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NATIONAL DAM SAFETY PROGRAM. LAKE WINDSOR DAM (NJ-00034), HUDSO--ETC(U)

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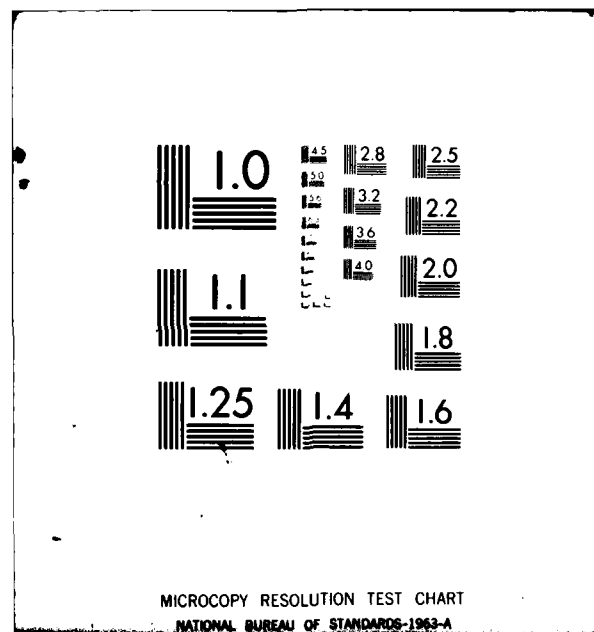
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⑥ National Dam Safety Program Lake
Windsor Dam (NJ-00034)

HUDSON RIVER BASIN,
TRIBUTARY PAPAKATING CREEK,
SUSSEX COUNTY,
NEW JERSEY.

① Inspection Report

LAKE WINDSOR DAM

⑨ Final Report

NJ 00034

⑫ 81 /

⑩ Peter Yu

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ELECTE
JUN 3 1981

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

⑪ PAC w 61-79-C-0011



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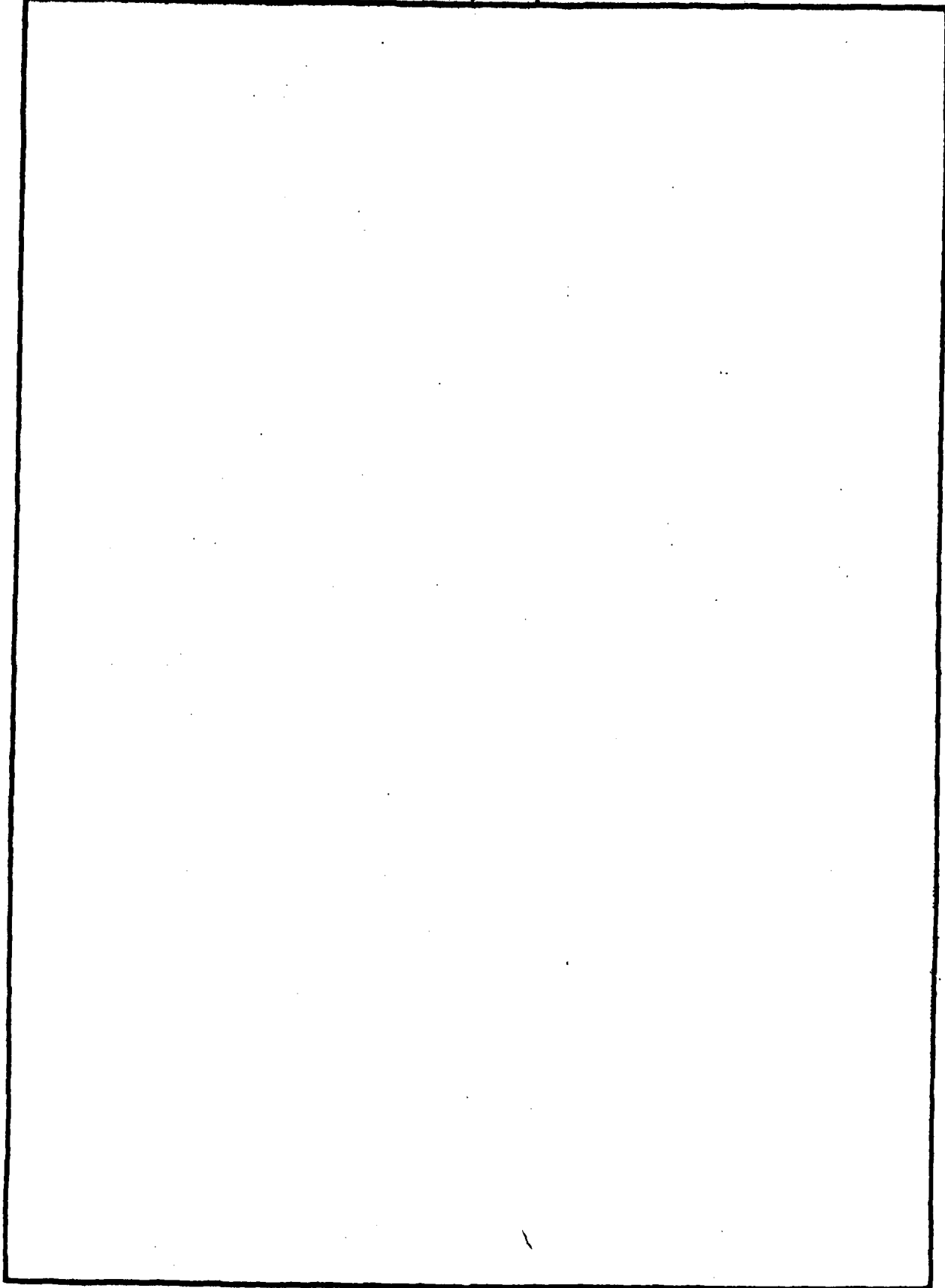
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.		

