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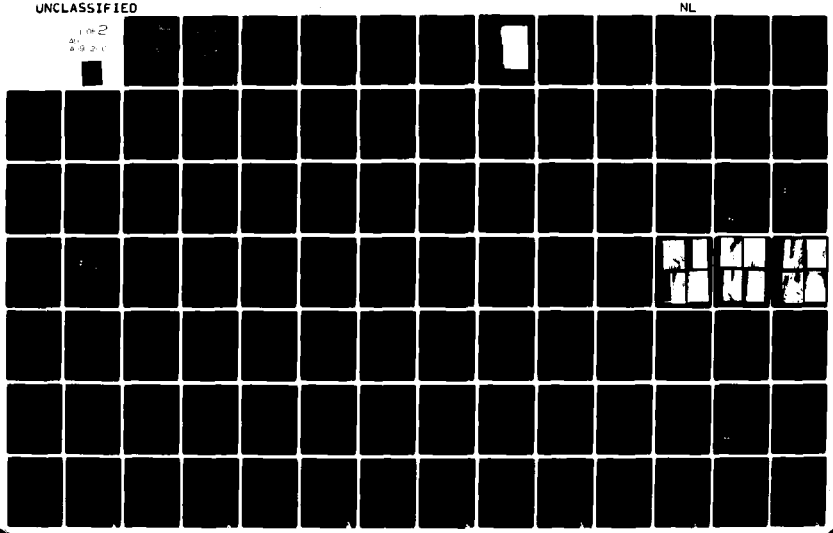

SUSQUEHANNA RIVER BASIN

OLEY CREEK, LUZERNE COUNTY

PENNSYLVANIA LEVEL II

LAKE OF THE FOUR SEASONS DAM

NDS ID NO. PA—568

DER ID NO. 40-225

AD A091266

DIVERSIFIED MORTGAGE INVESTORS INC.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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Prepared By

L. ROBERT KIMBALL & ASSOCIATES

CONSULTING ENGINEERS & ARCHITECTS

EBENSBURG, PENNSYLVANIA

15931

DACW31-80-C-0020

FOR

DEPARTMENT OF THE ARMY

BALTIMORE DISTRICT CORPS OF ENGINEERS

BALTIMORE, MARYLAND

21203

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SEPTEMBER, 1980

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SUSQUEHANNA RIVER BASIN,
OLEY CREEK, LUZERNE COUNTY,

(1)

PENNSYLVANIA

(6) National Dam Inspection Program,

LAKE OF THE FOUR SEASONS DAM

Number (NDS-ID NO. PA—568,
DER-ID NO. 40-225)

~~DIVERSIFIED MORTGAGE INVESTORS, INC.~~

PHASE I INSPECTION REPORT,
NATIONAL DAM INSPECTION PROGRAM

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(10) R. Jeffrey Kimball

Prepared By
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG, PENNSYLVANIA
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FOR

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BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

SEPTEMBER, 1980

411 057

PREFACE

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

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. 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 detemining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I REPORT
NATIONAL DAM INSPECTION REPORT

NAME OF DAM	Lake of the Four Seasons Dam
STATE LOCATED	Pennsylvania
COUNTY LOCATED	Luzerne
STREAM	Oley Creek
COORDINATES	Lat: 41° 02.9' Long: 75° 55.5'
DATE OF INSPECTION	April 8 and 9, 1980

ASSESSMENT

The assessment of Lake of the Four Seasons Dam is based upon visual observations made at the time of inspection, review of available records and data, hydraulic and hydrologic computations.

The inspection and review of available data of the Lake of the Four Seasons Dam did not reveal any problems which require emergency action. The main embankment and dike section appear to be in good condition. The spillway structures are both under construction. The completed portion of the ogee spillway appeared to be in good condition. The ogee spillway exit channel is under construction.

The reservoir was drained at the time of inspection and observation of any seepage was impossible. No evaluation of the structural stability of the dam could be made. Serious soil problems are associated with the ogee spillway approach and exit channel which may also exist under the embankments. The owner should provide documentation of embankment and foundation soil properties and stability and seepage analyses of the dam.

Lake of the Four Seasons Dam is a high hazard-intermediate size dam. The spillway design flood for a dam of this size and classification is the PMF. The spillway and reservoir are capable of controlling approximately 54% of the PMF. Definitions used by the Corps of Engineers indicate that the spillway should be rated as inadequate. However, the temporary and permanent (as designed) auxiliary spillway has the potential for erosion of the exit channel and subsequent erosion of the toe of dam. It is possible that a failure of the dam could result at less than 1/2 PMF by erosion of the embankment toe.

Modifications currently proposed to the auxiliary spillway and plans to increase the top of dam do not appear to substantially increase the spillway capacity.

The following recommendations and remedial measures should be instituted immediately.

1. A study should be conducted by a registered professional engineer experienced in design and construction of dams to determine the erosion potential and capacity of the auxiliary spillway exit channel and its effect on the toe of the dam.

2. The owner should provide documentation of embankment (both main and dike) and foundation soil properties and stability analyses and seepage analyses for the long term stability of the structures.

3. A final inspection should be conducted at the dam upon completion of the project. The embankments should be monitored during and after initial filling of the reservoir to determine whether actual conditions are in agreement with assumed design parameters. The filling of the reservoir should be under the direct supervision of a registered professional engineer knowledgeable in dam design and construction.

4. Upon completion of the project the drain valve should be operated and lubricated on a regular basis.

5. A warning system should be developed to warn downstream residents of large spillway discharges or imminent failure of the dam upon completion of the project.

6. A safety inspection should be implemented with inspections at regular intervals by qualified personnel.

7. Repair erosion gullies on the embankment slopes and provide a means of eliminating the erosion potential.

8. It should be ascertained whether or not the pipe through the dike has been plugged, if not some means of positive upstream closure should be provided.

9. The top of dam elevation should be graded to minimum design elevations and maintained. Fill placement and grading operations should conform to current engineering practice.

LAKE OF THE FOUR SEASONS DAM
PA 568

SUBMITTED BY

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS

Date

R. Jeffrey Kimball, P.E.

APPROVED BY:

26/Sep/1980
Date

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Overview of Lake of the Four Seasons Dam

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PHASE I
NATIONAL DAM INSPECTION PROGRAM
LAKE OF THE FOUR SEASONS DAM
NDI. I.D. NO. PA 568
DER I.D. NO. 40-225

SECTION 1
PROJECT INFORMATION

1.1 General.

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

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

1.2 Description of Project.

a. Dam and Appurtenances. The Lake of the Four Seasons Dam consists of two earthfill impounding structures (see page A-12). The main embankment (dam) is an earthfill dam, 1500 feet long and 29 feet high. The measured crest width of the main embankment (dam) is 12 feet. The upstream slope of the embankment is 2.75H:1V and is protected with riprap. The downstream slope is 2H:1V and grass covered. Along the toe of the dam is a paved gutter which collects surface runoff and drains toward the outlet structure for the 24" drainline.

The drainline for the dam consists of a 24" diameter reinforced concrete pipe. A control structure on the upstream slope of the embankment controls flow through this pipe. The reservoir drain control structure is located approximately 350 feet from the left abutment.

At the left abutment of the main embankment (dam) are two spillways. One spillway consists of a concrete culvert type spillway, modified to function as an orifice. Immediately adjacent to the concrete structure at the left abutment is an open earth cut channel which serves as a temporary auxilary spillway for the dam. The open cut channel is trapezoidal in shape. Flow through the open cut spillway and the concrete orifice type spillway discharge into an open channel which runs parallel to the toe of the dam and discharges flows into the stream approximately 100 feet below the outlet structure for the drainline. The discharge channel for the spillways appears to have been cut into natural ground and is bounded on the right by a berm which serves to contain flows in the channel.

The second impounding structure (dike) is located approximately 1/2 mile southwest of the main embankment. The dike is approximately 600 feet long, and 26 feet high. The upstream and downstream slopes are 2H:1V and the upstream slope is protected with riprap. A small cast iron pipe exists through the dike section. The crest width of the dike is approximately 15 feet. A paved gutter exists along the downstream toe of the dam draining surface runoff toward the discharge structure.

A permanent concrete ogee spillway is located approximately 500 feet southwest of the dike on the left abutment. The structure consists of a concrete ogee spillway with a weir length of 120 feet. The spillway approach consists of an open cut earth channel approximately 900 feet long with earth dikes on each side. The spillway exit channel design has been completed but construction is not yet completed.

b. Location. The dam is located on Oley Creek, a tributary to the Nescopeck Creek, Luzerne County, Pennsylvania. Lake of the Four Seasons Dam can be located on the Freeland, U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. Lake of the Four Seasons Dam is an intermediate size dam (29 feet, 2440 ac-ft).

d. Hazard Classification. Lake of the Four Seasons Dam is a high hazard dam. Downstream conditions indicate that loss of more than a few lives is probable should the structure fail. An amusement park and approximately 30 homes are located immediately downstream of the dam, with most residents being located southwest of Route 309 and adjacent to the banks of the Nescopeck Creek. Approximately 150 people are located within this area downstream of the Lake of the Four Seasons Dam.

e. Ownership. Lake of the Four Seasons Dam is owned by the Diversified Mortgage Investors. Correspondence should be addressed to:

Mr. Howard Imme
Diversified Mortgage Investors
5915 Ponce DeLeon Boulevard
Coral Gables, Florida 33146

f. Purpose of Dam. Lake of the Four Seasons Dam was constructed for the purposes of recreation and real estate development.

g. Design and Construction History. Lake of the Four Seasons Dam is under construction. The dam originally was called the Penn Highland Dam. The Penn Highland Dam was constructed

around 1966. The original dam (Penn Highland) was designed and constructed by the original owner Mr. George Woelfel. The property was then sold to Eastern Pennsylvania Marine Properties, Inc. The Eastern Pennsylvania Marine Properties, Inc. planned to develop the land for the purposes of real estate development. The developer hired E. D'Appolonia of Pittsburgh who performed the design of the development and drawings relative to the spillway. The project was never fully constructed. Several drawings relative to the E. D'Appolonia design are included in Appendix E of this report. The project laid dormant for a number of years and around 1978 the present owner, Diversified Mortgage Investors (DMI), INMID Corporation, purchased the property from the bankrupted Eastern Pennsylvania Marine Properties, Inc.

During the 1972 flooding associated with Hurricane Agnes, the spillway, was damaged by the flooding. The dam and the dike were not damaged during this flooding. An ogee spillway section was initially planned to be constructed at the entrance of the existing spillway channel but was later moved to its present location (see appendix E-8).

Around 1973 or 1974 the Pennsylvania Department of Environmental Resources issued an order to padlock open the drain valve at the main embankment and to keep the lake drained until such a time as construction at the project was completed. The valve is still padlocked and the reservoir remains at a low level.

Before 1978, the existing concrete ogee spillway was completed. Several items including the spillway backfilling and the spillway approach were not completed. In 1978 the firm of Gannett Flemming Corddry & Carpenter Inc. were retained to review previous work and to recommend a future course for construction of the project related to the spillway and channel. The firm's recommended plan for the spillway facility, including the approach channel from the reservoir and the details of the exit channel between the weir and the downstream side of the recommended vehicular bridge as presented in their report, are as shown on Plate No. 1 (see appendix E-8).

In 1978, the design and construction work was resumed on the spillway exit channel. Many construction problems including high water tables, flowing sands, humus and peat were encountered and deposits have delayed the construction of the exit channel. The exit channel is still under construction.

In 1979, a temporary auxiliary spillway was cut in earth at the left abutment of the main embankment. This auxiliary spillway was to control spillway discharges during the construction of the ogee spillway exit channel. A spillway exit channel consisting of an earth cut and earth berm was constructed.

Design plans call for the auxiliary spillway to be made permanent by raising the weir elevation 3.2 feet and increasing the bottom width from 40 to approximately 50 feet.

h. Normal Operating Procedures. The reservoir, at the time of the inspection, was in a near drained condition. Normal flow into the reservoir is allowed to discharge through the drainline at the main embankment. The drainline valve is padlocked in an open condition. Since the project is not yet completed no normal operating procedures exist.

1.3 Pertinent Data.

a. Drainage Area. 8.47 square miles

b. Discharge at Dam Site (cfs).

Maximum flood at dam site	Unknown
Drainline capacity at normal pool	Unknown
Concrete orifice spillway	Undetermined
Spillway (ogee)	5415
Temporary auxiliary spillway	2405
Combined spillway and temporary auxiliary spillway capacity	7820

c. Elevation (U.S.G.S. Datum) (feet). - Field survey based on ogee spillway crest at elevation 1060.2 from design drawings (see appendix E-8).

Top of dam - low point - main embankment	1065.5
Top of dam - low point - dike	1067.5
Maximum pool - design surcharge	1066.0
Full flood control pool	N/A
Normal pool (proposed)	1060.0
Spillway crest (ogee)	1060.2
Temporary auxiliary spillway crest (average)	1058.3
Upstream invert - 24" RCP	Unknown
Downstream invert - 24" RCP	1039.2
Maximum tailwater	None
Toe of dam (embankment)	1037.0
Toe of dike	1041.0

d. Reservoir (feet).

Length of maximum pool	5700
Length of normal pool	5500

e. Storage (acre-feet).

Normal pool	1546
Top of dam (main embankment)	2440

f. Reservoir Surface (acres).

Top of dam (main embankment)	187
Normal pool	154
Spillway crest	154

g. Dam (main embankment).

Type	Earthfill
Length	1500 feet
Height	29 feet
Top width	12 feet
Side slopes (field measurement) - upstream	2.75H:1V
- downstream	2H:1V
Side slopes (design) - upstream	2H:1V
-downstream	2H:1V
Zoning	Unknown
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown

h. Dike.

Type	Earthfill
Length	585 feet
Height	26 feet
Top width	15 feet
Sideslopes (field measurement) - upstream	2H:1V
- downstream	2H:1V
Sideslopes (design) - upstream	2H:1V
- downstream	2H:1V
Zoning	Unknown
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown

i. Reservoir Drain (main embankment).

Type	24" reinforced concrete pipe
Length	Unknown
Closure	Gate valve
Access	Control structure on upstream slope
Regulating facilities	Valve in control tower on upstream slope

j. Spillway.

Type	Concrete ogee section
Length	120 feet
Crest elevation	1060.2
Upstream channel	Spillway approach channel
Downstream channel	Discharge channel which joins Oley Creek

k. Temporary auxiliary spillway.

Type	Open cut (trapezoidal)
Bottom width	40 feet
Crest elevation (average)	1058.3
Upstream channel	Lake (unrestricted)
Downstream channel	Discharge channel to natural streambed beyond toe of dam

l. Orifice spillway.

Type	Orifice
Crest length	12 feet
Crest elevation	1060.0
Area of opening	9 sq.ft.
Upstream channel	Lake (unrestricted)
Downstream channel	Discharge channel to natural streambed beyond toe of dam

SECTION 2
ENGINEERING DATA

2.1 Design. Most of the design information was obtained from the owner, E. D'Appolonia Consulting Engineers and the PennDER. The owner provided E. D'Appolonia drawings on remedial construction details, design drawings by Gannett Fleming Corddry and Carpenter, Inc., and a design report by Gannett Fleming Corddry and Carpenter, Inc., dated September 25,1978. E. D'Appolonia provided additional construction drawings. The PennDER provided a report by Gannett Fleming Corddry and Carpenter, Inc. dated August 6, 1980 on the spillways. No other information including correspondence, was provided by PennDER. All this information was reviewed for this study. Discussions with E. D'Appolonia, Gannett Fleming Corddry and Carpenter, Inc., Department of Environmental Resources and George Woelfel were conducted to obtain additional information.

No soils data (boring logs or test data) were available for the dike or embankment. Some soils data was available on the spillway and spillway exit channel. Hydrologic and hydraulic design data is summarized in Section 5.

2.2 Construction. Construction of the dam has progressed in various stages over a number of years. Several design engineers were involved in the design and construction of the dam and spillways. No information was available on the construction of the embankment and dike. Considerable construction information exists on the construction of the spillway exit channel, which is still under construction. Most of this information is summarized in Gannett Fleming Corddry and Carpenter, Inc. report of August 6, 1980. The report states that many problems were encountered during the construction of the exit channel including flowing sands, a high water table and humus and peat deposits.

2.3 Operation. The dam is not yet fully constructed. No operating records are maintained.

2.4 Evaluation.

a. Availability. Engineering data were provided by the owner. Design engineers were contacted for the purposes of this report and supplied minimal information. The PennDER only provided the Gannett Fleming Corddry and Carpenter, Inc. report of August 6, 1980.

b. Adequacy. The construction of the dam is still in progress. Design data and other information is available based on the present design but is subject to revision. The Phase I Report is based on visual inspection and hydraulic and hydrologic analysis. Sufficient information exists to complete a Phase I Report.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of Lake of the Four Seasons Dam was conducted by personnel of L. Robert Kimball and Associates accompanied by DER personnel on April 8 and 9, 1980. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portion of any outlet works and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. The dam appears to be in good condition. The reservoir area is maintained in a drained condition. Inflow into the reservoir area is discharged through the 24" RCP located through the main embankment of the dam. A low water level exists in the reservoir. At times inflow into the reservoir area exceeds the capacity of the 24" drainline forming a pool. The upstream slope of the dam was measured to be 2.75H:1V and is protected with riprap. The crest width of the dam measured 12 feet. The downstream slope of the dam is grass covered and the slope was measured to be 2H:1V. Several erosion channels exist on the downstream slope. A surface runoff collection drain exists along the toe of the dam and appears to be in good condition. No seepage was observed during the inspection on the downstream slope or along the toe of the dam; and, since the reservoir pool was nearly drained, the existence of seepage could not be determined. The area beyond the toe of the embankment is swampy.

A second impounding structure exists southwest of the main embankment section. This embankment is referred to as the dike. The crest width of the dike is approximately 15 feet and both the upstream and downstream slopes are 2H:1V. The upstream slope of the dike is protected with riprap. Almost no water is presently impounded at this structure. The downstream slope of the dike is grass covered and a surface runoff collection channel exists along the toe. An 8" or 12" cast iron pipe exists through the embankment section but drawings relative to the design indicate that the pipe has since been plugged. The valve for this pipe is located on the downstream end of the pipe at the toe of the dike section. Surface runoff has washed debris into this area and only the valve stem is visible. The design drawings are in conflict as to the size of this pipe.

c. Appurtenant Structures. The ogee spillway for the reservoir is located southwest of the dike. Construction continues in this area. The ogee section of this spillway is complete although work continues on the downstream section immediately below the spillway in the spillway exit channel. The spillway is a concrete ogee structure with a crest length of 120 feet. Flow into the spillway approach channel is partially blocked by a temporary dike at the entrance to the channel. The top of the temporary dike is below the spillway crest. The spillway exit channel has been partially excavated. No active work was in progress during the inspection.

A temporary auxiliary spillway exists at the left abutment of the main embankment. The temporary auxiliary spillway is cut into natural ground (earth) at the left abutment and is trapezoidal in shape. A discharge channel for the temporary auxiliary spillway flows parallel to the toe of the dam and outlets in the stream area below the toe of the dam. Construction in this area appears to be incomplete. A concrete orifice type flow structure exists near the left abutment of the dam and was the spillway structure for the original dam (Penn Highland Dam). Prior to construction of the temporary auxiliary spillway the box culvert spillway was modified as to serve as an orifice type spillway.

d. Reservoir Area. The watershed is covered mostly by timberland. The reservoir slopes are steep but do not appear to be susceptible to massive landslides which would affect the storage volume of the reservoir or cause overtopping of the dam by displacing water.

e. Downstream Channel. The downstream channel for the Lake of the Four Seasons Dam consists of Oley Creek which is a tributary of Neskopeck Creek.

