of the dam is approximately 35 feet and the maximum storage is estimated to be 216 acre-feet. Therefore, the dam is placed in the small size category as defined by the Recommended Guidelines for Safety Inspection of Dams (storage less than 1,000 acre-feet and height less than 40 feet).

d. Hazard Classification

The dam is located in a relatively undeveloped area made up of steep wooded hills. The nearest of the three dozen dwellings located near the downstream channel are approximately 4,000 feet away from the dam. Although most of the dwellings are located 10 or more feet above the channel bottom, there are a few which are close to the channel banks. If the dam broke, the narrow, steep sloped, heavily wooded downstream channel would help to dissipate most of the flood wave energy before it could reach the nearest dwellings. However, if the dwellings or the road that follows the steep channel banks downstream from the dam were flooded, potentially heavy property damage as well as the loss of a few lives could result. The Ingersoll-Rand Dam is therefore placed in the Significant Hazard category.

e. Ownership

The dam and surrounding property is owned by the Merrill Creek Owners Group/Ingersoll-Rand Company, 80 Park Place, Newark, New Jersey, 07101, of which the Public Service Electric and Gas Company (P.S.E.&G.) is a member. Information about the Ingersoll-Rand Dam and the Merrill Creek

Reservoir Project can be obtained by calling: Mr. Thomas Ochab (201)430-8382 or Mr. Harvey Shramm (201)454-1213.

f. Purpose of Dam

The dam was originally constructed to supply water to meet the industrial needs of the Ingersoll-Rand Company. It served also during the early years to provide potable water to the houses located downstream. A 12-inch pipe can still be seen near the downstream channel. This pipe was plugged in the 1960s. The dam no longer supplies water. In the near future, if the proposed Merrill Creek Reservoir is constructed, the Ingersoll-Rand Dam will be submerged.

g. Design and Construction History

The existing Ingersoll-Rand Dam was designed in 1903 and constructed in 1904 by the Ingersoll-Rand Company. Since then, it has been repaired and modified several times. The documentation of the work performed before 1980 is unavailable, however. Based on information obtained from P.S.E.&G., it appears that the exposed surfaces of the dam have been resurfaced and patched and that, at least on one occasion, in 1948, the reservoir was completely drained during the repair work performed on the dam. In 1965 an extension approximately 18 inches high was added to the spillway of the dam. In 1980, following a stability analysis performed by Charles T. Main Inc., of Boston, Massachusetts, the spillway extension was removed. The removal work was completed in June of 1980. During the removal work, the reservoir pool was lowered approximately 4 feet. The removal work was performed under Dam Application Permit No. 658.

1.3 PERTINENT DATA

a. Drainage Area

The watershed of the Ingersoll-Rand Dam has a drainage area of 3.8 square miles, which consists of woodland, cropland, meadowland, and rural residential development. The area includes four upstream dams on the main branch of the river.

- b. Principal Spillway Capacity at Maximum Pool
Elevation (Top of Dam) - 2,904 cfs
- c. Elevation (ft. above MSL)
Top of dam - 732.5
Recreation pool - 728.5 (spillway crest)
Streambed at centerline of dam - 697.5+ (varies)
- d. Reservoir
Length of maximum pool - 2,500 feet
Length of recreation pool - 1,200 feet
- e. Storage (acre-feet)
Recreation pool - 154
Top of dam - 199
- f. Reservoir Surface (acres)
Top of dam - 15.0
Recreation pool - 7.3
- g. Dam
Type - concrete with ogee type spillway
Length - 252 feet
Height - 35 feet
Top width - 2.5 feet
Side slopes - u/s vertical, d/s 1H:3V
Zoning - N/A
Cutoff - unknown
Grout curtain - unknown
- h. Diversion and Regulating Tunnel
None
- i. Spillway
Type - Ogee weir with concrete splash apron
Length - 119 feet
Crest elevation - 728.5
Gates - none
U/S channel - main reservoir
D/S channel - natural channel
- j. Regulating Outlets - 33-inch diameter C.I. pipe
with gate type valve

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The dam was designed in 1903. No computations are available to document the design criteria and data used. A plan of the dam, dated 1903, prepared by the former Lopatcong Water Company is available in the files of P.S.E.&G. Co., 80 Park Place, Newark, New Jersey 07101. In February 1980, Charles T. Main, Consulting Engineers of Boston, Massachusetts, performed stability calculations for the dam. From site inspection, it appears that the dam is founded on rock. The rock formation at the dam site is composed of Precambrian rocks of metasedimentary and meta-volcanic nature. The Precambrian gneiss is underlain by a resistant Precambrian crystalline sequence composed mainly of quartz-feldspathic gneisses with some inclusions of amphibolite and marble.

2.2 CONSTRUCTION

The only data on the original construction of the dam, in 1904, are the details shown on the 1903 Lopatcong Water Company plan for the dam. Since 1904, the Ingersoll-Rand Company has performed many small modifications and repairs of the dam. The only available documentation on such modifications are the plans and specifications for the removal in 1980 of the vertical extension of the spillway, originally constructed in 1965. The plans and specifications for the spillway extension removal work are available in the files of P.S.E.&G. Co.

2.3 OPERATION

Presently the dam does not serve any stated purpose. It will be eventually submerged after the construction of the proposed Merrill Creek Reservoir. The dam is checked once every hour by the Merrill Creek Reservoir Project security patrol. Should there be flood conditions, the security patrol would notify the engineering office, which would decide whether the low-level outlet pipe should be opened to lower the reservoir.

2.4 EVALUATION

a. Availability

Sufficient engineering data are available to assess the structural stability and hydrologic characteristics of this dam. The foundation stability is not questioned, given that the dam most certainly is founded on rock, although the founding levels of the various wall components are unknown.

b. Adequacy

The field inspection and review of available data reveal that the dam is structurally acceptable in its present condition. It is felt that adequate data were available to render the assessment contained in Sections 6 and 7 without recourse to gathering additional information.

c. Validity

The validity of the available data is not challenged and is accepted without recourse to further investigations.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

The on-site inspection was conducted on August 21, 1980. At this time, several inches of normal flow were discharging over the central part of the spillway crest, which is depressed with respect to the left and right ends of the spillway. The dam appears to be in an overall satisfactory condition except as noted hereinafter.

b. Dam

The dam is a concrete gravity-type dam with an ogee spillway. It closes a 252-foot-wide saddle in the gneiss bedrock. The dam end walls on each side of the spillway are approximately 3.5 feet higher than the spillway crest as recently modified. Due to spillway crest modification work a triangular depression, 0.45 feet deep at center and 38 feet wide, exists in the top of the spillway. The exposed concrete surface also exhibits numerous surface cracks and efflorescence. Spalling was also observed in several areas, particularly at construction (cold) joints. Several 2-inch-diameter steel pipes are protruding from the downstream face of the dam and the spillway. Based on information obtained from P.S.E.&G., these pipes were installed to allow for seepage through the cracks that developed over the years in the concrete of the dam. One such crack was noticed near the left abutment of the dam (see photo). This crack is discussed further in Section 6. During the site inspection it was observed that several of these pipes were seeping, particularly on the left half of the dam. The abutments of the dam against the adjacent bedrock seem to be in good condition; rain runoff has led to only minor erosion of the surface soil adjacent to the concrete of the dam.

c. Appurtenant Structures

The appurtenant structures of the Ingersoll-Rand Dam include a wooden gate house, a drawdown well, a concrete apron at the downstream edge of the spillway, and two water-level recording gages, one located upstream in the reservoir and the other attached to the left spillway sidewall.