3.2 Evaluation. Both the embankment and the dike appear to be in good condition. Erosion gullies are present on the downstream slope of the embankments. No determination of seepage problems could be made because the reservoir exists in a drained or near drained condition. The temporary auxiliary spillway located at the left abutment of the main embankment can only serve (in its present condition) as a temporary structure. Construction in this area is in progress. Design drawings (see appendix E-9) indicate that a permanent auxiliary spillway structure is to be constructed in this area. Construction of the permanent discharge channel for this structure as well as the modified concrete culvert spillway is not completed. The berm which forms the right embankment for the existing discharge channel is only sparcely riprapped and appears to require additional work to meet final design criteria. Flow through this channel could result in possible erosion of the right channel embankment and subsequent erosion of the downstream toe of the main embankment. The ogee spillway exit channel for the reservoir is still under construction.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. The water level in the reservoir is maintained in a drained or near drained condition. Construction of the Lake of the Four Seasons Dam is incomplete and the 24" drainline through the main embankment section is maintained in a locked open position. The drainline valve was not operated during the inspection.

4.2 Maintenance of the Dam. Construction of the dam is incomplete. No formal maintenance program exists.

4.3 Maintenance of Operating Facilities. Construction of the dam is yet incomplete. No formal maintenance program has yet been developed.

4.4 Warning System in Effect. There is no warning system in effect. The reservoir is maintained in a drained or near drained condition.

4.5 Evaluation. The condition of the dam and dike appear to be in good condition. Since construction at the site is as yet incomplete, no evaluation could be made as to operational procedures.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. No design information exists on the hydrologic or hydraulic analysis for the original dam. Gannett Fleming Corddry and Carpenter, Inc. have designed the permanent spillway facilities for this dam. Gannett Flemming Corddry and Carpenter, Inc. reports of September 25, 1978 and August 6, 1980 contain their hydrologic and hydraulic studies which are summarized below:

Top of dam	1066.0
Spillway design flood	About 1/2 PMF
Peak inflow (PMF)	16,000 cfs
Spillway capacity	67% PMF
Temporary auxiliary spillway capacity	Not stated
Permanent auxiliary spillway capacity	14% PMF
Total spillway capacity (spillway plus permanent auxiliary spillway combined)	81% PMF

During the construction of the spillway and spillway exit channel flowing sands, a high water table, humus and peat deposits were encountered.

b. Experience Data. No rainfall, runoff or reservoir level data were available.

c. Visual Observations. The ogee spillway structure appeared to be in good condition. Construction on the ogee spillway exit channel is not yet complete. The open cut temporary auxiliary spillway located on the left abutment of the main embankment exists as a temporary structure and remains to be completed as per design drawings located in Appendix E (see appendix E-9). The temporary auxiliary spillway exists as an open cut earth channel with construction of the discharge channel incomplete. Large flows through this area could affect the spillway, the right embankment of the discharge channel and the main embankment of the dam by erosion.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D.

5.2 Evaluation Assumptions. To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. The Spillway Design Flood (SDF) is considered as the PMF.

2. The dam was analyzed for hydrologic and hydraulic capabilities based upon the conditions existing at the time of inspection with the exception that the reservoir pool at the time of flood was at the temporary auxiliary spillway crest (1058.3) and the reservoir drain flows were neglected.

4. The top of dam was considered as the low spot elevation on the main embankment section. The top of dam was considered as 1065.5. The dike elevations and intermediate natural ground obstructions connecting the structures were analyzed through the $L, $V options provided in the (HEC-1) program option.

5. Both the ogee spillway and the temporary auxiliary spillway (in its temporary condition) were considered as being capable of discharging flow from the reservoir. Flow through the modified culvert spillway was not considered.

5.3 Summary of Overtopping Analysis. Complete summary sheets for the computer output are presented in Appendix D.

Peak inflow (PMF)	16455 cfs
Ogee spillway capacity	5415 cfs
Temporary auxiliary capacity	2405 cfs
Combined discharge capacity	7820 cfs

a. Spillway Adequacy Rating. The Spillway Design Flood (SDF) for this dam is the PMF. The SDF is based on the hazard and size classification of the dam. Based on the following definition provided by the Corps of Engineers, the spillway is rated as inadequate as a result of our hydrologic analysis.

Inadequate - All high hazard classification dams not capable of passing the spillway design flood (PMF).

The spillway and reservoir are capable of controlling approximately 54% of the PMF without overtopping the main embankment section of the dam.

Modifications currently prposed to the auxiliary spillway and plans to increase the top of dam do not appear to substantially increase the spillway capacity.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Erosion channels were visible on the downstream slopes of both the main embankment and the dike section. No seepage was visible in the area of the main embankment section or the dike. The reservoir is maintained in a near drained or drained condition and, therefore, no evaluation as to potential seepage could be determined. A swampy area was noted beyond the toe of the embankment. The drained condition of the dam and the lack of supporting geotechnical investigation make it impossible to assess the stability of the structure under the scope of this Phase I inspection.

Flow through the temporary auxiliary spillway discharge channel has the potential to erode the right embankment of the channel and the toe of the main embankment near the left abutment. Construction in this area is incomplete but the final design does not call for many revisions.

b. Design and Construction Data. Construction of the Lake of the Four Seasons Dam is not complete. The embankment structure as well as the dike appear to be complete. The spillway and the auxiliary spillway are still under construction. No known stability analyses have been conducted at the dam. Soils information in the form of boring logs and soils tests were not available. Their existence is uncertain. Representatives of PennDER indicated that the dam had seepage problems before it was ordered drained. There was discussion that some soils investigations were conducted to control the seepage but none were available from the sources contacted.

Insufficient information was available on the embankment and foundation soils to assess the stability of the embankments.

Considerable soil problems exist in the area of the ogee spillway and approach channel to the ogee spillway. The dam and reservoir is underlain with glacial deposits. During construction of the spillway approach and exit channels many soils problems were encountered. Gannett Fleming Corddry and Carpenter's report of August 6, 1980 states the following in regard to these soils problems:

> "Groundwater flowed freely through the fine sand areas causing springs, boils, and flowing masses of the finer sandy material in areas and locations where they were disturbed or exposed by an excavation cut."

> "Excavation on May 21, 1979 revealed the presence of fine organic silt, humus material and peat along the channel."

In view of the fact that these serious soil problems exist only several hundred feet away from the embankments, it is possible that they may exist there also. The reservoir has been drained for approximately 7 years and the problems associated with the original embankments are sketchy. When the reservoir is filled and during high heads, soil problems may occur in the area of the embankments. No monitors are present to detect unexpected conditions.

c. Operating Records. The Lake of the Four Seasons Dam is still under construction. No operating records exist.

d. Post Construction Changes. The Lake of the Four Seasons Dam is still under construction.

e. Seismic Stability. The dam is located in seismic zone 1. No seismic stability analyses has been performed. The long term stability of the embankments is unknown and any future analysis should consider the effects of seismic loading on the dam.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The main embankment of the dam and dike appear to be in good condition. Construction at the Lake of the Four Seasons Dam is not complete. Erosion channels were observed on the downstream slopes of the main embankment and the dike. No seepage was observed because the reservoir is maintained in a drained or near drained condition. Therefore, no seepage determination could be made. A swampy area was observed beyond the toe of the embankment.

Serious soil problems were encountered during construction of the ogee spillway, approach and exit channel. These areas are only several hundred feet away from the embankment. A stability analysis of the embankments (including subsurface investigation) should be conducted.

The temporary auxiliary spillway located at the left abutment at the main embankment exists in a temporary condition. Considerations should be given to the time frame which is estimated for the completion of the structure. If final construction appears to be delayed, measures should be taken to protect the spillway, discharge channel and right embankment section of the discharge channel against potential erosion.

The hydrologic and hydraulic analysis conducted for this study indicate that under conditions existing at the time of inspection, the spillways are capable of controlling 54% of the PMF without overtopping the embankment. Definitions used by the Corps of Engineers indicate that the spillway is inadequate. However, any large flows through the temporary auxiliary spillway may cause erosion of the toe and embankment.

The final design indicates that the auxiliary spillway will become permanent and the capacity may be less than the temporary spillway. The final design does not show additional erosion protection along the embankment toe. Should a storm approaching a magnitude of 1/2 PMF occur, potential discharges through the auxiliary spillway could erode the right embankment of the discharge channel, the toe of the dam near the left abutment and lead to potential failure of the dam.

Modific[illegible] to the auxiliary [illegible] and plans [illegible] not appear to substa[illegible] [illegible] spillway [illegible].

b. Ad[illegible] information. [illegible] information is available [illegible] Phase I Report. It should be noted that since this [illegible] under construction the potential for design modifications exists and any changes in the design would negate the applicability of this report.

c. [illegible] recommendations suggested below should be implemented [illegible].

d. Nec[illegible] further investigation. In order to accomplish [illegible] recommendations/remedial measures outlined below, further investigations will be required.

[illegible].2 Recommendations Remedial Measures.

1. [illegible] conducted by a registered professional [illegible] experienced in design and construction of [illegible] to det[illegible] on potential and capacity of the auxiliary [illegible] the [illegible] of [illegible].

2. [illegible] provide [illegible] of embankment both [illegible] foundation soil properties and stability [illegible] long term stability [illegible].

3. A [illegible] conducted [illegible] the dam upon [illegible]. The [illegible] should be monitored during [illegible] filling of the reservoir to determine [illegible] are in agreement with assumed design [illegible] of the reservoir should be under the direct su[illegible] registered professional engineer [illegible] design and construction.

4. [illegible] of the project the drain valve should [illegible] on a regular basis.

5. A [illegible] should be developed to warn downstream [illegible] spillway discharges or imminent failure of [illegible] dam [illegible] of the project.

6. [illegible] inspection should be implemented with inspections at [illegible] intervals by qualified personnel.

7. Repair [illegible] gullies on the embankment slopes and provide a [illegible] eliminating the erosion potential.

8. It should be ascertained whether or not the pipe through the [illegible] has been plugged, if not some means of positive [illegible] should be provided.

9. The top of dam elevation should be graded to minimum design elevations and maintained. Fill placement and grading operations should conform to current engineering practice.

APPENDIX A
CHECKLIST, VISUAL INSPECTION, PHASE I

CHECK LIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Lake of the Four Seasons Dam COUNTY Luzerne STATE Pennsylvania ID# 568

TYPE OF DAM Earthfill HAZARD CATEGORY High

DATE(s) INSPECTION April 8 and 9, 1980 WEATHER Overcast and cool TEMPERATURE 50°

POOL ELEVATION AT TIME OF INSPECTION 1048.0 M.S.L. TAILWATER AT TIME OF INSPECTION None M.S.L.

INSPECTION PERSONNEL:

R. Jeffrey Kimball, P.E. - L. Robert Kimball and Associates

James T. Hockensmith - L. Robert Kimball and Associates

O.T. McConnell - L. Robert Kimball and Associates

Brian Maguire - Pennsylvania Department of Environmental Resources

Dennis Dickey - Pennsylvania Department of Environmental Resources

James T. Hockensmith RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion channels developing on the downstream slope of the main embankment and dike.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Appear to be all right.	
RIPRAP FAILURES	None.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Downstream slopes, both at the main embankment and dike section are grass covered.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Appear to be all right.	
ANY NOTICEABLE SEEPAGE	No determination of seepage could be made. Reservoir maintained in a drained or near drained condition. Wet area beyond toe of dam.	
STAFF GAUGE AND RECORDER	None.	
DRAINS	Unobserved.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Not applicable.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Not applicable.	
DRAINS	Not applicable.	
WATER PASSAGES	Not applicable.	
FOUNDATION	Not applicable.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not applicable.	
STRUCTURAL CRACKING	Not applicable.	
VERTICAL AND HORIZONTAL ALIGNMENT	Not applicable.	
MONOLITH JOINTS	Not applicable.	
CONSTRUCTION JOINTS	Not applicable.	
STAFF GAUGE OR RECORDER	Not applicable.	

OUTLET WORKS (Reservoir Drain)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not observed.	Valve was locked open.
INTAKE STRUCTURE	Unobserved.	
OUTLET STRUCTURE	None.	
OUTLET CHANNEL	Open earth cut with riprap for approximately 25 feet.	
EMERGENCY GATE	Locked open.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete ogee section appears to be in good condition. Construction in this area is as yet incomplete. Immediate downstream channel below structure is still under construction.	
APPROACH CHANNEL	The ogee spillway approach channel appears to be in good condition. Temporary dike constructed at the entrance to the approach channel.	Soil problems. See text.
DISCHARGE CHANNEL	Under construction.	Soil problems. See text.
BRIDGE AND PIERS	None.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Open earth cut, trapezoidal.	Temporary.
APPROACH CHANNEL	Open earth cut.	
DISCHARGE CHANNEL	Open earth cut with earth berm. Limited riprap.	Potential to erode or overflow and erode toe embankment.
BRIDGE AND PIERS	Not applicable.	
GATES AND OPERATION EQUIPMENT	Not applicable.	

DOWNSTREAM CHANNEL

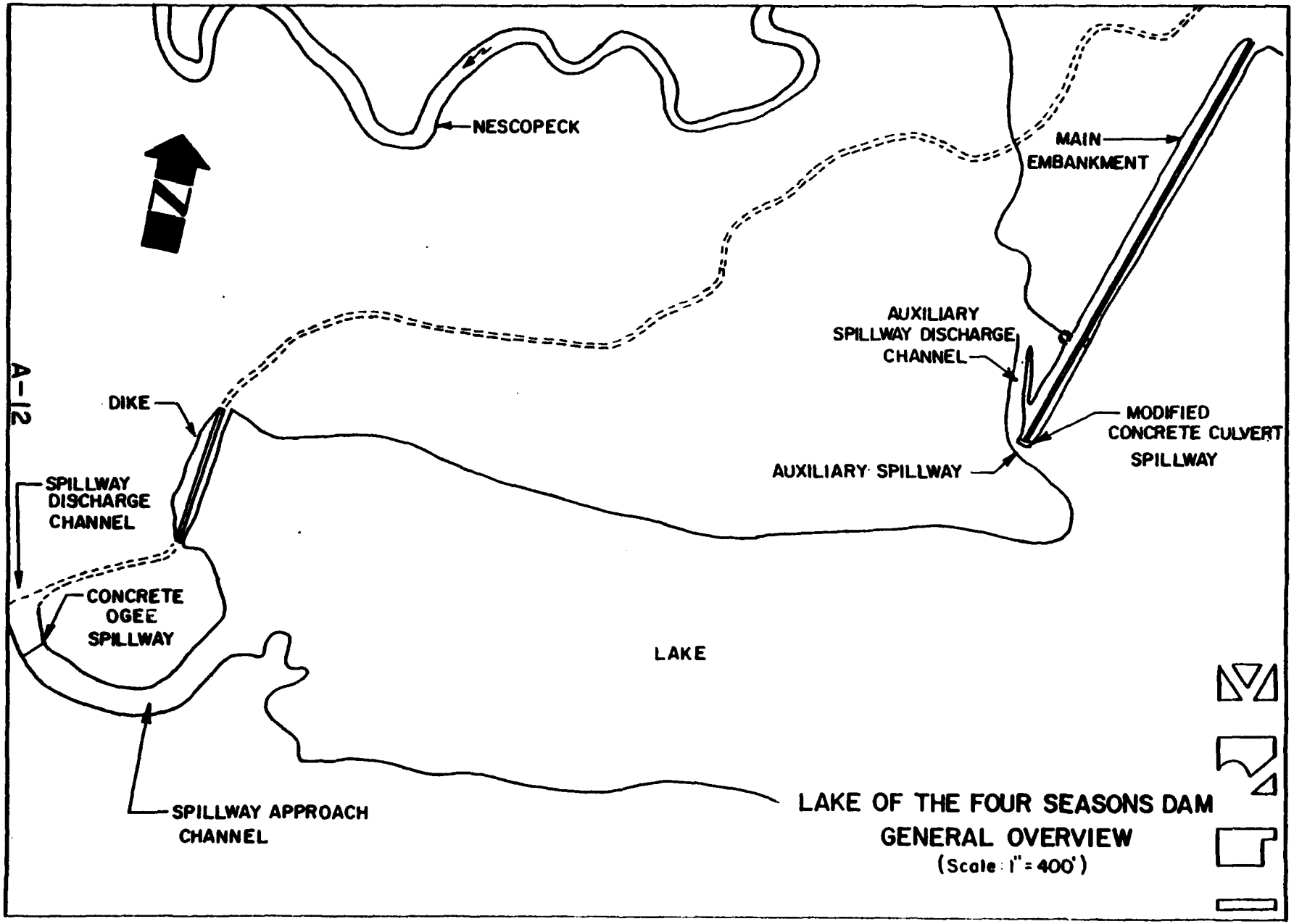
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Oley Creek exists as the downstream channel for the dam.	
SLOPES	Appear to be stable.	
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 30 homes - 120 people and an amusement park immediately adjacent to Route 309 downstream of dam.	

RESERVOIR

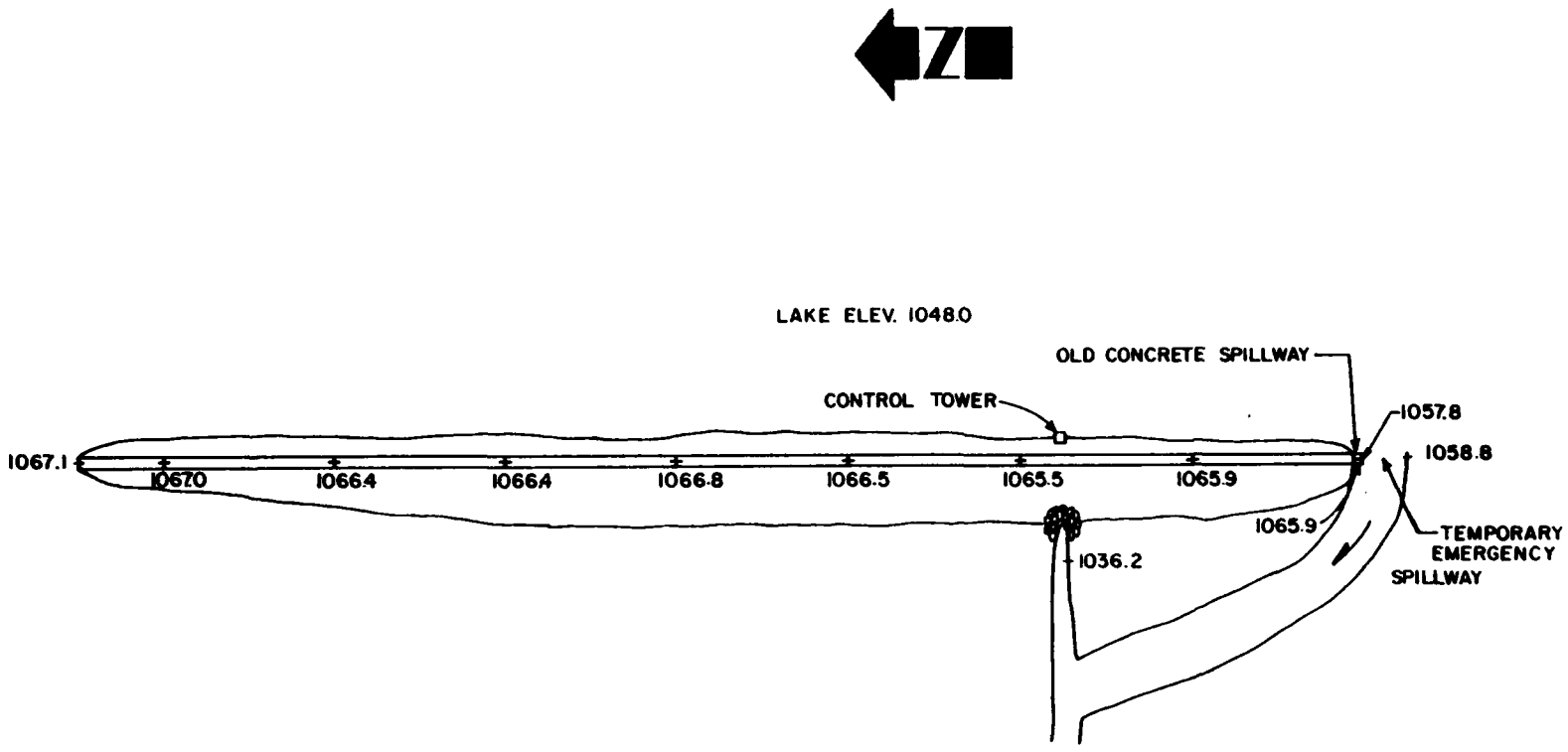
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Steep, appear to be stable.	
SEDIMENTATION	Unknown.	

INSTRUMENTATION

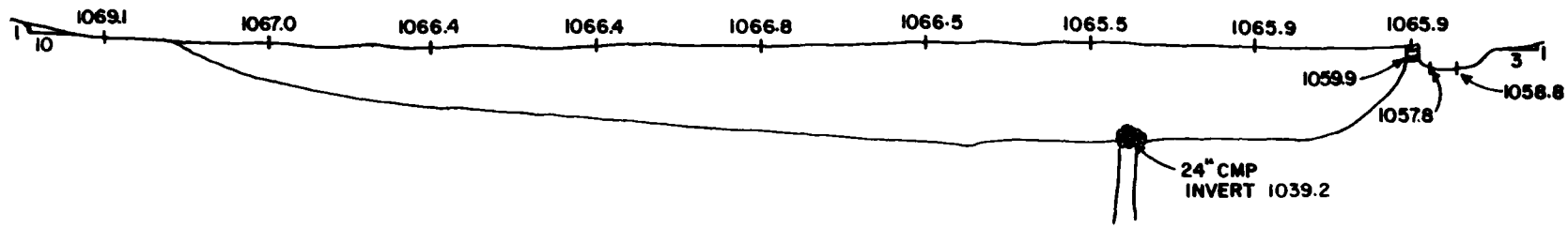
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	



LAKE OF THE FOUR SEASONS DAM
GENERAL OVERVIEW
(Scale: 1" = 400')



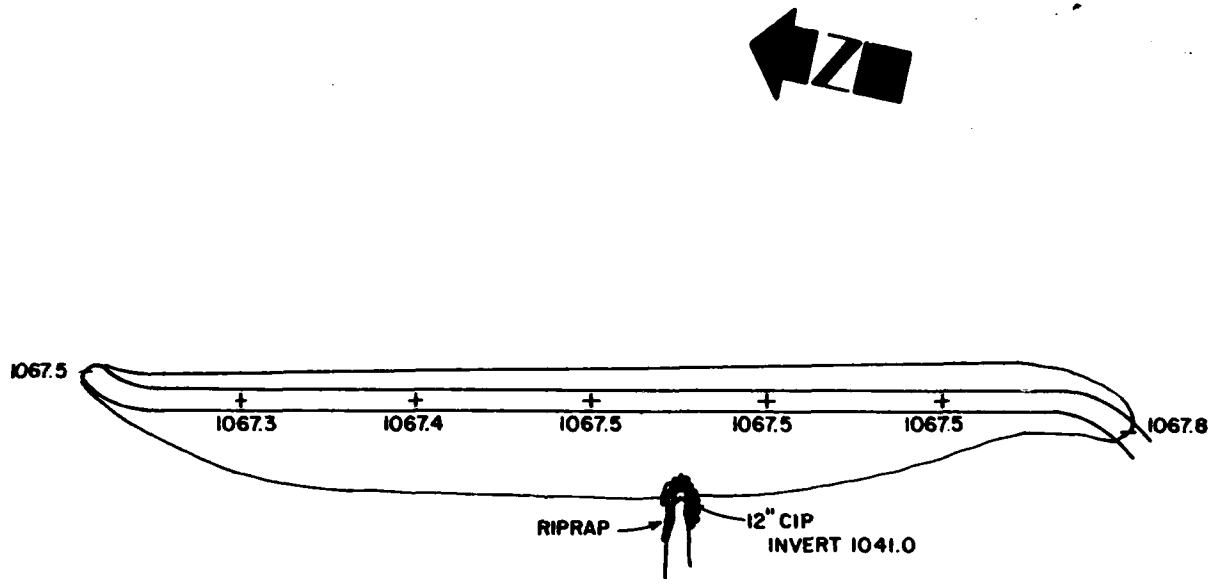
LAKE OF THE FOUR SEASONS DAM
(MAIN EMBANKMENT)
(Scale: 1" = 200')



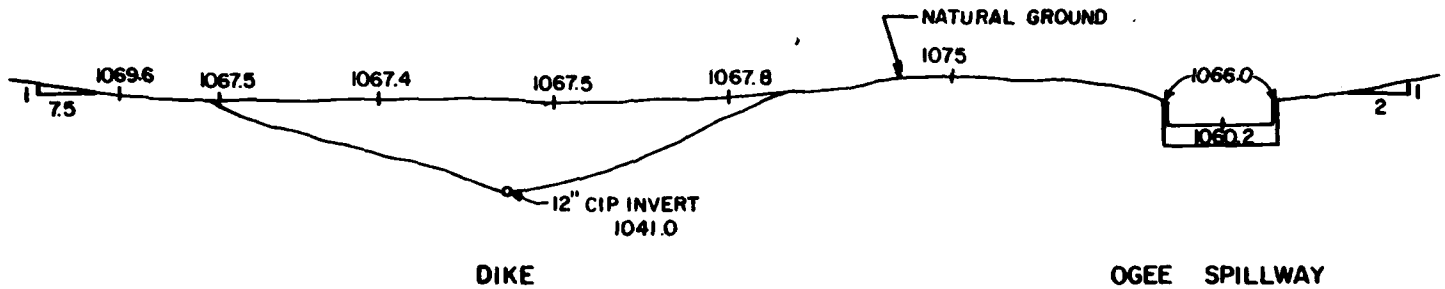
PROFILE OF MAIN EMBANKMENT
LOOKING UPSTREAM

Scale: Horiz. 1" = 200'
Vert. 1" = 50'

LAKE OF THE FOUR SEASONS DAM



LAKE OF THE FOUR SEASONS DAM
(DIKE)
(Scale: 1" = 100')



PROFILE OF DIKE AND OGEE SPILLWAY
LOOKING UPSTREAM

Scale: Horiz. 1" = 200'
Vert. 1" = 50'

LAKE OF THE FOUR SEASONS DAM

APPENDIX B
CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Lake of the Four Seasons Dam

ID# 568

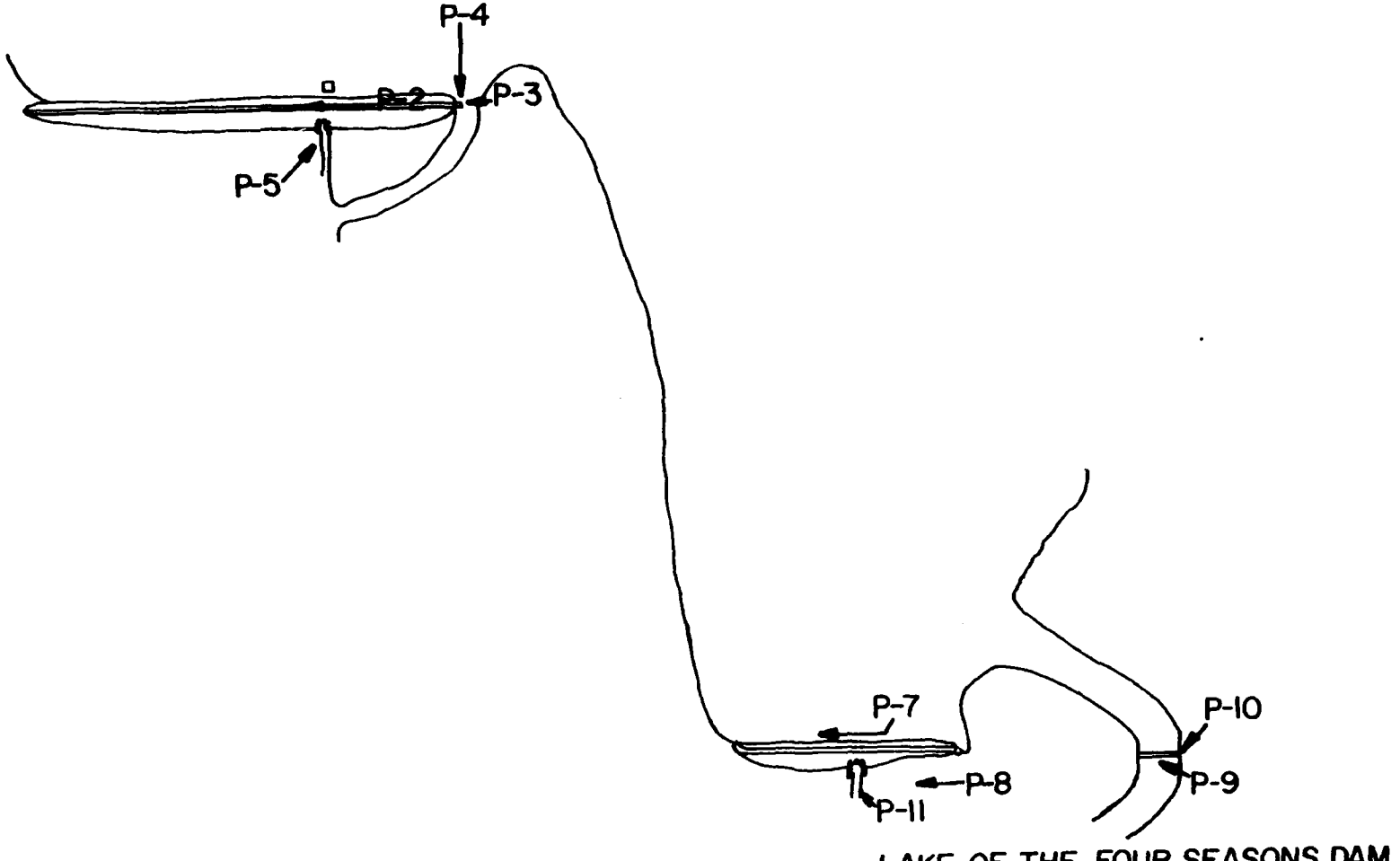
ITEM	REMARKS
AS-BUILT DRAWINGS	Construction incomplete.
REGIONAL VICINITY MAP	U.S.G.S. quadrangle.
CONSTRUCTION HISTORY	Construction not complete. See text.
TYPICAL SECTIONS OF DAM	Proposed sections in Appendix E.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS RAINFALL/RESERVOIR RECORDS	Appendix E. Appendix E. Unknown. Unknown. None.

ITEM	REMARKS
DESIGN REPORTS	Dam still under construction. Present reports available by the owner. See text - spillway design reports by Gannett, Fleming, Corddry, Carpenter Inc.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Unknown. Gannett Fleming Corddry and Carpenter, Inc. None. None.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Unknown. Gannett, Fleming, Corddry, Carpenter, Inc. has soil studies associated with spillway.
POST-CONSTRUCTION SURVEYS OF DAM	Dam still under construction.
BORROW SOURCES	Unknown.

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Dam still under construction.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Unknown.
MAINTENANCE OPERATION RECORDS	None.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	Appendix E.
OPERATING EQUIPMENT PLANS & DETAILS	None.

APPENDIX C
PHOTOGRAPHS



LAKE OF THE FOUR SEASONS DAM
PHOTO INDEX

P—INDICATES PHOTO LOCATION

LAKE OF THE FOUR SEASONS DAM
PA 568

Photograph Descriptions

Sheet 1. Front

(1) Upper left - Overview.
(2) Upper right - Main embankment section, upstream slope, downstream slope and embankment crest.
(3) Lower left - View of main embankment section from the left abutment, note emergency spillway in foreground.
(4) Lower right - Culvert spillway at left abutment of main embankment.

Sheet 1. Back

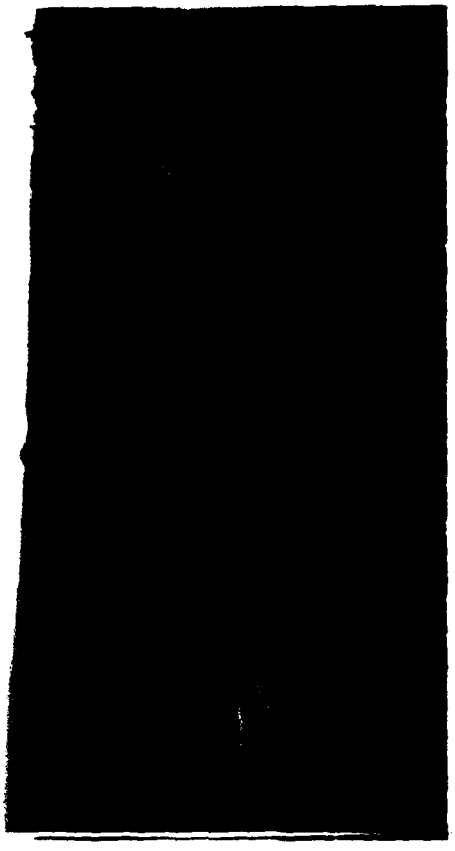
(5) Upper left - 24" reinforced concrete pipe (main embankment).
(6) Upper right - Overview.
(7) Lower left - Crest and upstream slope of dike.
(8) Lower right - Crest and downstream slope of dike.

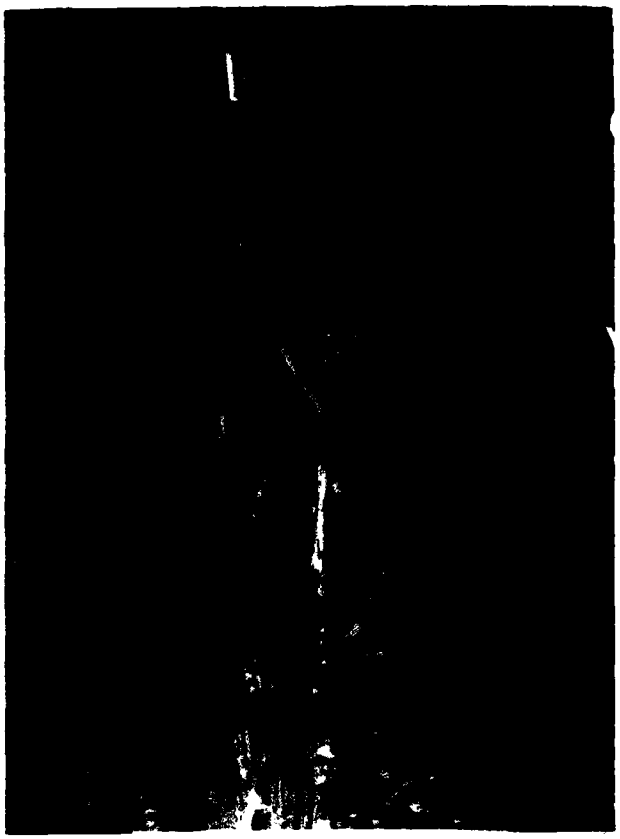
Sheet 2. Front

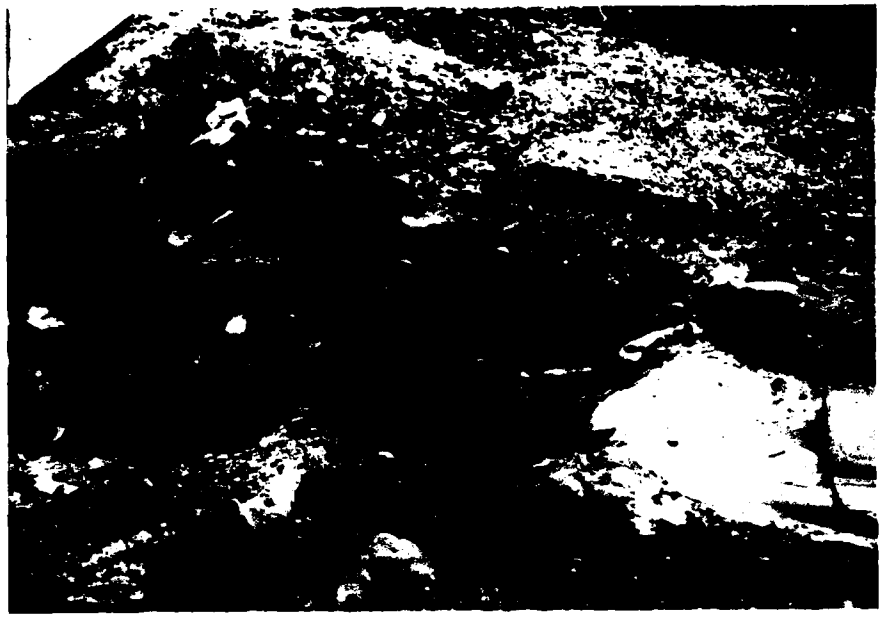
(9) Upper left - Principal spillway.
(10) Upper right - Discharge channel construction for principal spillway.
(11) Lower left - Valve at toe of dike.
(12) Lower right - Downstream exposure along Route 309 below dam.

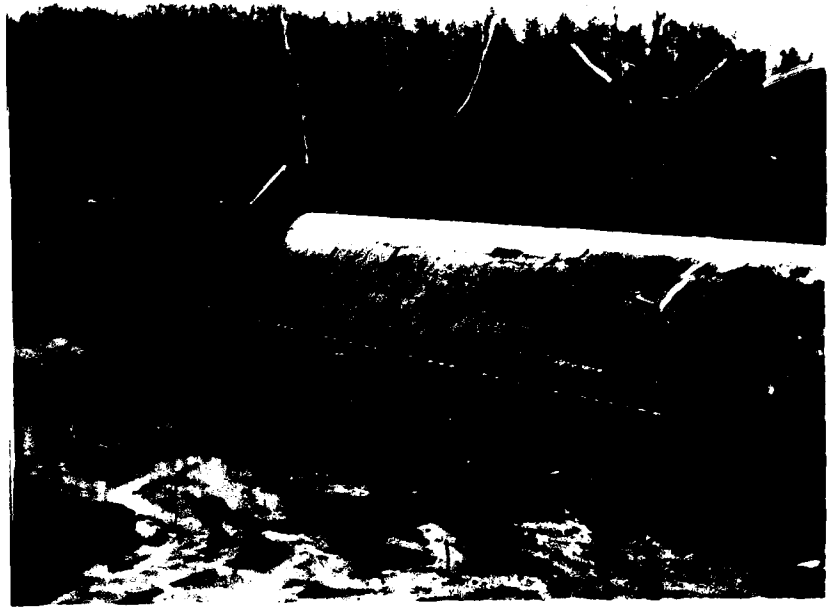
TOP OF PAGE

1	2
3	4









APPENDIX D
HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation. The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. 40" prepared by the U.S. Weather Bureau.

The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

Parameter	Definition	Where Obtained
Ct	Coefficient representing variations of watershed	From Corps of Engineers*
L	Length of main stream channel miles	From U.S.G.S. 7.5 minute topgraphic
Lca	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic
Cp	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

3. Routing. Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping. Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach and Downstream Routing. The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre-failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

HYDROLOGY AND HYDRAULICS ANALYSIS
DATA BASE

NAME OF DAM: Lake of the Four Seasons

PROBABLE MAXIMUM PRECIPITATION (PMP) = 2.22 (.99) = 21.98 inches

STATION	SUBAREA			
Station Description	A	B	C	D
Drainage Area (square miles)	1.09	1.78	3.25	2.35
Cumulative Drainage Area (square miles)	1.09	1.78	6.12	8.47
Adjustment of PMF for Drainage Area (%)(1)				
6 hours		117		
12 hours		127		
24 hours		136		
48 hours		143		
72 hours		145		
Snyder Hydrograph Parameters				
Zone (2)		13		
Cp (3)		.5		
Ct (3)		1.85		
L (miles) (4)	2.4	1.7	3.03	2.3
Lca (miles) (4)	.90	.80	1.7	1.00
tp = Ct(LxLca) 0.3 hrs.	2.33	2.03	3.03	2.37
Spillway Data				
Crest Length (ft)		120		
Freeboard (ft)		5.3		
Discharge Coefficient		3.7		
Exponent		1.5		

(1) Hydrometeorological Report 40 (Figure 1), U.S. Army Corps of Engineers, 1965.

(2) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's coefficients (C_p and C_t).