The gate house is in a run-down condition. The two 18-inch-diameter pipes within the drawdown well are no longer in use. The low level 33-inch-diameter pipe was used as recently as June 1980 to lower the reservoir level. All three pipes are equipped with gate-type valves. The inside concrete surfaces of the drawdown well appear to be in good condition except for a slight seepage around the perimeter of the two upper pipes. The two water-level-recording gauges are Leupold & Stevens Type F gauges. They are new and were installed recently by P.S.E.&G.

d. Reservoir Area

The reservoir area extends on both sides of the Fox Farm Road, which crosses the Merrill Creek on a 24-foot-span concrete bridge. The watershed area is protected against surrounding development and is composed of first-growth woodlands. Bed-rock outcrops are common along the shoreline, which rises on a 30 degree approximate slope from the reservoir surface, except near the Fox Farm Road, where the slope is flatter.

e. Downstream Channel

The downstream channel, 200 feet from the dam, is only 20 feet wide. The slopes on each side are relatively steep and heavily wooded. The channel bottom is covered with boulders and fallen tree logs. The channel width gradually widens to 100 or more feet as it approaches the first houses approximately 4,000 feet downstream from the dam. The channel slopes are less steep there and are sparsely wooded. There are approximately three dozen houses, most of which are located away from the channel banks, at least 10 feet above the stream bottom and on both sides of the channel. A few of the houses are located near the channel banks, however.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Ingersoll-Rand Dam does not serve any direct purpose at the present time. It will be submerged in the near future by the Merrill Creek Reservoir project. The routine operation consists of hourly patrols by the Merrill Creek project security staff. While the main purpose of the patrol is to prevent camping and undesirable activities within the Merrill Creek Reservoir project area, if a flood occurred or there were danger signs of one, the security patrol would alert the engineering office of the project, which would determine the appropriate action to be taken.

4.2 MAINTENANCE OF DAM

The dam is not maintained routinely. However, the responsibility for any maintenance relating to the safety of the dam would be undertaken by the engineering office of the Merrill Creek Reservoir project. An example is the removal of the vertical extension at the spillway in June 1980 in order to increase the stability and the safety factor of the dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

No apparent routine maintenance was evident, but it appears that the low-level outlet pipe can be operated when required for dam repairs, as was done most recently in June 1980.

4.4 DESCRIPTION OF WARNING SYSTEM

No formal warning system exists. The hourly patrolling of the dam by the Merrill Creek Reservoir project security patrol insures, however, that ample warning could be provided to the local authorities and to the owners of the dam. The security patrol is particularly careful to observe the dam during major storms.

4.5 EVALUATION

The existing operational and maintenance procedures and safeguards during major storms are considered adequate for the following reasons:

- The dam spillway has sufficient capacity to handle 81 percent of the 100 year flood. No known serious damage has occurred downstream during storms since the dam's construction in 1904.
- The stream channel is covered with boulders and its slopes are heavily wooded. Most of the energy of flow would therefore be dissipated before reaching the inhabited areas.
- In view of the future submergence of the dam by the proposed Merrill Creek Reservoir project and the fact that the dam is patrolled on an hourly basis, the present operational and maintenance procedures are considered sufficient and practical.

Nevertheless, in order to safeguard against potential property damage and loss of life, it is recommended that the owners institute and implement a formal early warning system that would permit quickly notifying the local authorities and downstream residents of any unusual occurrences noted at the dam during severe storms.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

Based on the criteria in the Recommended Guidelines for Safety Inspection of Dams, Ingersoll-Rand Dam is small in size and is placed in the significant hazard category. Accordingly, a 100-year frequency event was selected as the design storm and an inflow hydrograph calculated using precipitation data from Technical Paper 40 and NOAA Technical Memorandum NWS Hydro-35. Inflow to the reservoir was calculated utilizing the HEC-1 computer program, discharging a peak into the reservoir of 3,611 cfs. Routing this through the reservoir reduced the value slightly to 3,569 cfs. The spillway capacity before overtopping of the dam is 2,904 cfs and is therefore able to accommodate only 81 percent of the design flood.

b.

Experience Data

No recorded information is available regarding floods to which the Ingersoll-Rand Dam has been subjected in the past. P.S.E.&G. installed the water-level recording gauges in order to obtain flow data from August 1980 on. It is known, however, that the dam has been repaired a number of times during its existence and that the reservoir has been completely dewatered at least once.

c.

Visual Observations

There is no evidence of any problem concerning overtopping; the lake was in a normal condition at the time of inspection.

d.

Overtopping

The appended hydraulic analysis indicates that some potential exists for overtopping, primarily because of the limited spillway capacity. The design flood would overtop the dam crest by approximately 0.3 feet.

e.

Drawdown Potential

With the 33 inch-diameter low-level outlet, it would take approximately 13 hours to dewater the reservoir.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation

Based on field inspection and a stability analysis undertaken by Charles T. Main, the Ingersoll-Rand Dam is in satisfactory structural condition. Various evidence of concrete surface deterioration is not considered serious. The only item of serious concern is a vertical crack on the downstream face of the dam near the left abutment. This crack appears to be more than a few inches deep and there is evidence of past seepage through it. Presently, there are weeds growing out of a considerable length of the crack. Although this crack is not considered to represent an immediate danger, it should be checked periodically and monitored in the future. The dam appears otherwise to be in a satisfactory structural condition.

b. Design and Construction Data

Based on information obtained from P.S.E.&G., very little is known about the original construction of the dam. The dam has been repaired and modified on several occasions. The only drawings and design data available are those at P.S.E.&G., which consist of the 1903 drawing of the dam, the bid documents for the removal of the vertical extension for the spillway, and the stability analysis by Charles T. Main Company. In the context of this report, additional design and construction data would not basically alter any condition insofar as the downstream flooding conditions are concerned.

c. Operating Records

Written operating records are non-existent.

d. Post Construction Changes

As pointed out elsewhere in this report, it is known that the dam has been modified on several occasions, but it is believed that the modifications were minor and included only repairs to its concrete surfaces. The other changes consist of the 1965 vertical extension of the spillway and its subsequent removal in 1980.

e. Seismic Stability

This dam is stable under earthquake acceleration loadings. It is located in Seismic Zone 1, and experience reveals that dams stable under static gravity conditions will be adequately stable under dynamic loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ REMEDIAL ACTIONS

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection, the Ingersoll-Rand Dam is judged to be in a satisfactory overall condition. The dam has stood for over 75 years but has required various repairs in the past. Its spillway is able to discharge 81 percent of the design flood. It is believed overtopping of the dam would not endanger its structural stability and safety. The vertical crack extending the full height of the dam near the left abutment is of some concern and should be monitored in the future.

b. Adequacy of Information

The data located are deemed adequate for the enclosed analysis regarding safe operation and stability.

c. Urgency

The owners should implement immediately the recommendations set forth below for close monitoring of the dam. The recommended remedial work can be waived if the new Merrill Creek Reservoir is constructed; otherwise, the remedial work should be implemented in the near future.

d. Necessity for Further Study

Further studies are believed to be unnecessary under the purview of Public Law 92-367 as the owners have provisions for routine inspections of the dam and actions that are basically responsive to the requirements mandated under the Dam Safety Act.

7.2 RECOMMENDATIONS/REMEDIAL MEASUREMENTS

a. Recommendations

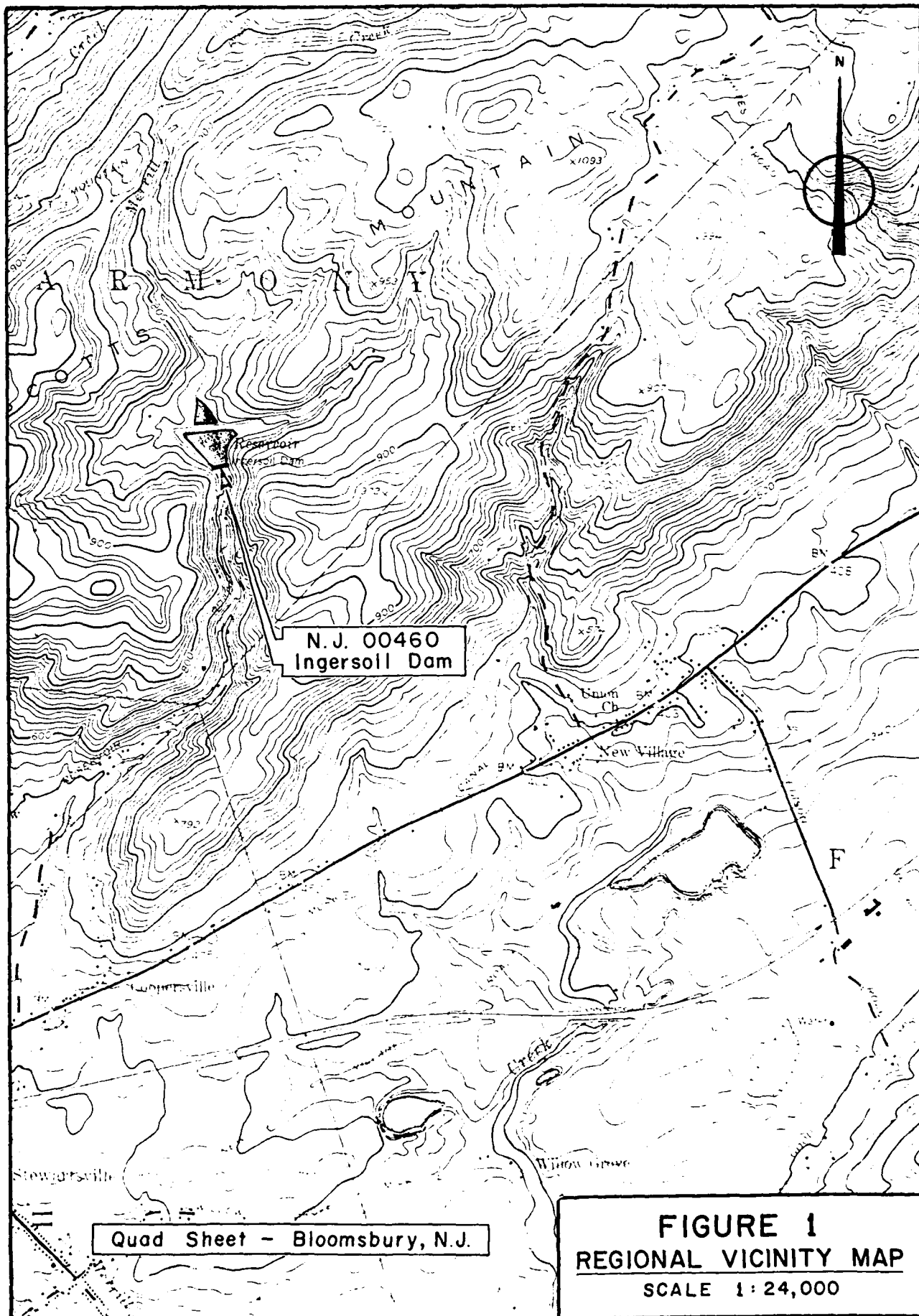
It is recommended that the vertical crack near the left abutment of the dam be closely monitored. If any signs of widening of the crack are noticed, immediate remedial work should be undertaken to implement repairs that will insure the

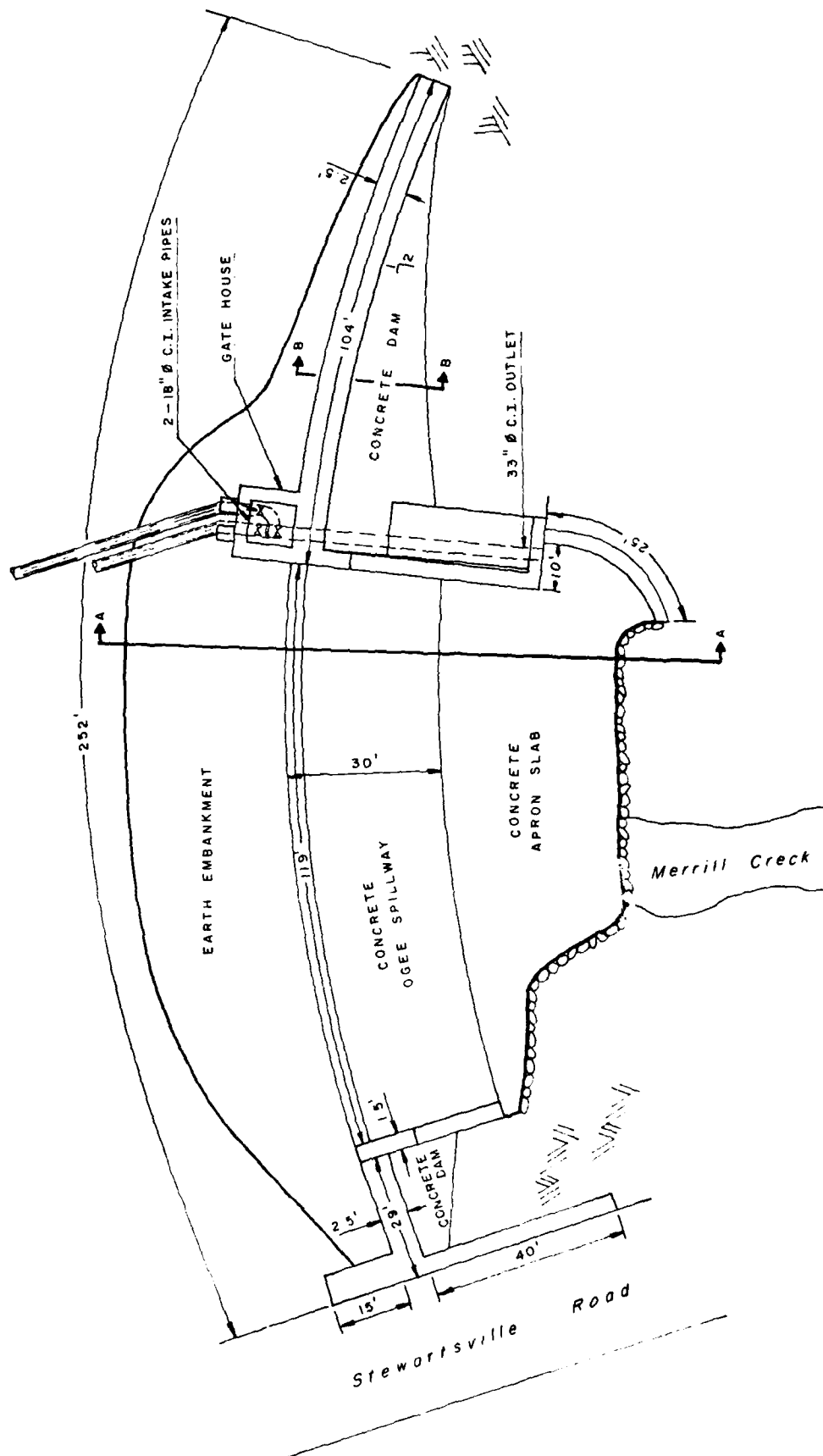
structural integrity of the affected portion of the dam. It is further recommended that the repairs of concrete surface cracks and spalling be implemented in the near future. However, this remedial work can be waived if the proposed Merrill Creek Reservoir project is constructed in the near future.

b. O&M Maintenance and Procedures

1. The owners should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam.
2. The owners should develop an emergency action plan, if one does not exist, and a downstream warning system in case an emergency occurs at the dam.