(3) Snyder's Coefficients.

(4) L=Length of longest water course from outlet to basin divide. L_{ca}=Length of water course from outlet to point opposite the centroid of drainage area.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: D.A. = 8.47 mi^2

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1546 ac-ft

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 2440 ac-ft

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1065.5 feet

SPILLWAY CREST:

a. Elevation 1060.2 feet
b. Type Concrete-ogee
c. Width 120 feet
d. Length Unknown
e. Location Spillover Discharge channel
f. Number and Type of Gates None

OUTLET WORKS:

a. Type 24" RCP
b. Location Through main embankment
c. Entrance inverts Unknown
d. Exit inverts 1039.2
e. Emergency draindown facilities 24" RCP

HYDROMETEOROLOGICAL GAUGES:

a. Type None
b. Location None
c. Records None

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

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CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE OF THE FOUR SEASONS
I.D. NUMBER PA. 568
SHEET NO. 1 OF 4
BY OTM DATE 8-4-80

LOSS RATE AND BASE FLOW PARAMETERS

AS RECOMMENDED BY THE BALTIMORE DISTRICT CORPS OF ENGINEERS.

STRTL = 1 INCH
CNSTL = 0.05 IN./HR.
STRTQ = 1.5 CFS /M.²
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.0

ELEVATION - AREA RELATIONSHIP

FROM D.E.R. FILES. DESIGN DRAWING (APPENDIX E, PAGE E-7)

ELEV. (FT)	AREA (AC.)
1040	0
1045	23
1050	85
1055	126
1060	154
1065	180
1070	213

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CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME FOUR SEASONS
I.D. NUMBER 56B
SHEET NO. 2 OF 4
BY SAB DATE 5-19-80

DISCHARGE RATING CURVE

TRAPEZOIDAL FLOW FROM:

$$Q = 8.03 C' h_v^{1/2} (h_p - h_v)\left[B + Z(h_p - h_v)\right]$$

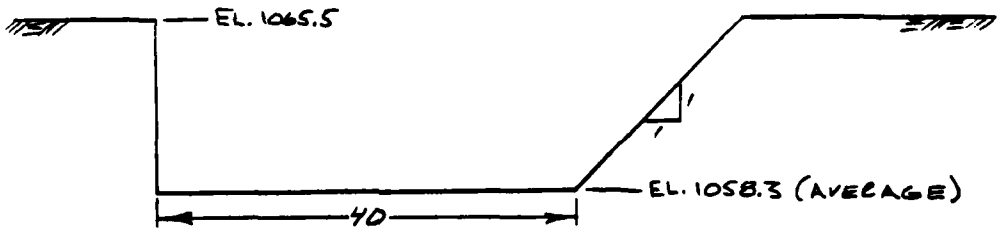
$$h_v = 3(2Z h_p + B) - (16 Z^2 h_p^2 + 16 Z B h_p + 9B^2)^{1/2}$$

WEIR FLOW FROM:

$$Q = C L h_p^{1.5}$$

SOURCE: WATER & WASTEWATER ENGINEERING
by: FAIR, GEYER, OKUM 1966

EXISTING AUXILIARY SPILLWAY
(NOT TO SCALE)



$C' = .95$ $B = 40$ $Z = .5$

$C = 3.2$ $L = 47.2$

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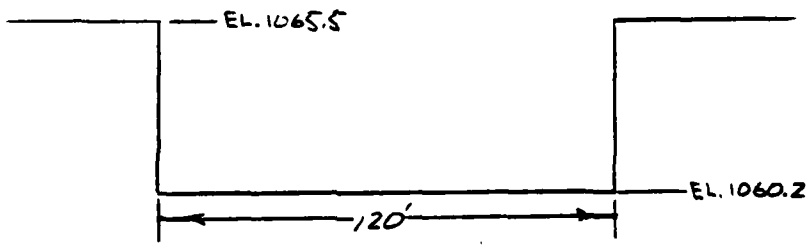
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME FOUR SEASONS
I.D. NUMBER 568
SHEET NO. 3 OF 4
BY CAB DATE 5-19-80

	TRAPEZOIDAL		WEIR		
ELEV (FT)	h_D (FT)	Q^* (CFS)	h_D (FT)	Q^* (CFS)	Q^*_{TOTAL}
1058.3	0	0			0
1059.0	.7	70			70
1060.0	1.7	265			265
1060.2	1.9	310			310
1062.0	3.7	860			860
1065.0	6.7	2150			2150
1065.5	7.2	2405			2405
1067.0			1.5	270	2675
1069.0			3.5	990	3395

PERMANENT SPILLWAY
(NOT TO SCALE)



$C = 3.7$
$L = 120$

	WEIR	
ELEV (FT)	h_D (FT)	Q^* (CFS)
1060.2	0	0
1062.0	1.8	1070
1065.0	4.8	4670
1065.5	5.3	5415
1067.0	6.8	7875
1069.0	8.8	11590

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME FOUR SEASONS
I.D. NUMBER 568
SHEET NO. 4 OF 4
BY CAB DATE 5-19-80

Y4	1058.3	1059	1060	1060.2	1062	1065
Y5	0	70	265	310	1930	6820

1065.5	1067	1069
7820	10550	14985

* VALUES ROUNDED TO NEAREST 5CFS

OVERTOPPING PARAMETERS

TOP OF DAM = 1065.5
LENGTH OF DAM (EXCLUDING SPILLWAY) = 2085
COEFFICIENT OF DISCHARGE = 3.1

SL	15	165	910	1400	2045	2200
SV	1065.5	1066	1066.5	1067	1067.5	1068

2330
1069

CHANNEL ROUTING PARAMETERS

CROSS SECTIONS OBTAINED FROM 7.5MIN. U.S.G.S. QUAD.

MANNING'S n

CHANNEL = .05
OVERBANK = .06

```
*******************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
*******************************
   1          A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
   2          A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF FOUR SEASONS DAM
   3          A3      RATIOS OF THE PMF ROUTED THROUGH THE RESERVOIR (568)
   4          B     288       0      15       0       0       0       0       0      -4       0
   5          B1      5
   6          J       1       4       1
   7          J1     .4      .5      .6       1
   8          K       0       1                                       1
   9          K1       INFLOW FROM SUBAREA A
  10          M       1       1    1.09
  11          P            21.98     117     127     136     143     145
  12          T                                                    1.0     .05
  13          W    2.33      .5
  14          X    -1.5    -.05     2.0
  15          K       0       2                                       1
  16          K1       INFLOW FROM SUBAREA B
  17          M       1       1    1.78
  18          P            21.98     117     127     136     143     145
  19          T                                                    1.0     .05
  20          W    2.03      .5
  21          X    -1.5    -.05     2.0
  22          K       2       3                                       1
  23          K1       COMBINING TWO HYDROGRAPH
  24          K       1       4                                       1
  25          K1       ROUTE THROUGH STREAM REACH 1
  26          Y                                   1       1
  27          Y1      1
  28          Y6    .08     .09     .08    1198    1240    6750    .015
  29          Y7      0    1240     150    1220     400    1200     404    1198     409    1198
  30          Y7    413    1200     575    1220     600    1240
  31          K       1       5                                       1
  32          K1       ROUTE THROUGH STREAM REACH 2
  33          Y                                   1       1
  34          Y1      1
  35          Y6    .06     .05     .06    1058    1100    9000    .016
  36          Y7      0    1100     475    1080     900    1060     904    1058     909    1058
  37          Y7    913    1060    1225    1080    1400    1100
  38          K       0       5                                       1
  39          K1       INFLOW FROM SUBAREA C
  40          M       1       1    3.25
  41          P            21.98     117     127     136     143     145
  42          T                                                    1.0     .05
  43          W    3.03      .5
  44          X    -1.5    -.05     2.0
  45          K       2       6                                       1
```

```
K1      COMBINING TWO HYDROGRAPHS
K       0       7                                                   1
K1      INFLOW FROM SUBAREA D
M       1       1     2.35
P           21.98     117     127     136     143     145

T                                                                   1.0     .05
W   2.37      .5
X   -1.5     -.05     2.0
K       2       8                                                   1
K1      COMBINING TWO HYDROGRAPHS
K       1       9                                                   1
K1      ROUTE THROUGH RESERVOIR
Y                                   1       1
Y1      1                                                   -1058.3     -1
Y41058.3    1059    1060  1060.2    1062    1065  1065.5    1067    1069
Y5      0      70     265     310    1930    6820    7820   10550   14985
SA      0      23      85     128     154     180     213
SE   1040    1045    1050    1055    1060    1065    1070
SS1060.2
SD1065.5     3.1     1.5    2085
SL     15     165     910    1400    2045    2200    2330
SV1065.5    1066  1066.5    1067  1067.5    1068    1069
K      99
```

```
*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
*********************************

RUN  DATE= 80/08/04.
     TIME= 10.30.34.


                    ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
                    HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF FOUR SEASONS DAM
                    RATIOS OF THE PMF ROUTED THROUGH THE RESERVOIR (568)

                                    JOB SPECIFICATION
          NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
         288       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=    .40    .50    .60   1.00


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

                          SUB-AREA RUNOFF COMPUTATION

          INFLOW FROM SUBAREA A

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

                                  HYDROGRAPH DATA
          IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
              1       1    1.09    0.00    1.09    0.00   0.000       0       0       0

                                    PRECIP DATA
                SPFE     PMS      R6     R12     R24     R48     R72     R96
                0.00   21.98  117.00  127.00  136.00  143.00  145.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                                    LOSS DATA
      LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
          0    0.00    0.00    1.00    0.00    0.00    1.00    1.00     .05    0.00    0.00
```

UNIT HYDROGRAPH DATA
TP= 2.33 CP= .50 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 73 END-OF-PERIOD ORDINATES, LAG= 2.35 HOURS, CP= .50 VOL= 1.00

5.	18.	36.	58.	81.	105.	126.	141.	150.	153.
147.	136.	126.	116.	107.	99.	92.	85.	78.	72.
67.	62.	57.	53.	49.	45.	42.	39.	36.	33.

30.	28.	26.	24.	22.	20.	19.	17.	16.	15.
14.	13.	12.	11.	10.	9.	9.	8.	7.	7.
6.	6.	5.	5.	5.	4.	4.	4.	3.	3.
3.	3.	2.	2.	2.	2.	2.	2.	2.	1.
1.	1.	1.							

END-OF-PERIOD FLOW

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.50	22.89	2.61	64480.
										(648.)	(581.)	(66.)	(1825.87)

```
**********        **********        **********        **********        **********

                         SUB-AREA RUNOFF COMPUTATION

          INFLOW FROM SUBAREA B

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

                                HYDROGRAPH DATA
        IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
            1       1    1.78    0.00    1.78    0.00   0.000       0       0       0

                                  PRECIP DATA
                SPFE     PMS      R6     R12     R24     R48     R72     R96
                0.00   21.98  117.00  127.00  136.00  143.00  145.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                                  LOSS DATA
      LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
          0    0.00    0.00    1.00    0.00    0.00    1.00    1.00     .05    0.00    0.00

                              UNIT HYDROGRAPH DATA
                          TP=  2.03    CP=  .50    NTA=  0

                                RECESSION DATA
                     STRTQ=   -1.50    QRCSN=    -.05    RTIOR= 2.00

        UNIT HYDROGRAPH 63 END-OF-PERIOD ORDINATES, LAG=   2.05 HOURS, CP=  .50  VOL= 1.00
      11.      40.      82.     131.     183.     230.     264.     284.     286.     269.
     246.     224.     205.     187.     171.     156.     142.     130.     118.     108.
      98.      90.      82.      75.      68.      62.      57.      52.      47.      43.
      39.      36.      33.      30.      27.      25.      23.      21.      19.      17.
      16.      14.      13.      12.      11.      10.       9.       8.       8.       7.
       6.       6.       5.       5.       4.       4.       4.       3.       3.       3.

       3.       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  25.50  22.89   2.61   105730.
                                                                       ( 648.)( 581.)(  66.)( 2993.94)
```

```
**********          **********          **********          **********          **********

                                    COMBINE HYDROGRAPHS

                COMBINING TWO HYDROGRAPH

                          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                              3       2       0       0       0       0       1       0       0

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

                                    HYDROGRAPH ROUTING

                ROUTE THROUGH STREAM REACH 1

                          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                              4       1       0       0       0       0       1       0       0
                                                ROUTING DATA
                    QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                      0.0   0.000    0.00       1       1       0       0               0

                          NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                              1       0       0   0.000   0.000   0.000      0.       0

NORMAL DEPTH CHANNEL ROUTING
----------------------------

          QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
          .0600   .0500   .0600  1198.0  1240.0   6750.  .01500

          CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
              0.00 1240.00  150.00 1220.00  400.00 1200.00  404.00 1198.00  409.00 1198.00
            413.00 1200.00  575.00 1220.00  600.00 1240.00

  STORAGE        0.00        3.28       17.02       46.36       91.29      151.82      227.95      319.68      427.01
   549.94
               688.45      837.66      993.49     1155.95     1325.03     1500.74     1683.08     1872.04     2067.62
  2269.83

  OUTFLOW        0.00       98.91      627.92     2073.53     4836.85     9258.88    15647.07    24285.83    35442.32
 49370.03
             66424.19    88824.75   114224.26   142614.81   174004.07   208410.54   245860.56   286386.27   330024.19
```

376814.20

STAGE	1198.00	1200.21	1202.42	1204.63	1206.84	1209.05	1211.26	1213.47	1215.68
1217.89	1220.11	1222.32	1224.53	1226.74	1228.95	1231.16	1233.37	1235.58	1237.79
1240.00									
FLOW	0.00	98.91	627.92	2073.53	4836.85	9258.88	15647.07	24285.83	35442.32
349370.03	66424.19	88824.75	114224.26	142614.81	174004.07	208410.54	245860.56	286386.27	330024.19
376814.20									

MAXIMUM STAGE IS 1204.9

MAXIMUM STAGE IS 1205.4

MAXIMUM STAGE IS 1205.9

MAXIMUM STAGE IS 1207.5

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

HYDROGRAPH ROUTING

ROUTE THROUGH STREAM REACH 2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	1058.0	1100.0	9000.	.01600

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

0.00 1100.00 475.00 1080.00 900.00 1060.00 904.00 1058.00 909.00 1058.00
913.00 1060.00 1225.00 1080.00 1400.00 1100.00

STORAGE	0.00	4.45	32.54	97.82	200.31	340.00	516.90	731.00	982.30
1270.81	1596.51	1957.02	2350.34	2776.47	3235.42	3727.17	4251.74	4809.12	5399.31
6022.31									
OUTFLOW	0.00	102.41	818.75	3101.64	7713.25	15296.31	26427.81	41640.18	61432.67
386278.37	116673.08	153841.78	197210.40	247091.89	303798.52	367640.03	438922.68	517948.79	605016.56
700419.97									
STAGE	1058.00	1060.21	1062.42	1064.63	1066.84	1069.05	1071.26	1073.47	1075.68
1077.89	1080.11	1082.32	1084.53	1086.74	1088.95	1091.16	1093.37	1095.58	1097.79
1100.00									
FLOW	0.00	102.41	818.75	3101.64	7713.25	15296.31	26427.81	41640.18	61432.67

786278.37
116673.08 153841.78 197210.40 247091.89 303798.52 367640.03 438922.68 517948.79 605016.56
700519.97

MAXIMUM STAGE IS 1064.0

MAXIMUM STAGE IS 1064.6

MAXIMUM STAGE IS 1064.9

MAXIMUM STAGE IS 1066.1

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

SUB-AREA RUNOFF COMPUTATION

INFLOW FROM SUBAREA C

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.25	0.00	3.25	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.98	117.00	127.00	136.00	143.00	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.03 CP= .50 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 95 END-OF-PERIOD ORDINATES, LAG= 3.05 HOURS, CP= .50 VOL= 1.00

8.	29.	59.	95.	135.	178.	223.	264.	299.	325.
344.	354.	352.	337.	317.	298.	281.	264.	249.	234.
220.	207.	195.	184.	173.	163.	153.	144.	136.	128.
120.	113.	106.	100.	94.	89.	83.	78.	74.	70.
65.	62.	58.	55.	51.	48.	45.	43.	40.	38.
36.	34.	32.	30.	28.	26.	25.	23.	22.	21.
19.	18.	17.	16.	15.	14.	14.	13.	12.	11.
11.	10.	9.	9.	8.	8.	7.	7.	7.	6.
6.	5.	5.	5.	5.	4.	4.	4.	4.	3.
3.	3.	3.	3.	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	25.50	22.89	2.61	191163.
										(648.)	(581.)	(66.)	(5413.13)

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

COMBINE HYDROGRAPHS

COMBINING TWO HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	2	0	0	0	0	1	0	0

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

SUB-AREA RUNOFF COMPUTATION

```
                    INFLOW FROM SUBAREA D

                          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                              7       0       0       0       0       0       1       0       0

                                          HYDROGRAPH DATA
                 IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                     1       1    2.35    0.00    2.35    0.00   0.000       0       0       0

                                            PRECIP DATA
                        SPFE     PMS      R6     R12     R24     R48     R72     R96
                        0.00   21.98  117.00  127.00  136.00  143.00  145.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                                             LOSS DATA
             LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
                 0    0.00    0.00    1.00    0.00    0.00    1.00    1.00     .05    0.00    0.00

                                        UNIT HYDROGRAPH DATA
                                   TP=  2.37    CP= .50    NTA=  0

                                          RECESSION DATA
                          STRTQ=   -1.50    QRCSN=    -.05    RTIOR= 2.00

          UNIT HYDROGRAPH 74 END-OF-PERIOD ORDINATES, LAG=   2.38 HOURS, CP=  .50  VOL= 1.00
            10.      37.      76.     121.     171.     222.     266.     299.     320.     327.
           315.     293.     271.     250.     232.     214.     198.     183.     169.     157.
           145.     134.     124.     115.     106.      98.      91.      84.      78.      72.
            66.      61.      57.      53.      49.      45.      42.      38.      36.      33.
            30.      28.      26.      24.      22.      21.      19.      18.      16.      15.
            14.      13.      12.      11.      10.       9.       9.       8.       7.       7.
             6.       6.       5.       5.       5.       4.       4.       4.       3.       3.
             3.       3.       3.       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  25.50  22.89   2.61   138977.
                                                                               ( 648.)( 581.)(  66.)( 3935.39)

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

                                        COMBINE HYDROGRAPHS

                    COMBINING TWO HYDROGRAPHS

                          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
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```
                                  8       2       0       0       0       0       1       0       0

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

                                          HYDROGRAPH ROUTING

                    ROUTE THROUGH RESERVOIR

                                ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                    9       1       0       0       0       0       1       0       0
                                                   ROUTING DATA
                          QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                            0.0   0.000    0.00       1       1       0       0               0

                                NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                    1       0       0   0.000   0.000   0.000  -1058.      -1

     STAGE     1058.30     1059.00     1060.00     1060.20     1062.00     1065.00     1065.50     1067.00     1069.00

      FLOW        0.00       70.00      265.00      310.00     1930.00     6820.00     7820.00    10550.00    14985.00

  SURFACE AREA=      0.        23.        85.       126.       154.       180.       213.

     CAPACITY=       0.        38.       292.       816.      1515.      2349.      3331.

    ELEVATION=    1040.      1045.      1050.      1055.      1060.      1065.      1070.

                                CREL   SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                              1060.2     0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                                          DAM DATA
                                                   TOPEL    COQD    EXPD  DAMWID
                                                  1065.5     3.1     1.5   2085.

    CREST LENGTH       15.       165.       910.      1400.      2045.      2200.      2330.
    AT OR BELOW
    ELEVATION       1065.5     1066.0     1066.5     1067.0     1067.5     1068.0     1069.0

  PEAK OUTFLOW IS     5733. AT TIME  43.75 HOURS

  PEAK OUTFLOW IS     7240. AT TIME  43.75 HOURS

  PEAK OUTFLOW IS     8783. AT TIME  43.50 HOURS

  PEAK OUTFLOW IS    16295. AT TIME  42.75 HOURS
```

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	RATIO 1 .40	RATIO 2 .50	RATIO 3 .60	RATIO 4 1.00
				RATIOS APPLIED TO FLOWS			
HYDROGRAPH AT	1	1.09 (2.82)	1	896. (25.37)	1120. (31.72)	1344. (38.06)	2240. (63.43)
HYDROGRAPH AT	2	1.78 (4.61)	1	1589. (45.00)	1986. (56.24)	2383. (67.49)	3972. (112.49)
2 COMBINED	3	2.87 (7.43)	1	2470. (69.94)	3087. (87.42)	3705. (104.90)	6174. (174.84)
ROUTED TO	4	2.87 (7.43)	1	2457. (69.57)	3071. (86.97)	3686. (104.36)	6158. (174.36)
ROUTED TO	5	2.87 (7.43)	1	2414. (68.37)	3020. (85.51)	3640. (103.07)	6085. (172.30)
HYDROGRAPH AT	5	3.25 (8.42)	1	2286. (64.72)	2857. (80.90)	3429. (97.09)	5714. (161.81)
2 COMBINED	6	6.12 (15.85)	1	4689. (132.79)	5863. (166.03)	7052. (199.70)	11758. (332.95)
HYDROGRAPH AT	7	2.35 (6.09)	1	1919. (54.34)	2399. (67.92)	2878. (81.51)	4797. (135.85)
2 COMBINED	8	8.47 (21.94)	1	6568. (185.99)	8212. (232.52)	9870. (279.50)	16455. (465.94)
ROUTED TO	9	8.47 (21.94)	1	5733. (162.34)	7240. (205.00)	8783. (248.71)	16295. (461.42)

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS

.40	2457.	1204.9	42.00
.50	3071.	1205.4	42.00
.60	3686.	1205.9	42.00
1.00	6158.	1207.5	42.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	2414.	1064.0	42.50
.50	3020.	1064.6	42.50
.60	3640.	1064.9	42.50
1.00	6085.	1066.1	42.25

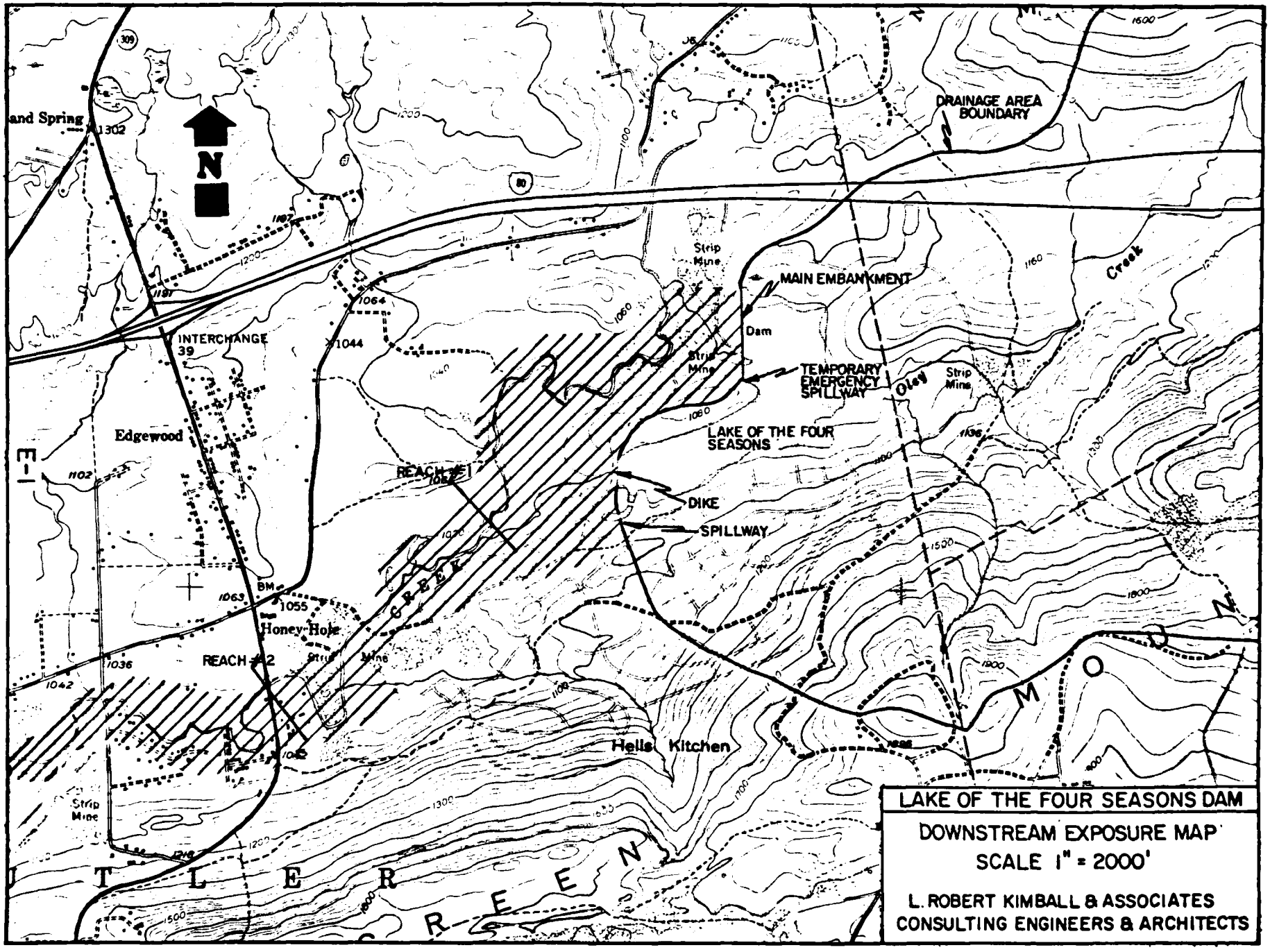
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1058.30	1060.20	1065.50
STORAGE	1262.	1946.	2440.
OUTFLOW	0.	310.	7820.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	1064.33	0.00	2230.	5733.	0.00	43.75	0.00
.50	1065.21	0.00	2387.	7240.	0.00	43.75	0.00
.60	1065.99	.49	2530.	8783.	2.50	43.50	0.00
1.00	1067.40	1.90	2799.	16295.	6.00	42.75	0.00

APPENDIX E
DRAWINGS

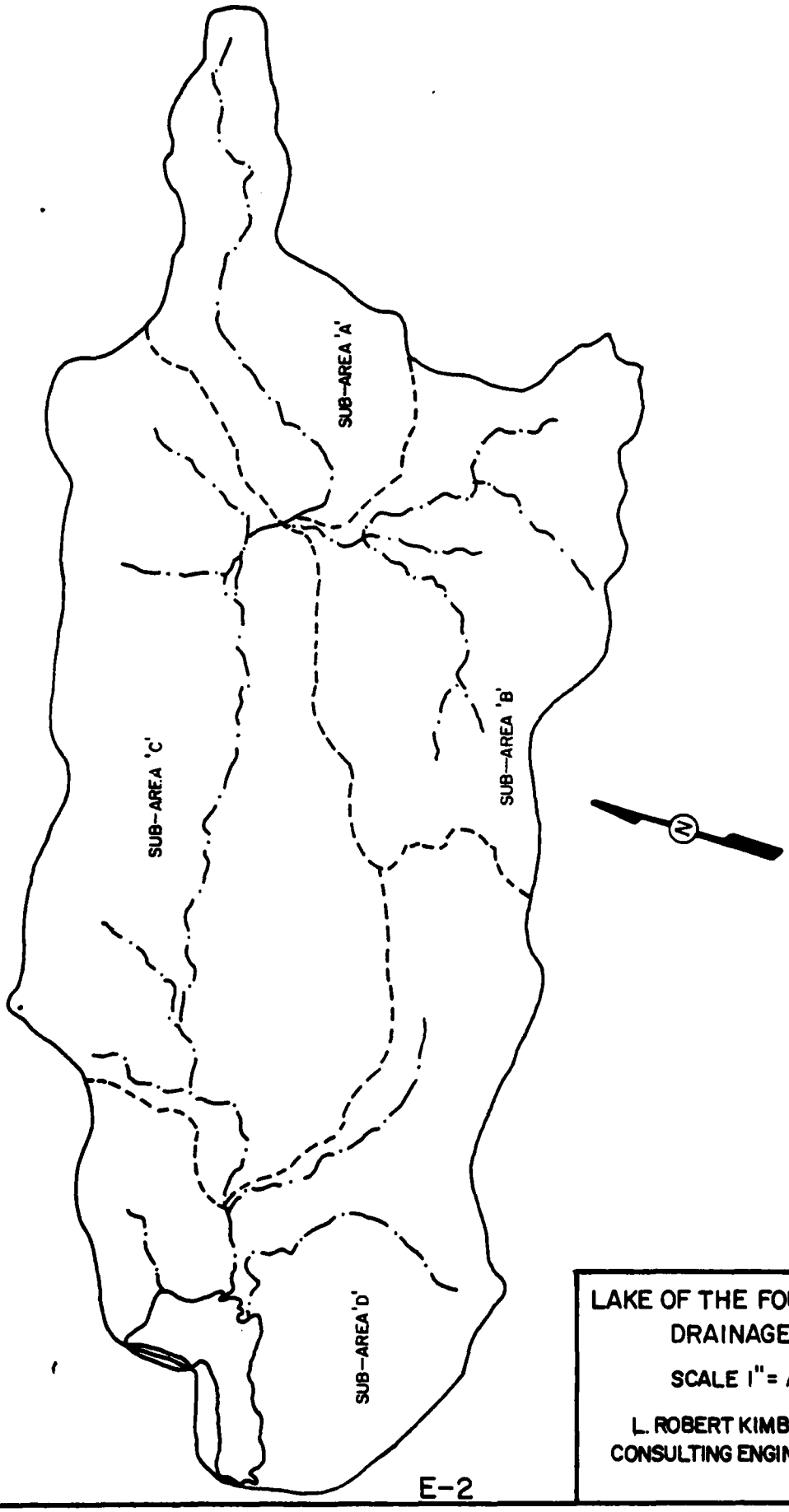


LAKE OF THE FOUR SEASONS DAM

DOWNSTREAM EXPOSURE MAP

SCALE 1" = 2000'

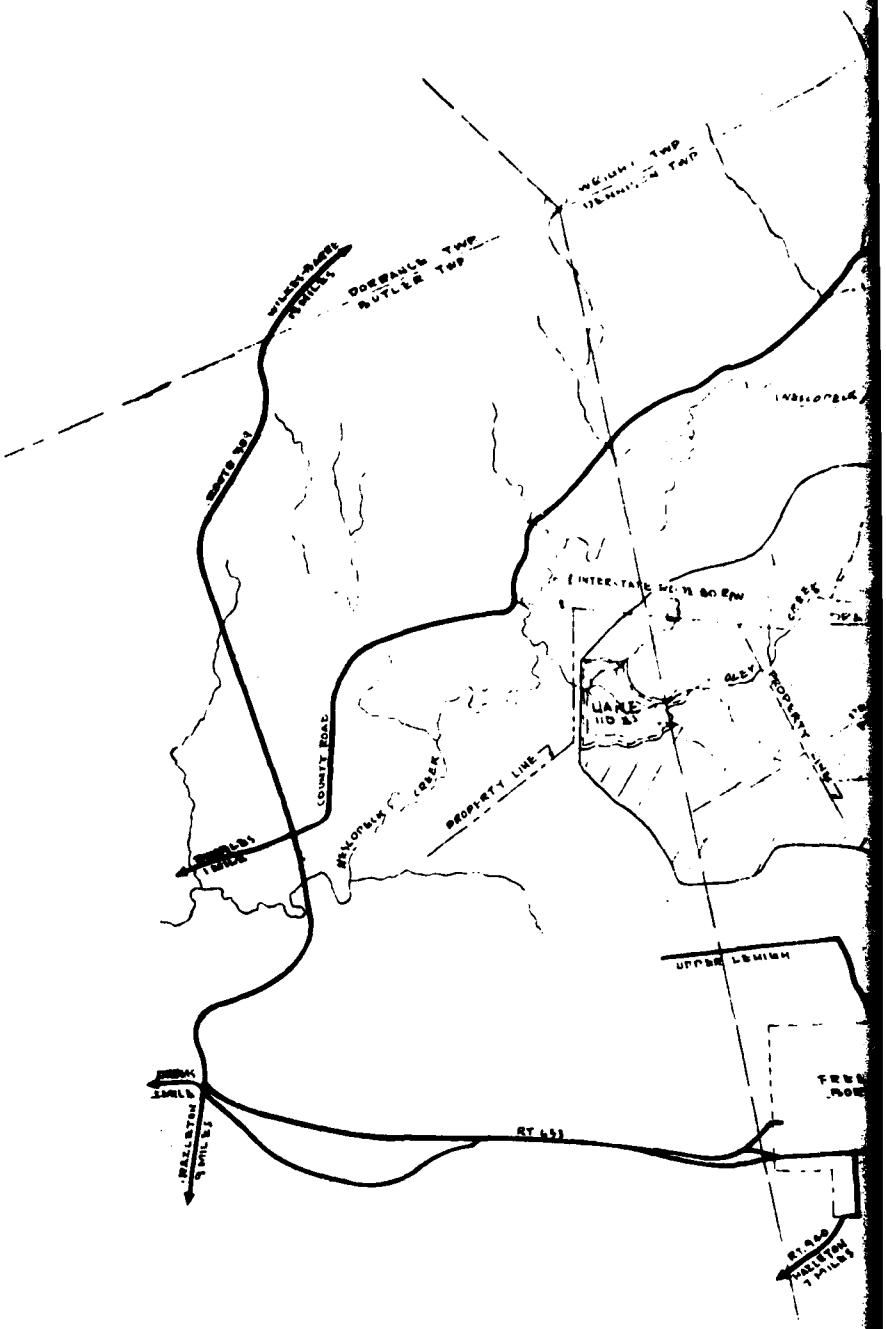
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



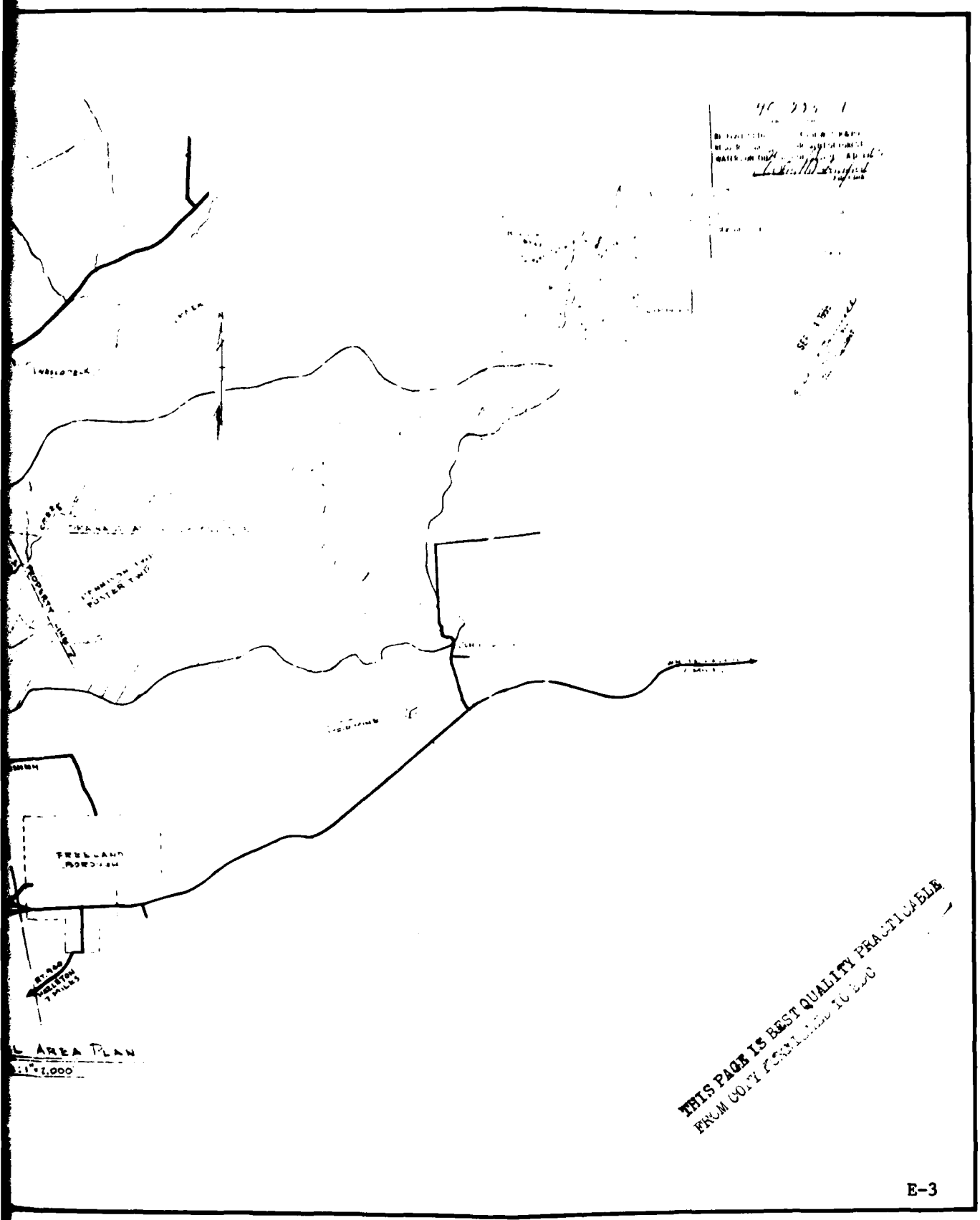
LAKE OF THE FOUR SEASONS DAM
DRAINAGE AREA MAP

SCALE 1" = APPROX. 3000'

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



GENERAL AREA
SCALE: 1" = 2,000'