The above listed O&M procedures and emergency action plan should be maintained by the owners until the Merrill Creek Reservoir project is completed.

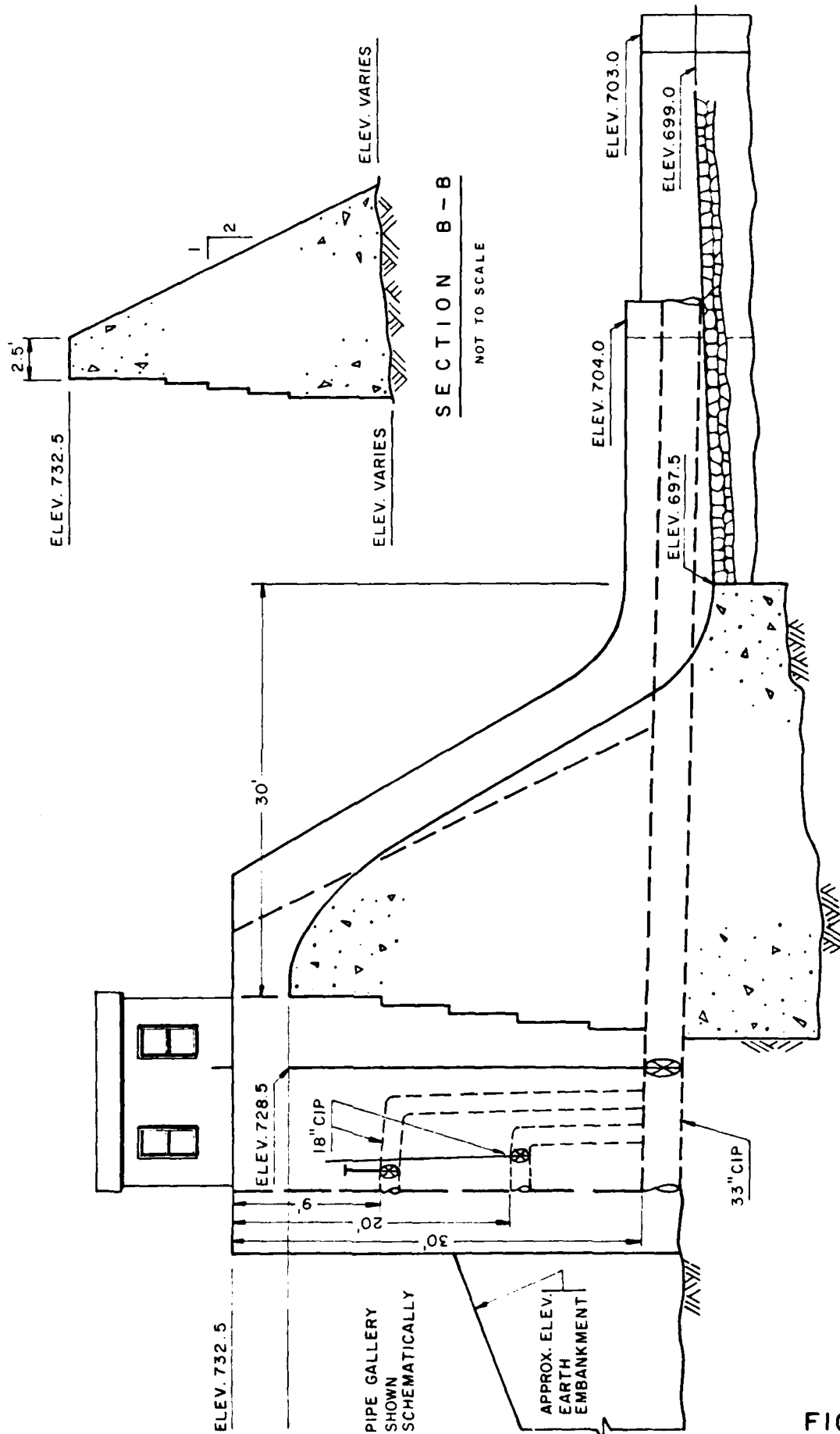




INGERSOLL RAND DAM
N.J. 00460

PLAN OF DAM
NOT TO SCALE

FIGURE 2



INGERSOLL RAND DAM
N.J. 00460

FIGURE 3

Check List
Visual Inspection
Phase I

Name Dam Ingersoll-Rand County Warren State New Jersey Coordinates N.J.D.E.P.

Date(s) Inspection 8/21/80 Weather Sunny Temperature 85 °F

Pool Elevation at Time of Inspection 727.5 M.S.L. Tailwater at Time of Inspection 697.5 M.S.L.

Inspection Personnel:

A. Perera J. Greenstein

T. Chapter

D. Lang

A. Perera Recorder

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEEPAGE OR LEAKAGE	None observed	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Slight erosion due to rain runoff	Insignificant in view of future Merrill Creek Project.
DRAINS	Several 2-inch diameter pipes in spillway and abutments, randomly located. Some are leaking.	Appear to be functioning adequately.
WATER PASSAGES	None	
FOUNDATION	Bedrock (Gneiss)	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Many surface cracks.	Should be repaired in the event that Merrill Creek Reservoir project is not constructed in the near future.
STRUCTURAL CRACKING	None evident	
VERTICAL AND HORIZONTAL ALIGNMENT	Good, no movement is evident	
MONOLITH JOINTS	Unknown	
CONSTRUCTION JOINTS	Spalled in several locations	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None observed. Concrete surfaces in draw down well below gate house in good condition except for some seepage around the perimeter of 18-inch-diameter C.I. pipes. Outlet conduit is 33-inch-diameter C.I. pipe.	Seepage insignificant in view of time frame of Merrill Creek Project.
INTAKE STRUCTURE	Submerged concrete intake channel not visible from the surface.	
OUTLET STRUCTURE	Concrete return wall at 90 degree with spillway sidewall, serving as endwall for 33-inch-diameter C.I. outlet pipe, in good condition.	
OUTLET CHANNEL	See downstream channel section	
EMERGENCY GATE	Gate valve inside the drawdown well. In operable condition.	

UNCATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Ogee type spillway. Horizontal surface crack approximately 2 feet from crest. Several 2-inch-diameter pipes protruding from downstream face. Some spalling at construction (cold) joints.	Spalling is insignificant in view of Merrill Creek Project.
APPROACH CHANNEL	Reservoir upstream from dam fed by Merrill Creek.	
DISCHARGE CHANNEL	See downstream channel section.	
BRIDGE AND PIERS	None	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Steep to mild. Heavily wooded. Two local roads approximately 4 feet above water level. One along west shore, the other crossing the reservoir north of the dam with a 24-foot-span bridge over the former Merrill Creek channel.	
SEDIMENTATION	Slight	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Channel bottom covered with boulders and fallen trees. Channel approximately 20 to 30 feet wide.	
SLOPES	Steep and heavily wooded. Rock outcroppings evident.	
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 3 dozen homes 4000 to 5000 feet downstream from the dam. All except few, near the channel banks, situated 10 or more feet above the stream bottom.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available - 1903 drawing of original dam construction and 1980 drawing for spillway modifications - P.S.E. & G. Co., 80 park place, Newark, New Jersey, 07101.
REGIONAL VICINITY MAP	Available - U.S.G.S. Quad -
CONSTRUCTION HISTORY	None available
TYPICAL SECTIONS OF DAM	None available
HYDROLOGIC/HYDRAULIC DATA	None available
OUTLETS - PLAN	Available - P.S. E. & G. Company
- DETAILS	None available
- CONSTRAINTS	Unknown
- DISCHARGE RATINGS	None available
RAINFALL/RESERVOIR RECORDS	None available

ITEM	REMARKS
SPILLWAY PLAN	Available - P.S.E. & G. Company, Newark, New Jersey
SECTIONS	Available - P.S.E. & G. Company, Newark, New Jersey
DETAILS	Available - P.S.E. & G. Company, Newark, New Jersey
OPERATING EQUIPMENT PLAN & DETAILS	None available

ITEM	REMARKS
------	---------

DESIGN REPORTS

None Available

GEOLOGY REPORTS

None Available

 DESIGN COMPUTATIONS
 HYDROLOGY & HYDRAULICS
 DAM STABILITY
 SEEPAGE STUDIES

 None Available
 None Available
 None Available
 None Available

 MATERIALS INVESTIGATIONS
 BORING RECORDS
 LABORATORY
 FIELD

 None Available
 None Available
 None Available
 None Available

POST-CONSTRUCTION SURVEYS OF DAM

Available for spillway only - 1980 - P.S.E.&G. Company

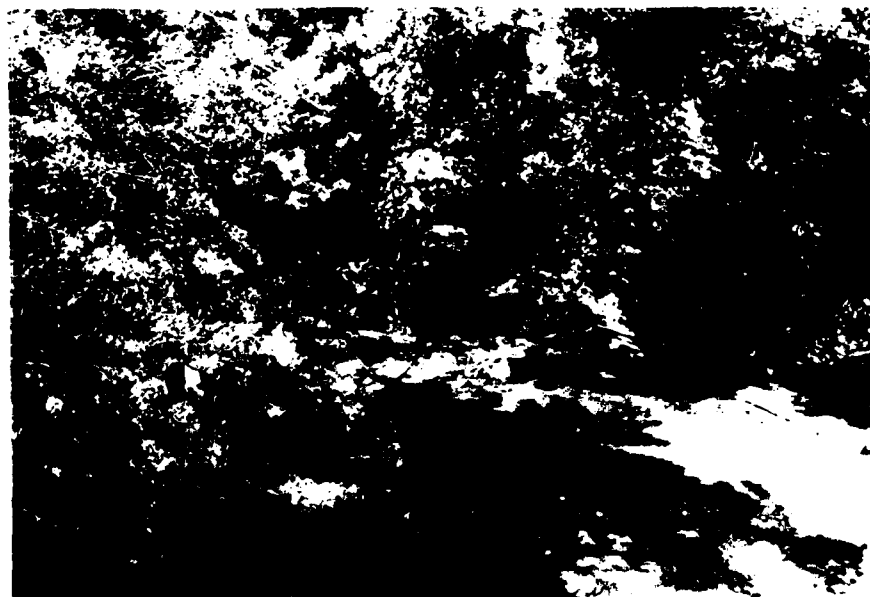
BORROW SOURCES.

N/A Concrete sources unknown

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	Spillway extension (vertical) construction in 1965 Spillway extension (vertical) removal in 1980
HIGH POOL RECORDS	None Available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Available at P.S.E.&G. Company (spillway extension removal and stability analysis by Charles T. Main Company)
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None Recorded None Available None Available
MAINTENANCE OPERATION RECORDS	None Available



August, 1980
View of Right Abutment



August, 1980
View of Downstream from Dam Crest

UNITED STATES GOVERNMENT
GEOLOGICAL SURVEY



August, 1980

View of Outlet Structure



August, 1980

Cracking On Dam Face Near Left Abutment



August, 1980
View of Dam from Right Abutment



August, 1980
View of Dam Looking Downstream

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 3.8 sq. miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 728.5

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 732.5

CREST: Spillway

- a. Elevation 728.5 MSL
- b. Type Concrete ogee weir
- c. Width 2+ foot narrow crested weir
- d. Length 119 feet
- e. Location Spillover 29 feet from right abutment
- f. Number and Type of Gates None

OUTLET WORKS: 3 stage inlet pipe gallery

- a. Type 33-inch-dia. CIP
- b. Location Left side of spillway
- c. Entrance inverts 722, 711, 700
- d. Exit inverts 699
- e. Emergency draindown facilities Same

HYDROMETEOROLOGICAL GAGES:

- a. Type Flow gauge
- b. Location Spillway toe sidewall/outlet pipe conjunction
- c. Records Unknown

MAXIMUM NON-DAMAGING DISCHARGE: 2904 cfs

BY W. J. J. J. DATE 2/2/57

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A1 OF 113

CHKD. BY DATE

THUNDERBOLT DAM

PROJECT 9-262

SUBJECT _____

TIME OF CONCENTRATION:

LENGTH ALONG CONCENT. WATERSHED TO DRAINAGE DIVIDE = 19,750 FT
= 3.74 MI.

ΔH = 512.5 Δ SLOPE = 2.60%

ASSUME VELOCITY OF 2' / SEC.

$$\therefore t_c = \frac{19,750}{3 \times 2600} = 1.53 \text{ HOURS}$$

CALIFORNIA CULVERTIC METHOD

$$t_c = \left(\frac{11.9 \times 3.74^3}{512.5} \right)^{0.555} = 1.08 \text{ HOURS}$$

BY SCS METHOD (FROM URBAN HYDROLOGY FOR SMALL WATERSHEDS
TECHNICAL RELEASE NO. 55)

ASSUME C_N FOR WATERSHED = 77

SLOPE = 2.5%

L = 17,750 FT.

USING HYDROGRAM (FIG. 5.2) FOR $L = \frac{L^{0.6}(C_N - 1)^{0.7}}{1300Y^{0.5}}$

L = LAG IN HOURS

L = 2.35 HRS.

$$\therefore t_c = \frac{LAG}{C_N} = \frac{2.35}{0.6} = 3.92 \text{ HRS.}$$

USE $t_c = 2.10 \text{ HRS.}$

$$T_p = 0.2 + 0.6 t_c \quad T_p = \frac{2.25}{2} + 0.6(2.10) = 1.32$$

BY J. LONG DATE SEPT 10
 CHKD. BY _____ DATE _____
 SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A2 OF 112
 PROJECT 2-1-22

UNITGRAPH

$$q_p = \frac{454(3.1)(1)}{1.39} = 1079 \text{ CFS}$$

UNITGRAPH TIME HOURS	T/T _p	DIMENSIONLESS ORDINATE (D.O.)	Q (CFS) Σ = 8025
0.25	0.13	0.663	68
0.50	0.36	0.232	250
0.75	0.54	0.498	537
1.00	0.72	0.803	866
1.25	0.90	0.97	1047
1.50	1.05	0.124	1062
1.75	1.26	0.872	941
2.00	1.44	0.714	770
2.25	1.62	0.546	589
2.50	1.80	0.42	453
2.75	1.98	0.33	356
3.00	2.16	0.256	276
3.25	2.34	0.198	214
3.50	2.52	0.15	162
3.75	2.70	0.114	123
4.00	2.88	0.093	95
4.25	3.06	0.07	76
4.50	3.24	0.056	60
4.75	3.42	0.042	45
5.00	3.60	0.032	35
			Σ = 8025