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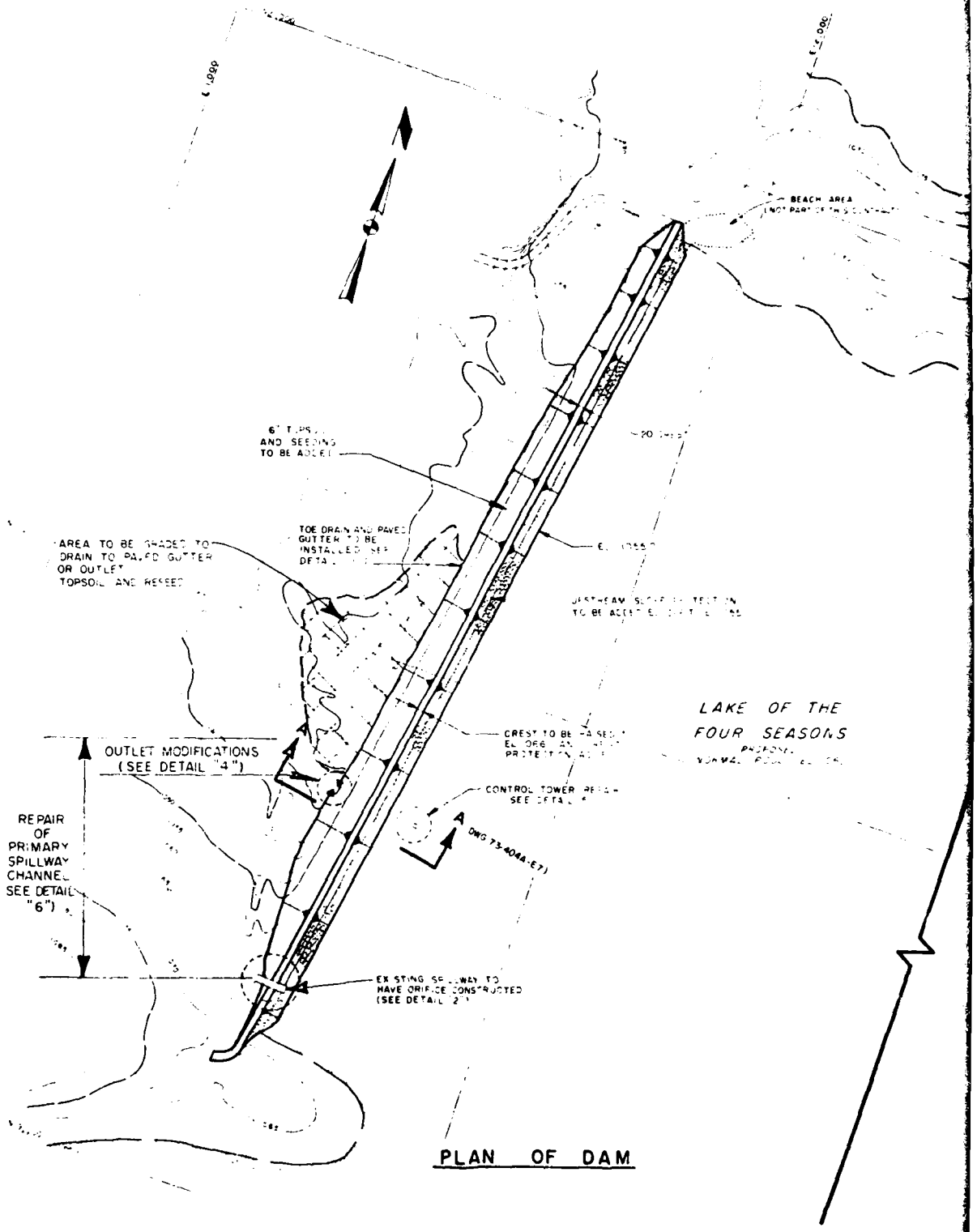
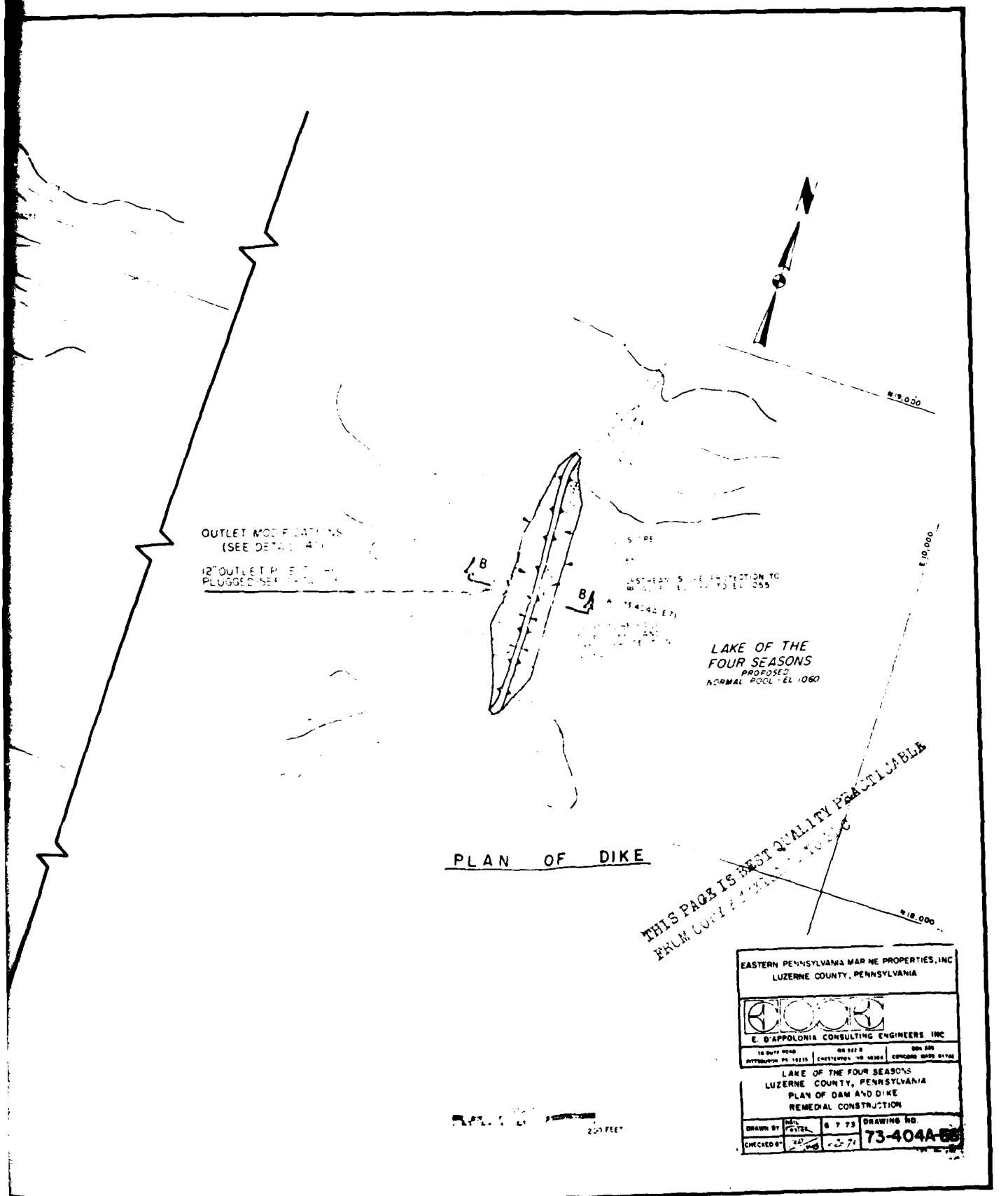
FROM COPY FURNISHED TO DDC


BEACH AREA
AREA TO BE GRADED TO DRAIN TO PAVED GUTTER OR OUTLET TOPSOIL AND RESEED
OUTLET MODIFICATIONS (SEE DETAIL "4")
REPAIR OF PRIMARY SPILLWAY CHANNEL SEE DETAIL "6")
LAKE OF THE FOUR SEASONS
PLAN OF DAM



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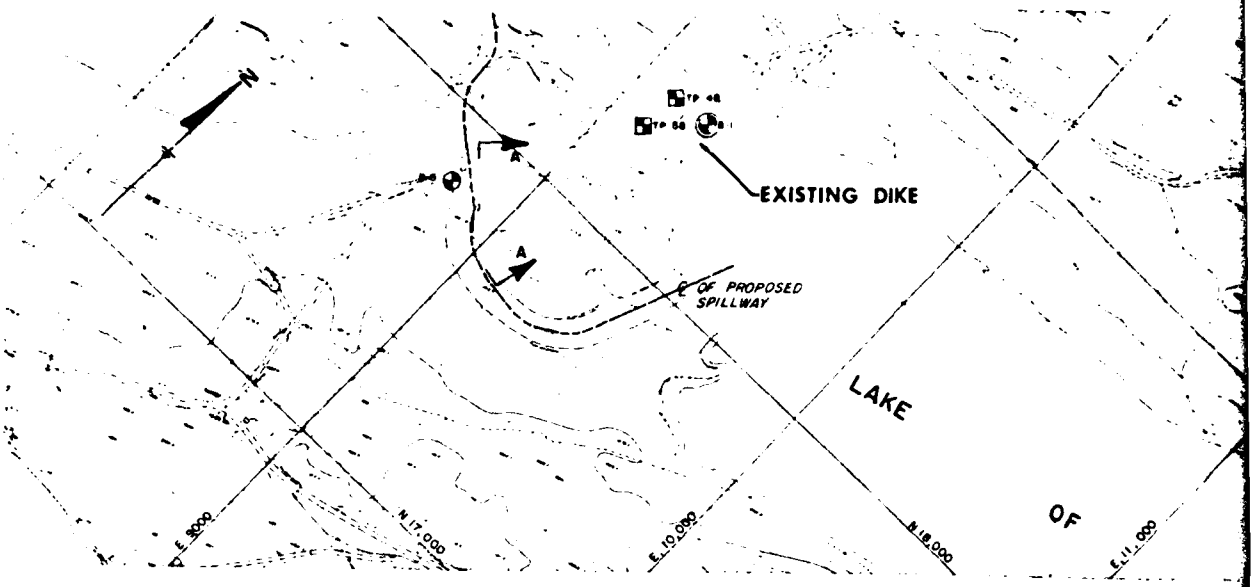
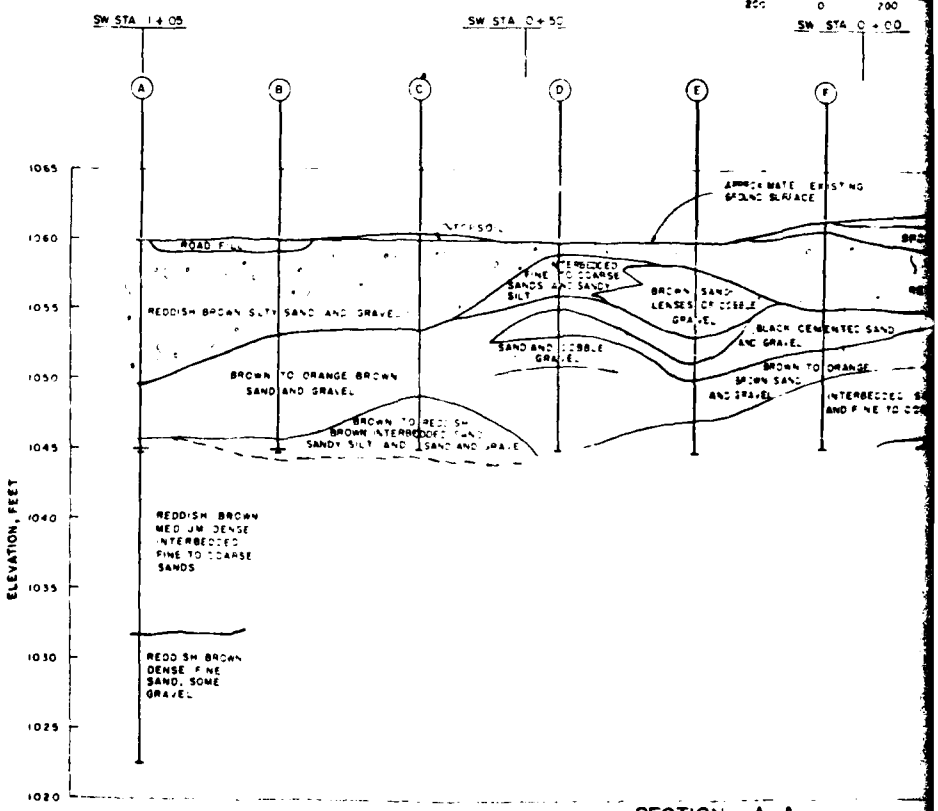
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



PLAN

SCALE



SECTION A-A

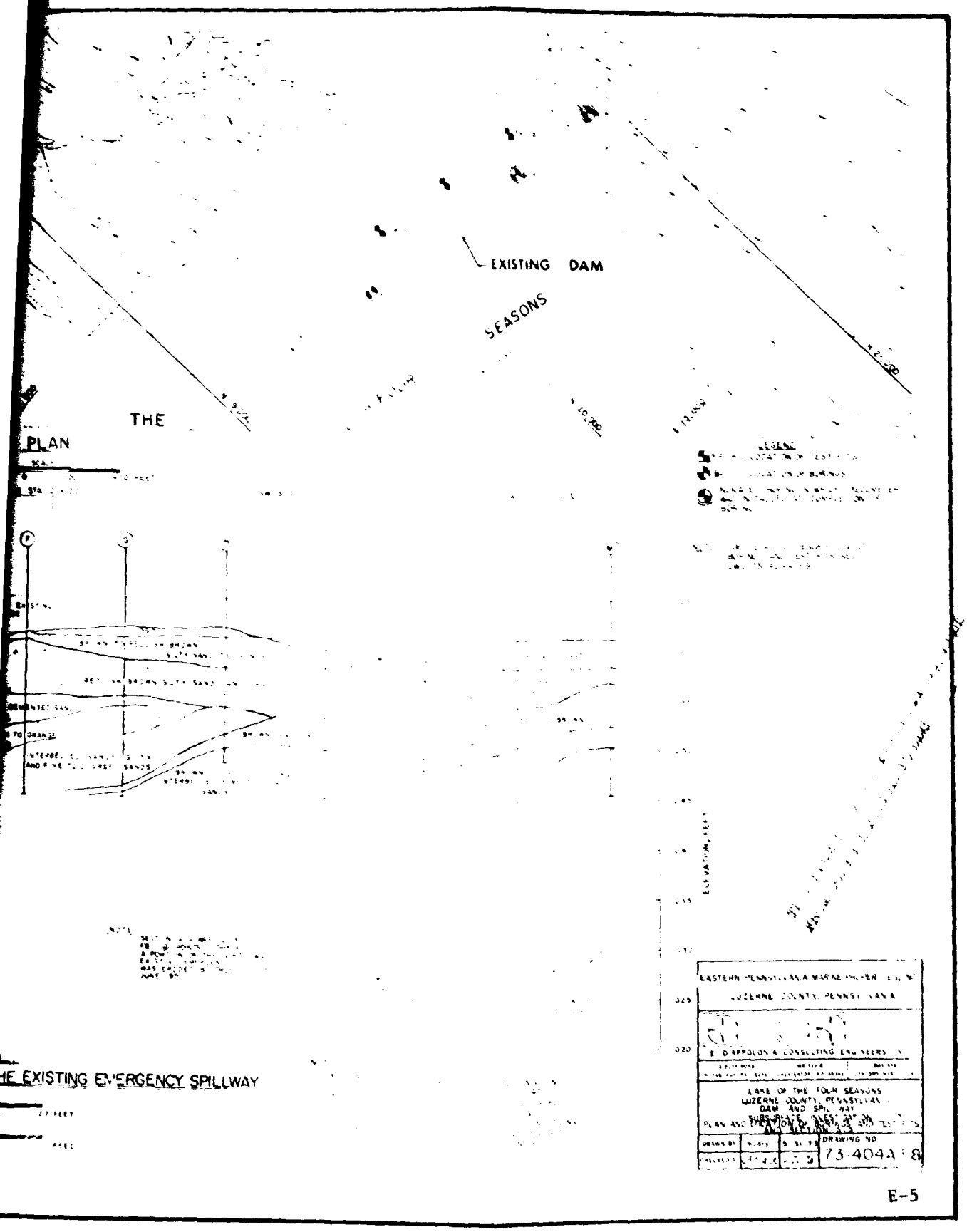
THROUGH THE NORTH SIDE OF THE EXISTING

HORIZONTAL SCALE

10 0 10 20 FEET

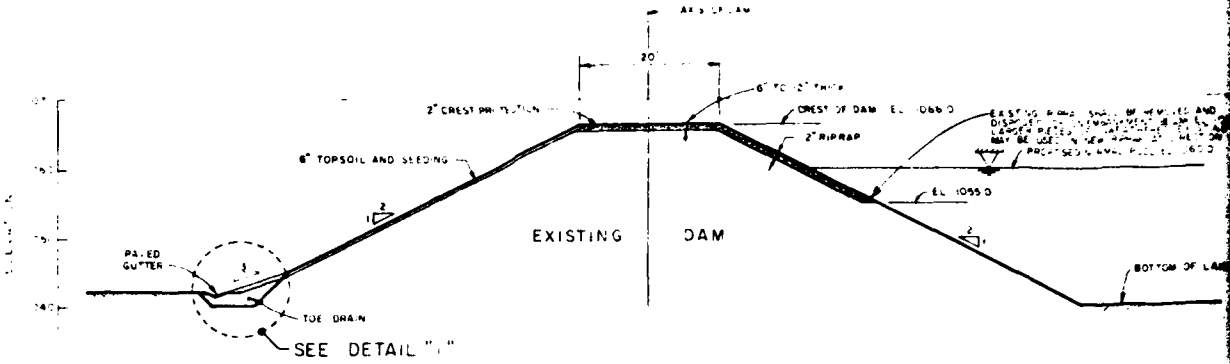
VERTICAL SCALE

5 0 5 10 FEET

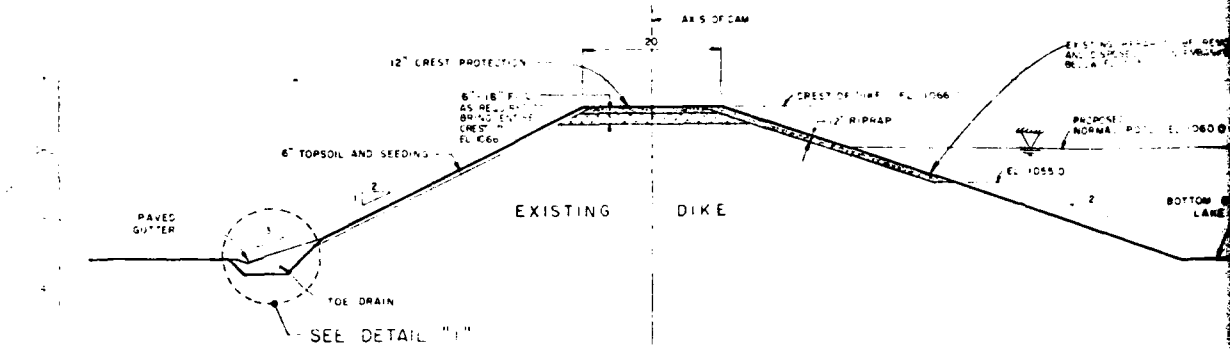


E-5

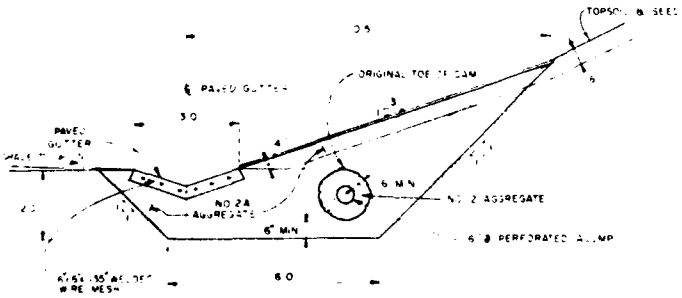
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



SECTION A-A

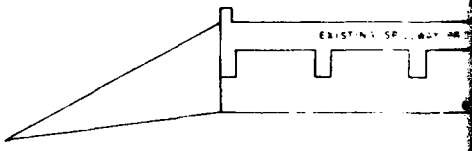


SECTION B-B



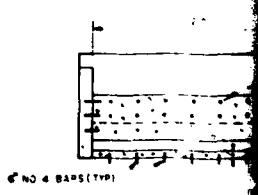
DETAIL "1"

TOE DRAIN AND PAVED GUTTER



DETAIL "2"