OVERALL

$$\frac{5025 \times 12 \times 3300}{1 \times 3.1 \times 3300} = 1.003 \approx 1 \text{ INCH}$$

BY D. L. LANE DATE 7/16/80
 CHKD. BY _____ DATE _____
 SUBJECT TEST SERIAL 100150 PREPARED

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A2 OF A14
 PROJECT C-225

PRECIPITATION DATA FROM 7-10-80 - 7-10-80
 MEMORANDUM NRE 47500-80

<u>TIME</u>	<u>PRECIPITATION</u>	<u>Δ</u>	<u>REARRANGE Δ</u>
0.15	1.7	0.1	0.1
0.30	2.4	0.7	0.06
0.75	2.8	0.4	0.06
1.00	3.1	0.3	0.06
1.25	3.4	0.3	0.07
1.50	3.7	0.3	0.07
1.75	3.8	0.10	0.09
2.00	4.00	0.2	0.13
2.25	4.11	0.11	0.14
2.50	4.22	0.11	0.16
2.75	4.31	0.09	0.2
3.00	4.40	0.09	0.2
3.25	4.49	0.09	0.2
3.50	4.57	0.08	0.2
3.75	4.64	0.07	0.20
4.00	4.71	0.07	0.2
4.25	4.78	0.07	0.11
4.50	4.84	0.06	0.11
4.75	4.90	0.06	0.11
5.00	4.96	0.06	0.11
5.25	5.02	0.06	0.09
5.50	5.08	0.06	0.09
5.75	5.14	0.06	0.09
6.00	5.20	0.06	0.09

BY: SAK DATE SEPT 1960
 CHKD. BY: DATE
 SUBJECT: NOT 1

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A4 OF 114
 PROJECT 2-264

INBESOLL DAM
SPILLWAY DISCHARGE

ELEV.	SPILLWAY NOTCH				SPILLWAY				OVER DAM				SQ
	L	C	H	Q	L	C	H	Q	L	C	H	Q	
728.50			0										0
729.0	19	3.4	0.5	23			0						23
730.0	↓	3.5	1.5	122	100	3.4	1	340					462
731.0		3.6	2.5	270	↓	3.5	2	990					1260
732.0		↓	3.5	448		3.6	3	1871					2319
732.5			4.0	547		3.5	3.5	2357			0		2704
733.0			4.5	653			4	2880	149	3.4	0.5	179	3712
734.0			5.5	832			5	4025	↓	3.5	1.5	958	5265
735.0			6.5	1134			6	5291		3.6	2.5	2120	8545
736.0			7.5	1405			7	6667			3.5	3512	11584
737.0			8.5	1675			8	8146			4.5	5120	14761
738.0	↓	↓	9.5	2003	↓		9	9720	↓		5.5	6719	18,642

$$\text{LENGTH 'OVER DAM'} = 159' - 10' = 149'$$

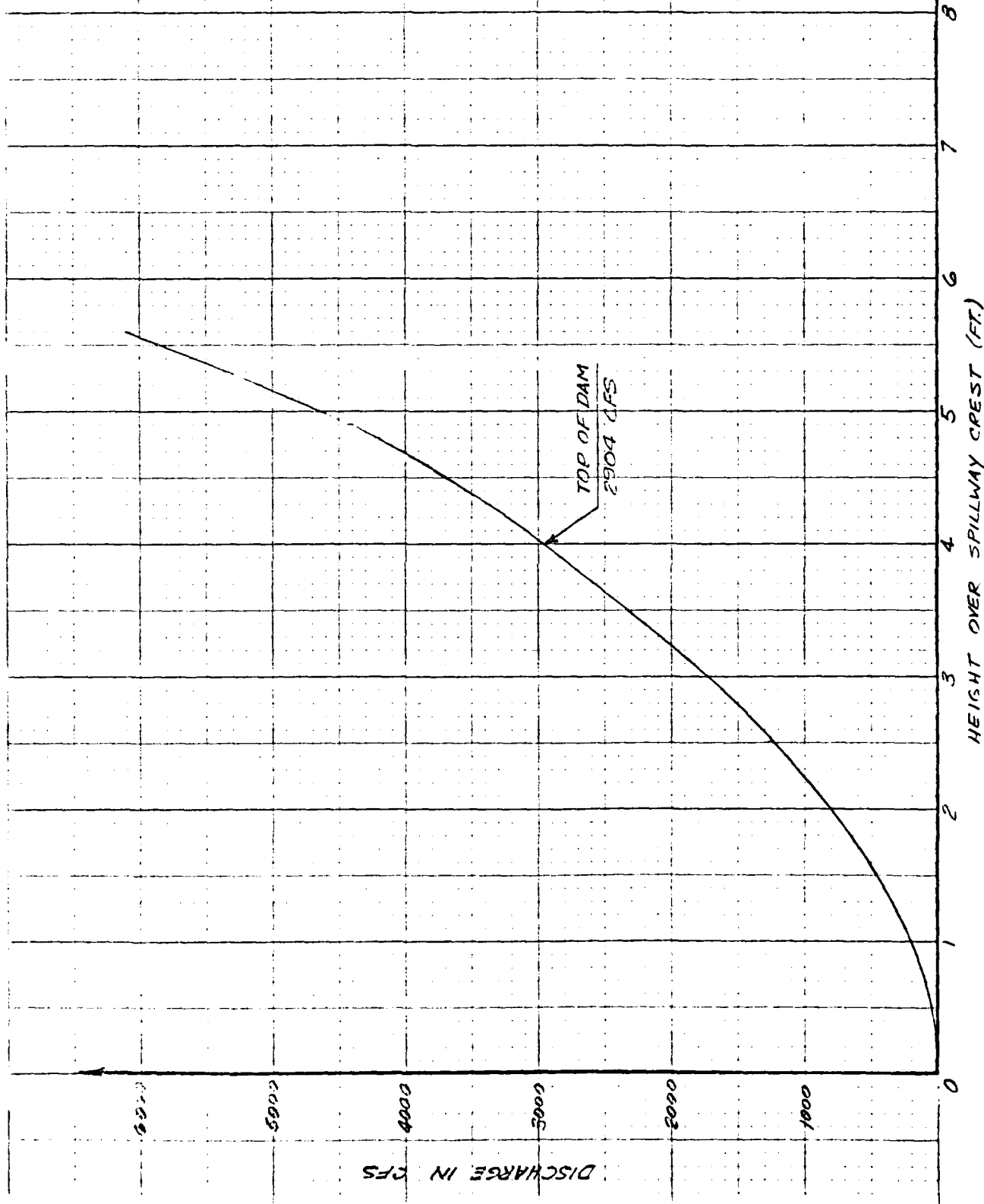
↗ GATE HOUSE WIDTH

46 0780

RECEIVED IN BUREAU
RECEIVED IN BUREAU

A5 OF
A14

INGERSOLL DAM
STAGE - DISCHARGE
CURVE



BY E. AMI DATE SEPT. 27
 CHKD. BY DATE
 SUBJECT AREA

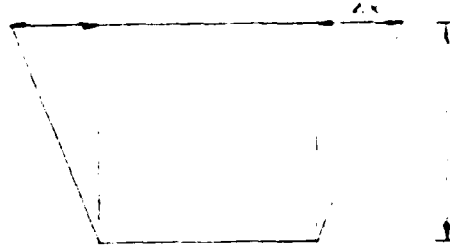
LOUIS BERGER & ASSOCIATES INC.

INTERIOR DAM
 SURCHARGE STORAGE

SHEET NO. 46 OF 413
 PROJECT 2

AREA OF LAKE @ ELEV 728.5 = 7.3 AC
 AREA @ CONTOUR 740 = 25.4 AC.

EL 740



EL 728.5

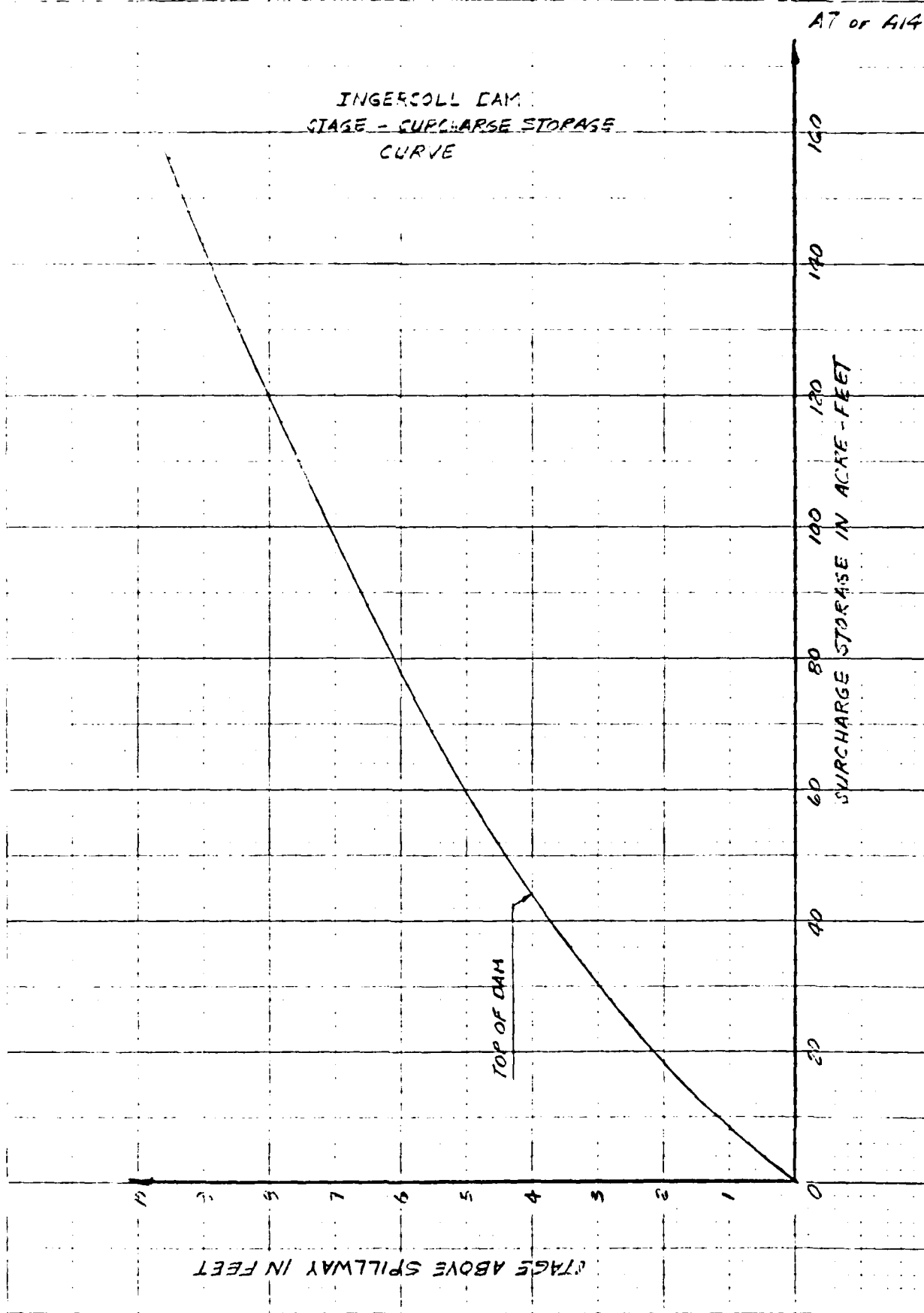
$$\Delta x = \frac{1.72}{2} = 0.76$$

$$CY = CY + CX,$$

ELEV.	HEIGHT ABOVE SPILLWAY CREST (FT.)	AREA ACRES	SURCHARGE STORAGE ACRE-FT.
728.5	0	7.3	0
729.0	0.5	8.3	4
730.0	1.5	10.2	13
731.0	2.5	12.1	24
732.0	3.5	14.0	37
732.5	4.0	15.0	45
733.0	4.5	15.9	52
734.0	5.5	17.9	69
735.0	6.5	19.8	88
736.0	7.5	21.7	100
737.0	8.5	23.6	131
738.0	9.5	25.6	156

W. 3/26

U. S. GEOLOGICAL SURVEY
WASHINGTON, D. C.



BY 3/5 DATE 1/2
CHKD. BY DATE
SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 45 OF 45
PROJECT

Page 45 Deleted

BY DATE 10/1/80
CHKD. BY DATE
SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 19 OF 412
PROJECT C-262

INTERIOR WALL
STORAGE - DISCHARGE IN LBS

HEIGHT ABOVE FLOOR (FEET)	STORAGE (LBS/FT)	DISCHARGE (LBS/FT)
0	0	0
10	12	462
20	24	1260
30	37	2317
40	52	3712
50	67	5865
60	80	7545
70	100	11504
80	131	14961
90	156	18642

BY D. LANG DATE SEPT. 21
 CHKD. BY _____ DATE _____
 SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 112 OF 114
 PROJECT C-282

INGERSOLL DAM
 D. LANG
 SEPTEMBER 3, 1980

JOB SPECIFICATION
 IDAY NHR NMIN IMIN METRC IPLT IPRT NSTAN
 100 0 15 0 0 0 0
 JOPER NWT
 3 0

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAG IECON ITAPE JPLT JPRT INAME
 1 0 0 0 0 1

HYDROGRAPH DATA

IHYDG IUNG TAREA SNAP TRSDA TRSPC RATIO IENOW ISAME LOCAL
 0 -1 3 10 0.00 3.10 0.00 0.000 0 0 0

PRECIP DATA

NP STORM DAK
 24 0.00 0.00 0.00
 PRECIP PATTERN
 0.07 0.07 0.07 0.06 0.09
 1.70 0.40 0.11 0.11 0.09

0.06 0.04 0.05 0.05 0.14 0.16
 0.30 0.30 0.70 0.70 0.09 0.09
 0.07 0.06 0.06 0.06 0.09 0.09

LOSS DATA

STRKR DLTWR RTIOL ERAIN STRKS RTIOK STRTL CNSTL ALSMX RTIMP
 0 00 0.00 1.00 0.00 0.00 1.00 0.50 0.10 0.00 0.00

GIVEN UNIT GRAPH, NUHGG= 20

68. 250. 537. 866. 1047. 1062. 941. 770. 453
 396. 276. 214. 152. 123. 95. 76. 60. 35