ORIFICE CONSTRUCTION AT



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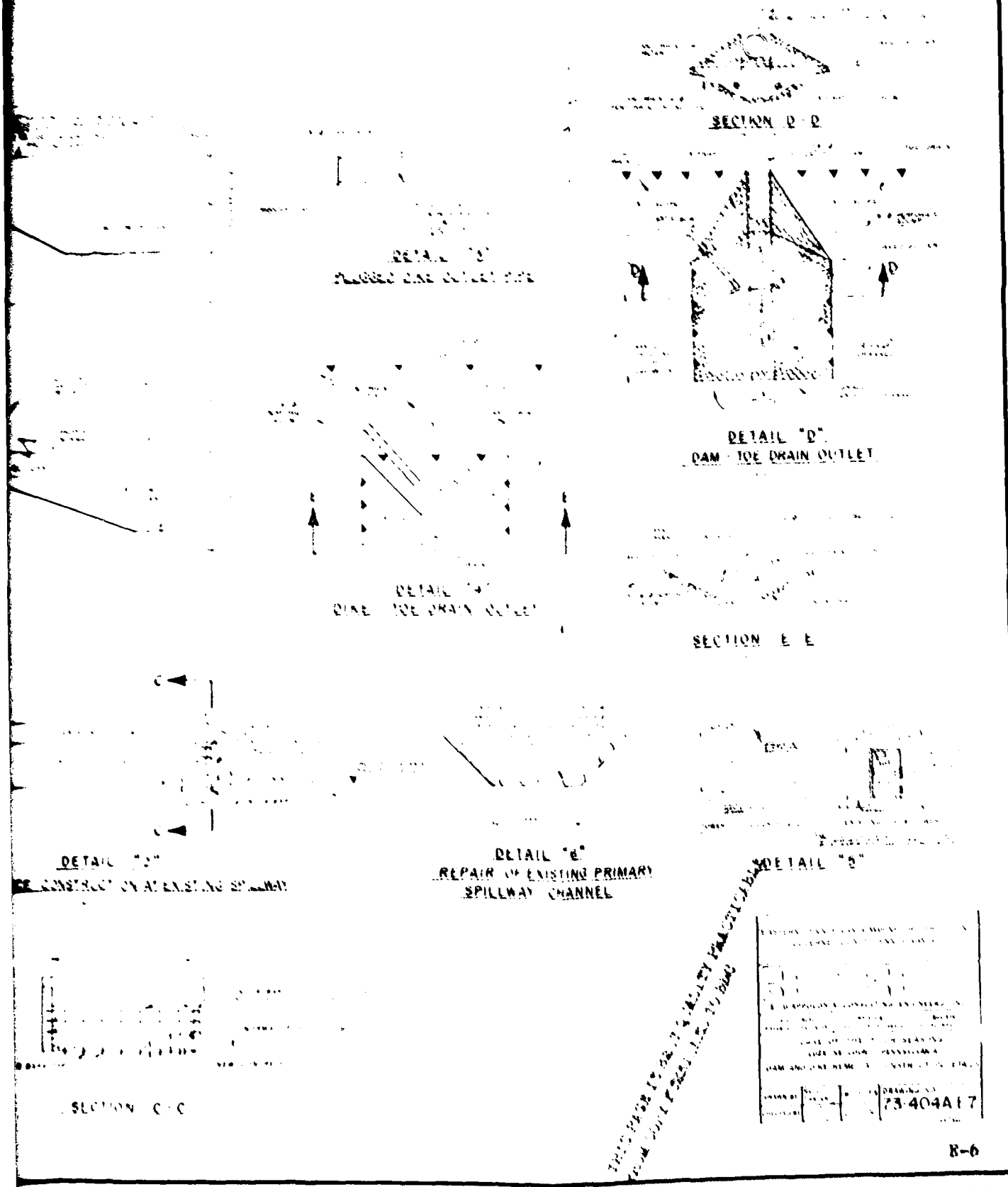
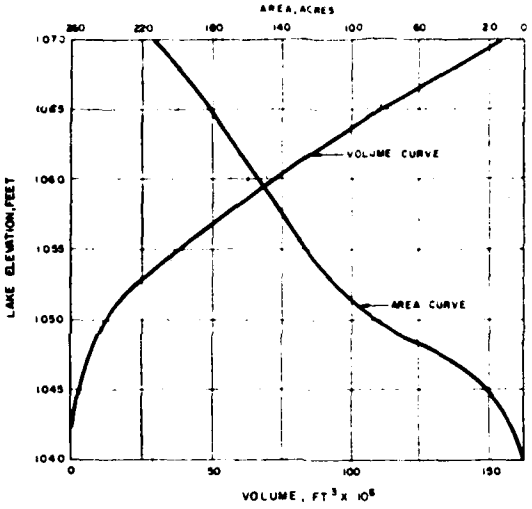
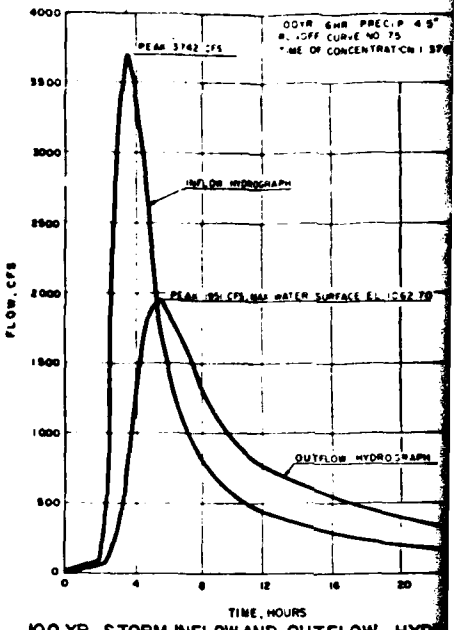


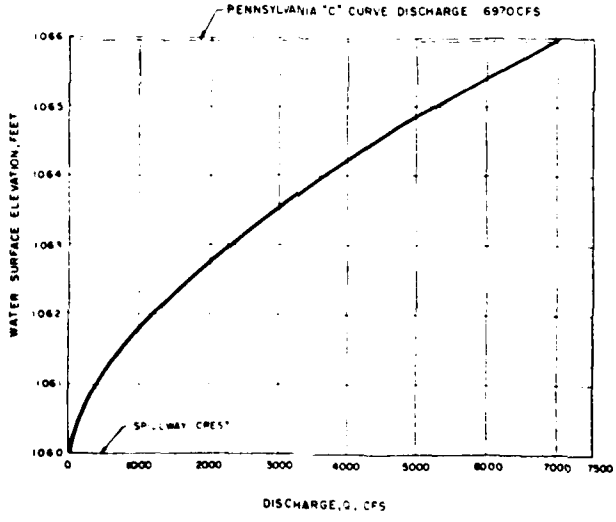
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



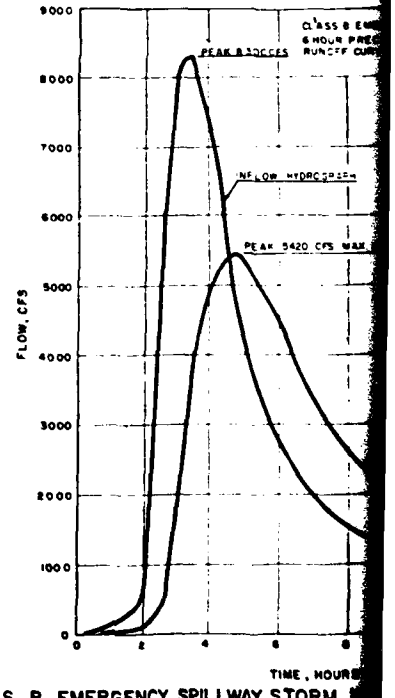
LAKE ELEVATION VS VOLUME AND AREA CURVES



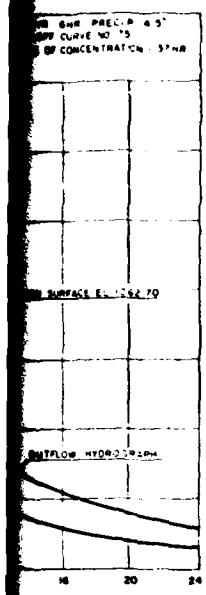
100 YR. STORM INFLOW AND OUTFLOW HYD



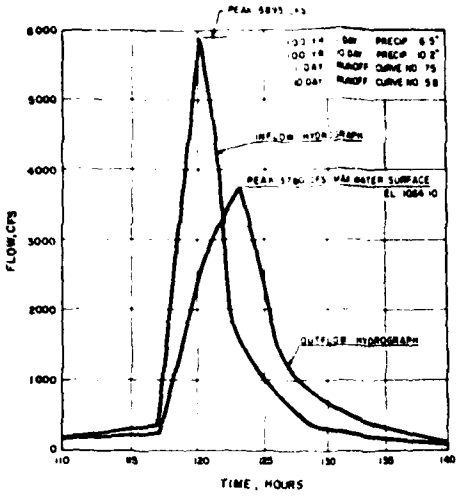
SPILLWAY ELEVATION - DISCHARGE CURVE



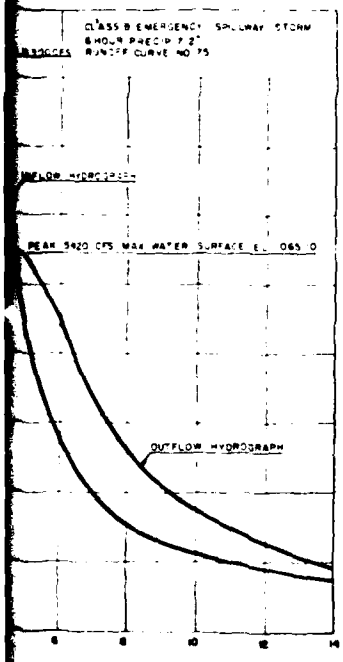
CLASS B EMERGENCY SPILLWAY STORM



OUTFLOW HYDROGRAPHS



SCS 100YR. STORM INFLOW AND OUTFLOW HYDROGRAPHS



AY STORM INFLOW AND OUTFLOW HYDROGRAPHS

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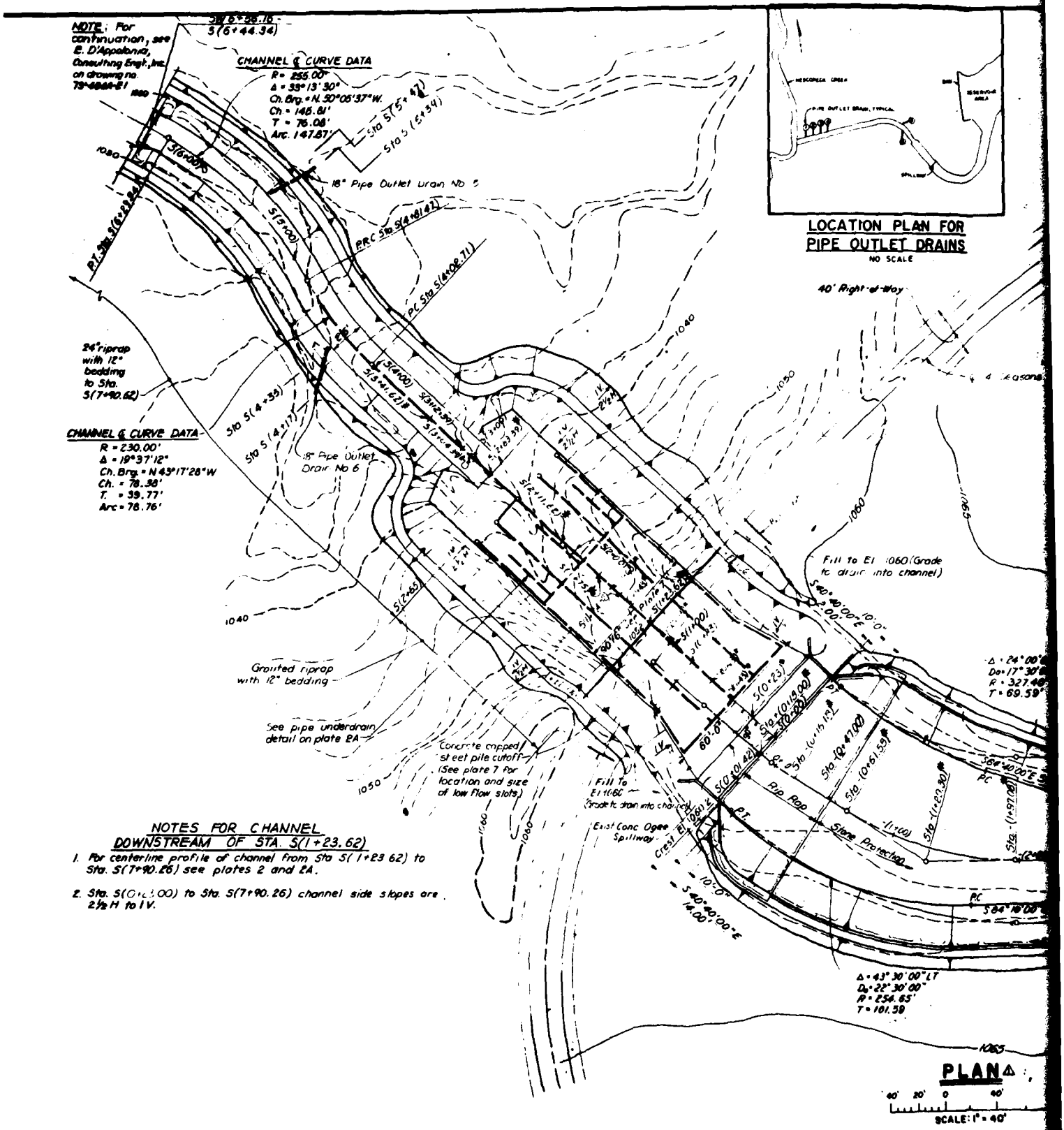
EASTERN PENNSYLVANIA MARINE PROPERTIES, INC
LUZERNE COUNTY, PENNSYLVANIA

E. D'APPOLONIA CONSULTING ENGINEERS, INC

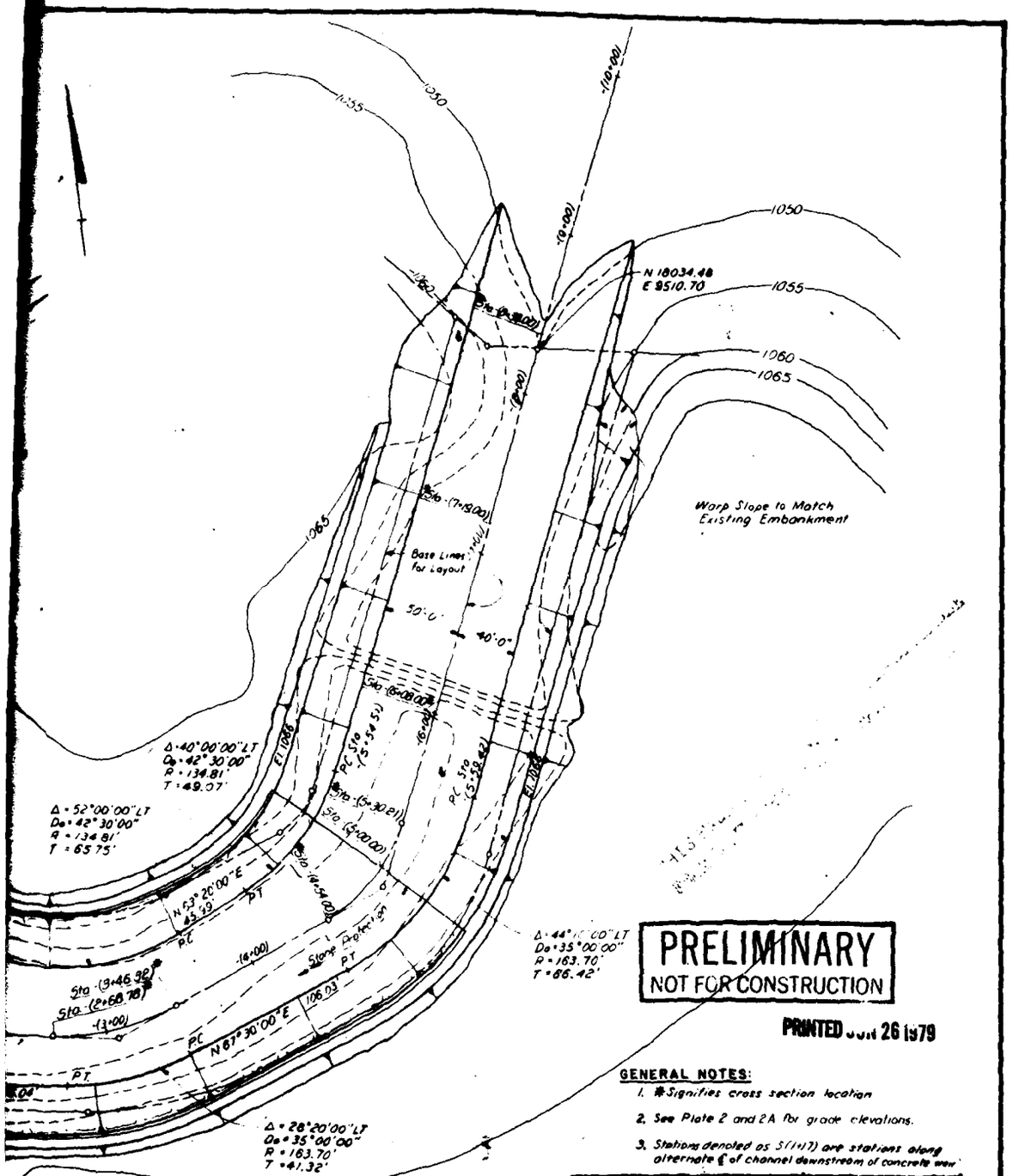
LAKE OF THE FOUR SEASONS
LUZERNE COUNTY, PENNSYLVANIA
HYDRAULIC AND HYDROLOGY
DATA SHEET

DRAWN BY	D.W.	5-14-73	DRAWING NO.
CHECKED BY			73-404A-E3



NOTES FOR CHANNEL DOWNSTREAM OF STA. S(1+23.62)

1. For centerline profile of channel from Sta S(1+23.62) to Sta. S(7+90.26) see plates 2 and 2A.
2. Sta. S(0+00.00) to Sta. S(7+90.26) channel side slopes are 2½H to 1V.



Note: Side slope varies from weir to Sta -(2+00)
Side slope from Sta. -(2+00) to end of work is 2 Horizontal on 1 Vertical

PRELIMINARY
NOT FOR CONSTRUCTION

PRINTED JUN 26 1979

GENERAL NOTES:

1. * Signifies cross section location
2. See Plate 2 and 2A for grade elevations.
3. Stations denoted as S(1+17) are stations along alternate ℄ of channel downstream of concrete weir

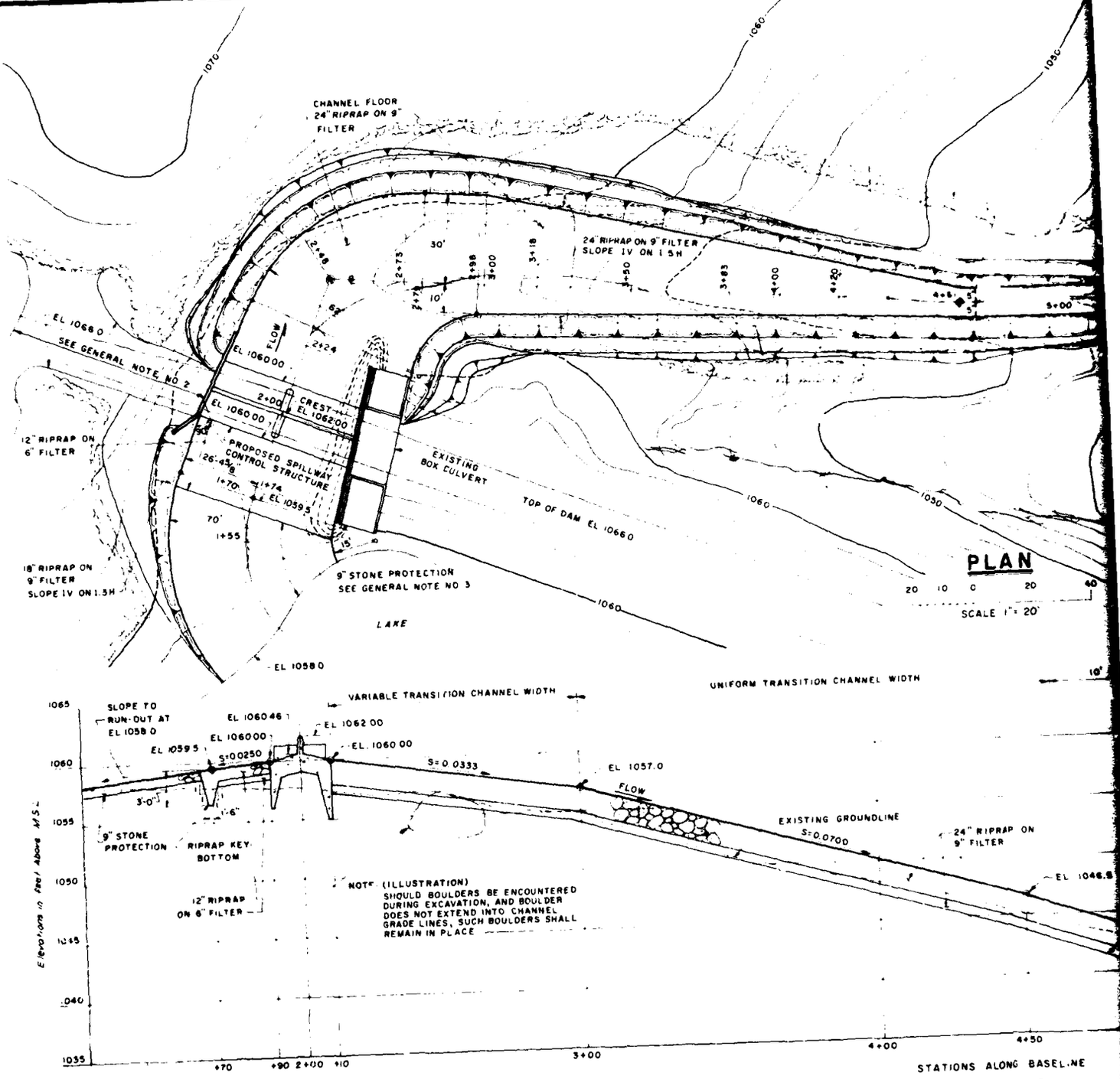
REVISIONS			
NO	DESCRIPTION	DATE	BY
1	Revised planimetric details downstream of Sta. S(0+25)	8-10-79	C.W.P.
2	Revised planimetric details downstream of Sta. S(0+25)	8-28-79	C.W.P.