UNIT GRAPH TOTALS 8025 CFS OR 1.00 INCHES OVER THE AREA

RECESSION DATA

STRIG 0 00 GRCSN= 0.00 RTIOR= 1.00

BY D. L. H. S. DATE 1/25/77

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 411 OF 414

CHKD. BY _____ DATE _____

TIME 2.00 DAMPROJECT 0262

SUBJECT _____

YES - 2 OUTPUT

TIME	END-OF-PERIOD FLOW			COMP. 3			
	RAIN	EXCESS					
1	0.06	0.00		0.	51	0.00	0.00
2	0.06	0.00		0.	52	0.00	0.00
3	0.06	0.00		0.	53	0.00	0.00
4	0.06	0.00		0.	54	0.00	0.00
5	1.07	0.00		0.	55	0.00	0.00
6	0.07	0.00		0.	56	0.00	0.00
7	0.08	0.00		0.	57	0.00	0.00
8	0.07	0.04		0.	58	0.00	0.00
9	0.14	0.12	17.	0.	59	0.00	0.00
10	0.16	0.13	57.	0.	60	0.00	0.00
11	0.30	0.27	145.	0.	61	0.00	0.00
12	0.30	0.27	297.	0.	62	0.00	0.00
13	0.30	0.27	511.	0.	63	0.00	0.00
14	0.70	0.67	798.	0.	64	0.00	0.00
15	1.70	1.67	1236.	0.	65	0.00	0.00
16	0.40	0.38	1882.	0.	66	0.00	0.00
17	0.11	0.08	2610.	0.	67	0.00	0.00
18	0.11	0.08	3293.	0.	68	0.00	0.00
19	0.09	0.07	3811.	0.	69	0.00	0.00
20	0.07	0.07	3532.	0.	70	0.00	0.00
21	0.07	0.04	3163.	0.	71	1.00	0.00
22	0.06	0.03	2675.	0.	72	0.00	0.00
23	0.06	0.03	2183.	0.	73	0.00	0.00
24	0.06	0.03	1781.	0.	74	1.00	0.00
25	0.00	0.00	1484.	0.	75	0.00	0.00
26	0.00	0.00	1197.	0.	76	0.00	0.00
27	0.00	0.00	970.	0.	77	0.00	0.00
28	0.00	0.00	771.	0.	78	0.00	0.00
29	0.00	0.00	603.	0.	79	0.00	0.00
30	1.00	0.00	455.	0.	80	0.00	0.00
31	0.00	0.00	381.	0.	81	0.00	0.00
32	0.00	0.00	270.	0.	82	0.00	0.00
33	0.00	0.00	202.	0.	83	0.00	0.00
34	0.00	0.00	102.	0.	84	0.00	0.00
35	0.00	0.00	62.	0.	85	0.00	0.00
36	0.00	0.00	37.	0.	86	0.00	0.00
37	0.00	0.00	27.	0.	87	0.00	0.00
38	0.00	0.00	18.	0.	88	0.00	0.00
39	0.00	0.00	12.	0.	89	0.00	0.00
40	0.00	0.00	8.	0.	90	1.00	0.00
41	0.00	0.00	5.	0.	91	0.00	0.00
42	0.00	0.00	3.	0.	92	0.00	0.00
43	1.00	0.00	1.	0.	93	0.00	0.00
44	1.00	0.00	0.	0.	94	0.00	0.00
45	0.00	0.00	0.	0.	95	0.00	0.00
46	1.00	0.00	0.	0.	96	0.00	0.00
47	1.00	0.00	0.	0.	97	0.00	0.00
48	0.00	0.00	0.	0.	98	0.00	0.00
49	0.00	0.00	0.	0.	99	0.00	0.00
50	0.00	0.00	0.	0.	100	0.00	0.00
				SUM	5.20	4.25	34394

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3611.	1423.	358.	344	34394
INCHES		4.27	4.30	4.30	4.30
AC-FT		714	711	711	711

BY C. LINS DATE Sept 11
 CHKD. BY DATE
 SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A12 OF A14
 PROJECT C232

HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

ISTAO	ICOMP	IECON	ITAPE	UPLT	UPRT	INAME
1	1	0	0	0	0	1

ROUTING DATA

GLSS	CLOSS	AVG	RES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.000	0.000	0.000	0

STORAGE= 0. 13. 24. 37. 45. 52. 69. 88. 109. 131. 156.
 OUTFLOW= 0. 462. 1260. 2319. 2904. 3712. 5865. 8545. 11584. 14961. 18642.

TIME	EOP	STOR	AVG IN	EOP OUT
1	0.	0.	0.	0.
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	1.	1.	1.
9	0.	10.	10.	5.
10	1.	37.	37.	22.
11	2.	101.	101.	65.
12	4.	221.	221.	149.
13	8.	404.	404.	286.
14	13.	654.	654.	497.
15	20.	1017.	1017.	942.
16	27.	1549.	1549.	1475.
17	35.	2236.	2236.	2171.
18	44.	2952.	2952.	2925.
19	49.	3452.	3452.	3441.
20	50.	3577.	3577.	3569.
21	48.	3348.	3348.	3352.
22	44.	2919.	2919.	2928.
23	38.	2429.	2429.	2439.
24	33.	1982.	1982.	2013.
25	29.	1620.	1620.	1656.
26	25.	1330.	1330.	1359.
27	22.	1084.	1084.	1117.
28	19.	871.	871.	906.
29	17.	687.	687.	718.
30	14.	536.	536.	562.
31	13.	415.	415.	446.
32	11.	317.	317.	377.
33	8.	238.	238.	302.
34	7.	170.	170.	231.

BY DATE SEPT 19

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 412 OF 414CHKD. BY DATE PROJECT Q262SUBJECT THREE-1
HES-1 ATP-17

35	5.	100.	101.
36	3.	49.	101.
37	2.	32.	64.
38	1.	22.	42.
39	1.	15.	27.
40	1.	10.	18.
41	0.	6.	12.
42	0.	4.	8.
43	0.	2.	5.
44	0.	1.	2.
45	0.	0.	1.
46	0.	0.	1.
47	0.	0.	0.
48	0.	0.	0.
49	0.	0.	0.
50	0.	0.	0.
51	0.	0.	0.
52	0.	0.	0.
53	0.	0.	0.
54	0.	0.	0.
55	0.	0.	0.
56	0.	0.	0.
57	0.	0.	0.
58	0.	0.	0.
59	0.	0.	0.
60	0.	0.	0.
61	0.	0.	0.
62	0.	0.	0.
63	0.	0.	0.
64	0.	0.	0.
65	0.	0.	0.
66	0.	0.	0.
67	0.	0.	0.
68	0.	0.	0.
69	0.	0.	0.
70	0.	0.	0.
71	0.	0.	0.
72	0.	0.	0.
73	0.	0.	0.
74	0.	0.	0.
75	0.	0.	0.
76	0.	0.	0.
77	0.	0.	0.
78	0.	0.	0.
79	0.	0.	0.
80	0.	0.	0.
81	0.	0.	0.
82	0.	0.	0.
83	0.	0.	0.
84	0.	0.	0.
85	0.	0.	0.
86	0.	0.	0.
87	0.	0.	0.
88	0.	0.	0.
89	0.	0.	0.

BY DATE Sept 10
 CHKD. BY DATE
 SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A14 OF A14
 PROJECT C262

IN EXCEL DATA
HEC-1 ROUTING

90	0.	0.	0.
91	0.	0.	0.
92	0.	0.	0.
93	0.	0.	0.
94	0.	0.	0.
95	0.	0.	0.
96	0.	0.	0.
97	0.	0.	0.
98	0.	0.	0.
99	0.	0.	0.
100	0.	0.	0.
SUM			34396.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3569.	1418.	358.	344.	34396.
INCHES		4.25	4.30	4.30	4.30
AC-FT		703.	711.	711.	711.

**

 **

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	3611.	1423.	358.	344.	3.10
ROUTED TO	1	3569.	1418.	358.	344.	3.10

DATE
FILMED
— 8