DESIGNED	DIVERSIFIED MORTGAGE INVESTORS	SHEET NO.
DRAWN	THE LAKE OF THE 4 SEASONS INVESTIGATIVE REPORT	JOB NO. 7623
TRACED		
CHECKED	SPILLWAY FACILITY RECOMMENDED LAYOUT	DATE SEPT 1978
APPROVED		

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
ENGINEERS
P.O. BOX 1963 HARRISBURG, PENNA

PLATE 1

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS


CHANNEL FLOOR
24" RIPRAP ON 9"
FILTER
24" RIPRAP ON 9" FILTER
SLOPE 1V ON 1.5H
EL 1068.0
SEE GENERAL NOTE NO 2
FLOW
EL 1060.00
CREST
EL 1062.00
12" RIPRAP ON
6" FILTER
PROPOSED SPILLWAY
CONTROL STRUCTURE
EXISTING
BOX CULVERT
TOP OF DAM EL 1066.0
18" RIPRAP ON
9" FILTER
SLOPE 1V ON 1.5H
9" STONE PROTECTION
SEE GENERAL NOTE NO 3
LAKE
EL 1058.0
PLAN
SCALE 1" = 20'
VARIABLE TRANSITION CHANNEL WIDTH
UNIFORM TRANSITION CHANNEL WIDTH
SLOPE TO
RUN-OUT AT
EL 1058.0
EL 1060.46
EL 1062.00
EL 1060.00
EL 1059.5
S=0.0250
S=0.0333
EL 1057.0
FLOW
EXISTING GROUNDLINE
S=0.0700
24" RIPRAP ON
9" FILTER
EL 1046.5
9" STONE
PROTECTION
RIPRAP KEY
BOTTOM
12" RIPRAP
ON 6" FILTER
NOTE (ILLUSTRATION)
SHOULD BOULDERS BE ENCOUNTERED
DURING EXCAVATION, AND BOULDER
DOES NOT EXTEND INTO CHANNEL
GRADE LINES, SUCH BOULDERS SHALL
REMAIN IN PLACE
ELEVATIONS IN FEET ABOVE M.S.L.
STATIONS ALONG BASELINE
PROFILE
SCALES HORIZ. 1" = 20'-0"
VERT. 1" = 5'-0"

BASE LINE DATA

PLAN

GENERAL NOTES

1. DASHED CONTOUR LINES INDICATE EXISTING GROUND LINE
2. RAISE GRADE OF EXISTING CARTWAY TO EL. [illegible] IN INDICATED AREA TO BE PAID FOR AS EARTH FILL MEASURED BY MUTUAL AGREEMENT BETWEEN CONTRACTOR AND OWNER
3. STONE PROTECTION SHALL CONSIST OF A MIXTURE OF SIZE DIMENSIONS OF PENNDOT NO 4 AND NO 1 WEIGHT OF NO 20 COARSE AGGREGATE. PAYMENT FOR STONE PROTECTION WILL BE BASED ON THE NUMBER OF CUBIC YARDS TO BE PLACED AS SHOWN ON THE DRAWING

EXCAVATION

TRAPEZOIDAL BOTTOM AND SIDES OF CHANNEL

END OF PROTECTION

BASE LINE

PILE

DIVERSIFIED MORTGAGE INVESTORS	
THE LAKE OF THE 4 SEASONS	
INVESTIGATIVE REPORT	
AUXILIARY SPILLWAY	
GENERAL PLAN AND PROFILE	DATE OCTOBER 1979

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
ENGINEERS
P.O. BOX 1963 HARRISBURG PENNA

REVISIONS

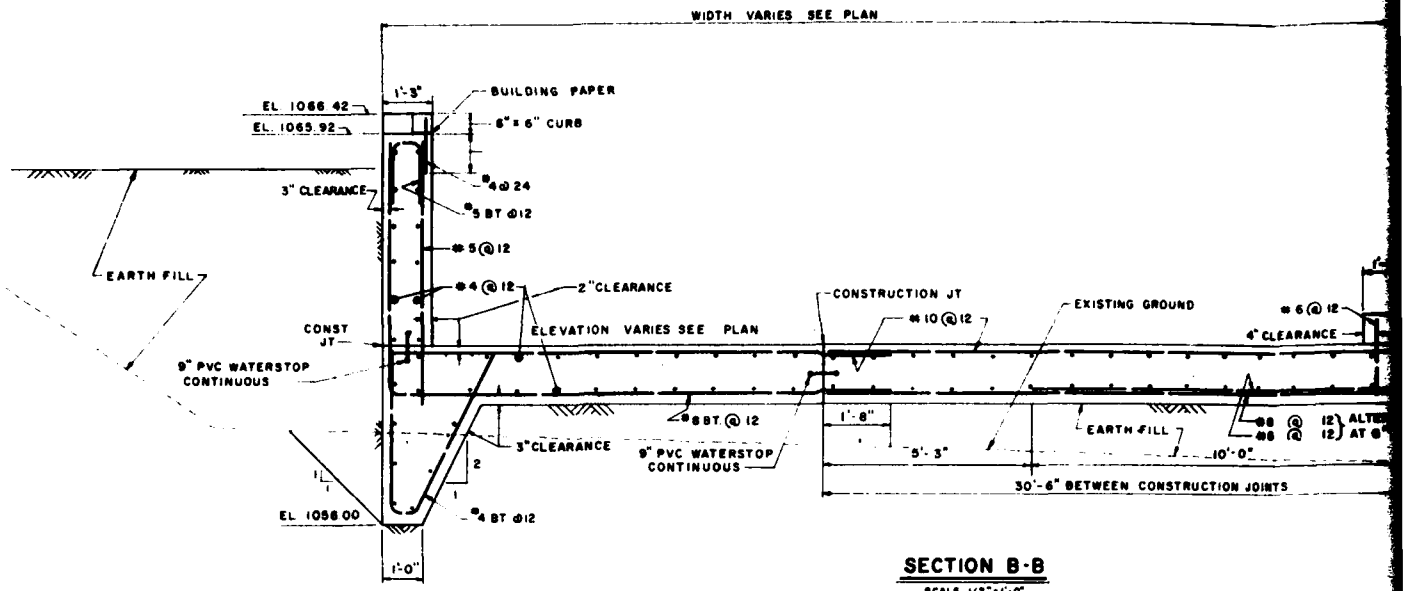
PLATE 3.1
E-9

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

AD-A091 266 KIMBALL (L ROBERT) AND ASSOCIATES EBENSBURG PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. LAKE OF THE FOUR SEASONS DAM (--ETC(U)
SEP 80 R J KIMBALL DACW31-80-C-0020

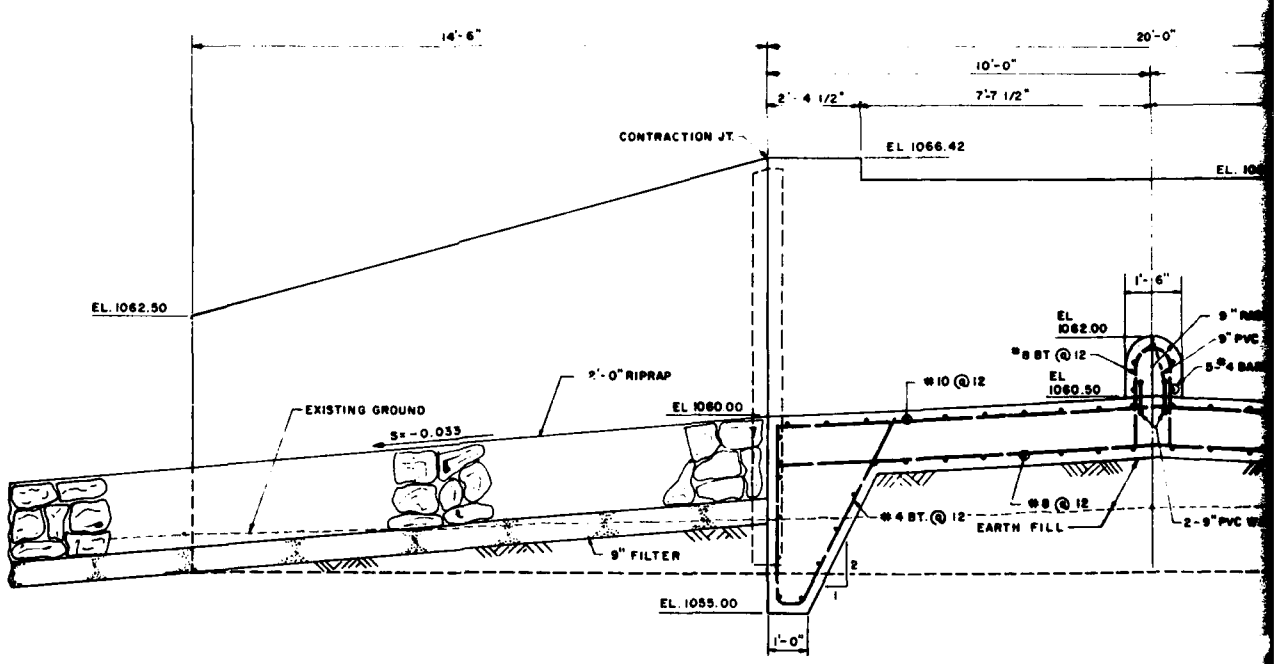
UNCLASSIFIED NL

END
DATE
FILMED
1 -80
DTIC



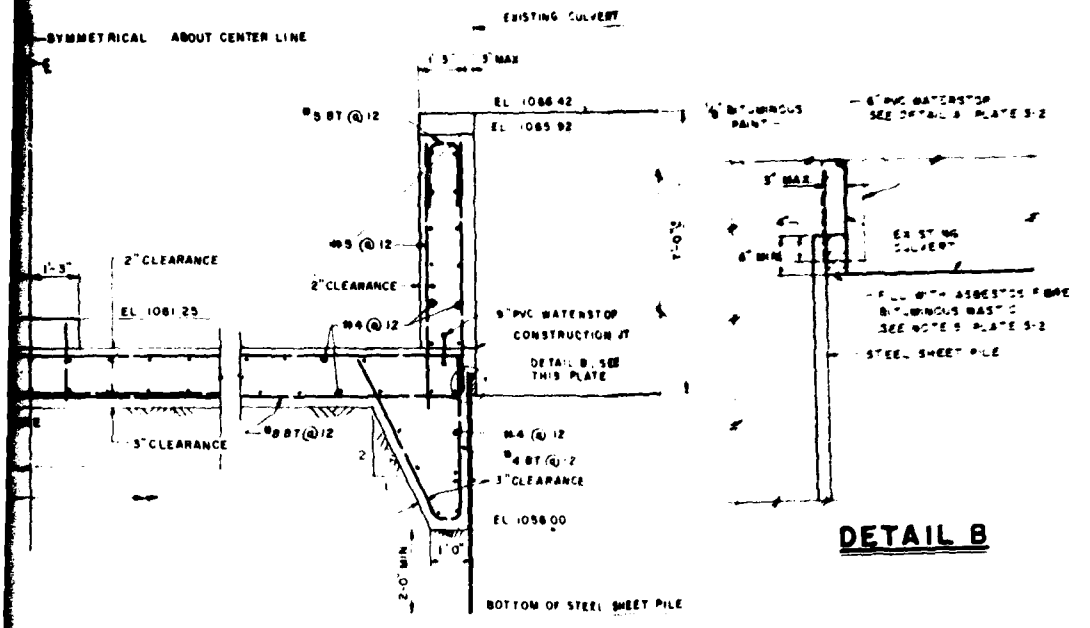
SECTION B-B

SCALE 1/2"=1'-0"

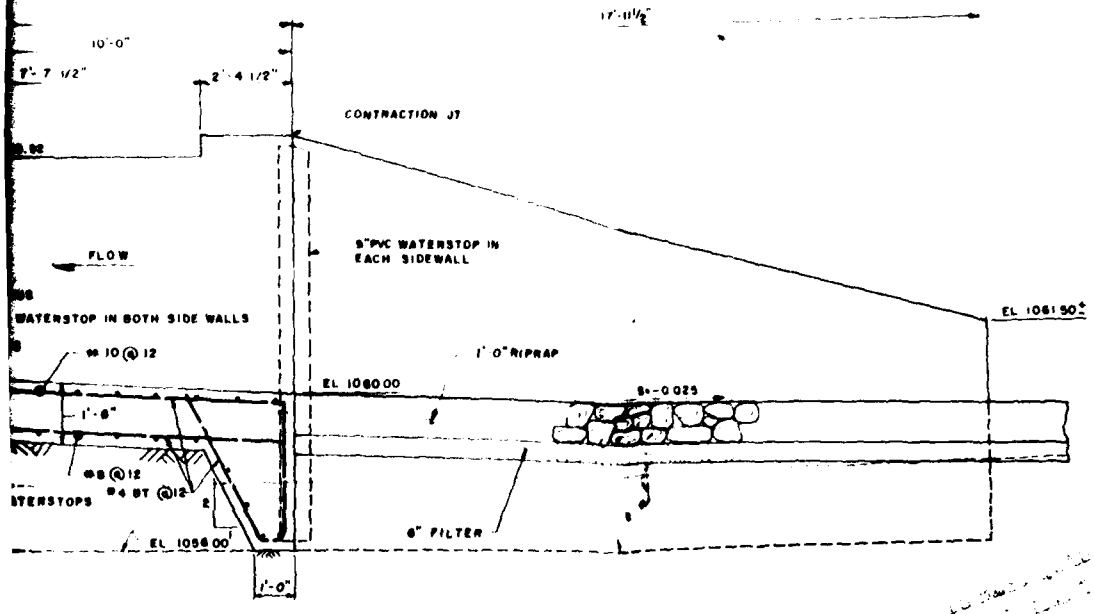


SECTION A-A

SCALE 1/2"=1'-0"



DETAIL B



DESIGNED C.W.P.	DIVERSIFIED MORTGAGE INVESTORS	SHEET NO 3
DRAWN H.T.	THE LAKE OF THE 4 SEASONS INVESTIGATIVE REPORT AUXILLARY SPILLWAY	JOB NO 7623
TRACED J.L.F.		
CHECKED C.W.P.	CONCRETE SECTIONS AND DETAILS NO. 1	DATE OCTOBER 1979
APPROVED C.W.P.		

GANNETT FLEMING CORDDRY AND CARPENTER, INC
ENGINEERS
P.O. BOX 1963 HARRISBURG, PENNA.

REVISIONS

NO	DESCRIPTION	DATE	BY

PLATE S-3

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

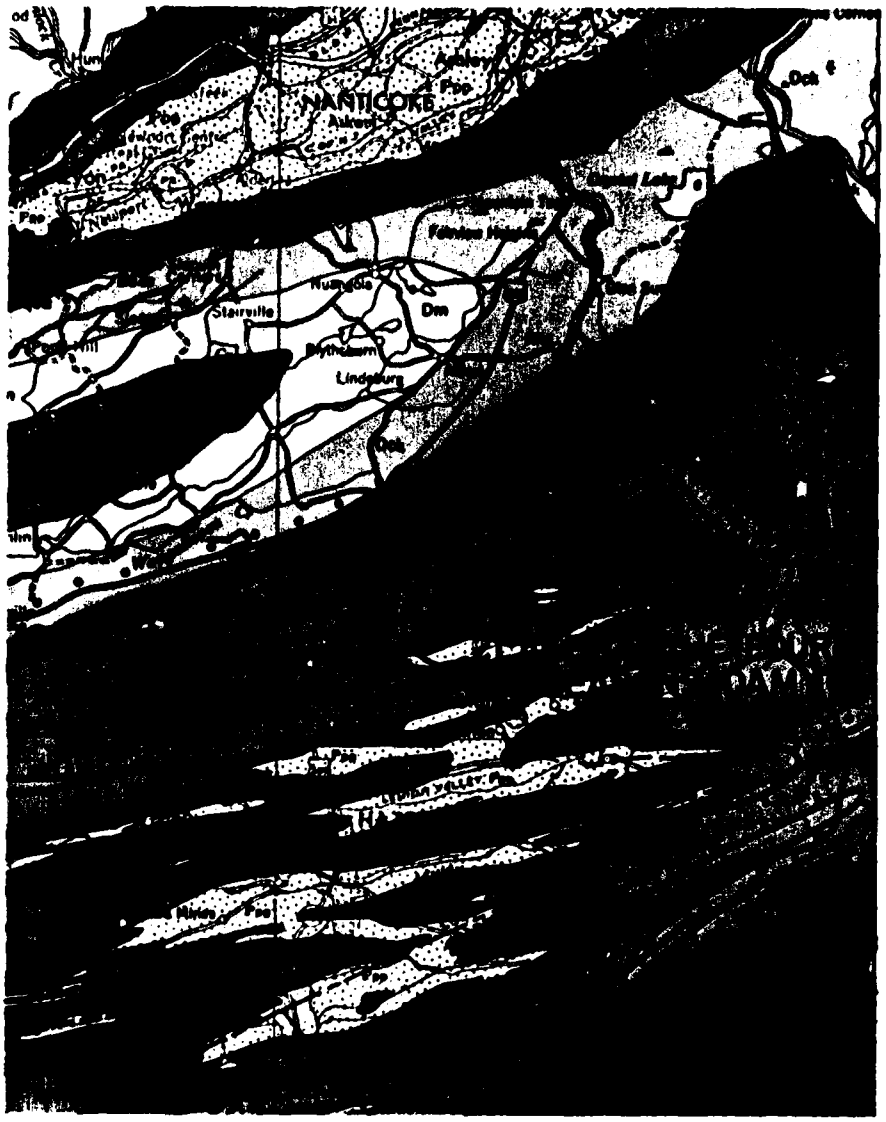
APPENDIX F
GEOLOGY

General Geology

Lake of the Four Seasons lies within the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. This region is characterized by overturned and assymetric folds, local shearing and large, low-angle thrust faults. There is some minor faulting indicated six or seven miles to the southeast of the reservoir.

The bedrock in this area consists of the Mississippian aged Mauch Chunk Formation. The rocks in this formation are generally red shales and claystones, and gray to green sandstones and siltstones. The thin beds are moderately well developed. The abundant joints are regularly spaced and moderately well formed. The sandstone and siltstone are very resistant to weathering while the shale and claystone may be severely weathered. The rocks form a good foundation for havy structures if excavated to sound material. The total effective porosity of the formation is high due to the jointing.

Lake of the Four Seasons lies at the approximate southern edge of the Wisconsin Drift. This area is characterized by glacial features and deposits which average between 25 to 50 feet in the northern Appalachians. This nonstratified sediment, or till, consists of boulder to clay sized particles.



Geologic Map of The Lake Of The Four Seasons Dam Area

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.

Scale: 1: 250,000