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

IN REPLY REFER TO
NAPEN-N

28 MAY 1981

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

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Dear Governor Byrne:

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

Based on visual inspection, available records, calculations and past operational performance, Lake Windsor Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition and the spillway is considered adequate. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The following actions should be initiated within six months from the date of approval of this report:

(1) Remove debris which has accumulated in the spillway discharge channel.

(2) Investigate the operating condition of the low level outlet and repair if necessary.

(3) Provide safe access to the control for operating the low level outlet.

(4) Repair cracked and spalled concrete in the spillway structure.

(5) Repair deteriorated or dislodged riprap on the upstream face of the embankment and at the downstream toe of the spillway.

(6) Repair eroded areas on the embankment of the dam.

b. The following remedial actions should be initiated within twelve months from the date of approval of this report:

(1) Perform additional investigation to determine seepage conditions through and under the dam, the engineering properties of the dam and foundation, and determine whether or not conventional safety margins exist under more severe stress conditions than those observed during the inspection, and what modifications may be required to achieve such safety margins.

NAPEN-N

Honorable Brendan T. Byrne

(2) Properly remove all trees and provide adequate filter coverage on the downstream face to prevent any piping which may occur as a result of future root decay.

c. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

d. An emergency action plan should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

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

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

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

Sincerely,



KENNETH R. MOSER
Major, Corps of Engineers
Acting District Engineer

1 Incl
As stated

Copies furnished:

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

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

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LAKE WINDSOR DAM (NJ00034)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 26 September 1980 by Langan Engineering Associates, Inc., under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Lake Windsor Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition and the spillway is considered adequate. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The following actions should be initiated within six months from the date of approval of this report:

(1) Remove debris which has accumulated in the spillway discharge channel.

(2) Investigate the operating condition of the low level outlet and repair if necessary.

(3) Provide safe access to the control for operating the low level outlet.

(4) Repair cracked and spalled concrete in the spillway structure.

(5) Repair deteriorated or dislodged riprap on the upstream face of the embankment and at the downstream toe of the spillway.

(6) Repair eroded areas on the embankment of the dam.

b. The following remedial actions should be initiated within twelve months from the date of approval of this report:

(1) Perform additional investigation to determine seepage conditions through and under the dam, the engineering properties of the dam and foundation, and determine whether or not conventional safety margins exist under more severe stress conditions than those observed during the inspection, and what modifications may be required to achieve such safety margins.

(2) Properly remove all trees and provide adequate filter coverage on the downstream face to prevent any piping which may occur as a result of future root decay.

c. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

d. An emergency action plan should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

APPROVED:

Kenneth R. Moser

KENNETH R. MOSER

Major, Corps of Engineers

Acting District Engineer

DATE:

27 May 1981

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	LAKE WINDSOR DAM
ID NUMBER:	FED ID No NJ 00034
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	SUSSEX
STREAM:	TRIBUTARY PAPA KATING CREEK
RIVER BASIN:	UPPER HUDSON
DATE OF INSPECTION:	SEPTEMBER 1980

ASSESSMENT OF GENERAL CONDITIONS

✓ Lake Windsor Dam, classified as having significant hazard potential, is in fair overall condition. There is seepage of water and spongy ground at the downstream toe of the embankment and erosion on the embankments. The embankments are covered with thick brush and trees. The riprap on the upstream face and the toe of the spillway is deteriorating and becoming dislodged in areas. Numerous cracks exist in the concrete of the spillway chute. The control of the low level outlet slide gate is not visible and its operating condition is unknown. There is essentially no available information concerning the design, construction and operation of the dam. Additional investigation is necessary to adequately evaluate the future performance of the dam.

The spillway capacity as determined by the Corps of Engineers Screening criteria is adequate.

The following are recommended to be done soon:

Remove debris which has accumulated in the spillway discharge channel. Investigate the operating condition of the low level outlet and repair if necessary. Provide safe access to the control for operating the low level outlet. Repair cracked and spalled concrete in the spillway structure. Repair deteriorated or dislodged riprap on the upstream embankments and at the downstream toe of the spillway. Repair eroded areas on the embankments of the dam. Develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

✓

The following are recommended to be done in the near future:

Perform additional investigation to determine seepage conditions through and under the dam, the engineering properties of the dam and foundation, and determine whether or not conventional safety margins exist under more severe stress conditons than those observed during our inspection, and what modifications may be required to achieve such safety margins. Properly remove all trees and provide adequate filter coverage on the downstream face to prevent any piping which may occur as a result of future root decay.


K. Peter Yu, P.E.



OVERALL VIEW
LAKE WINDSOR DAM

26 September 1980

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	LAKE WINDSOR DAM
ID NUMBER:	FED ID No NJ 00034
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	SUSSEX
STREAM:	TRIBUTARY - PAPA KATING CREEK
RIVER BASIN:	UPPER HUDSON
DATE OF INSPECTION:	SEPTEMBER 1980



LANGAN ENGINEERING ASSOCIATES, INC.

Consulting Civil Engineers
990 CLIFTON AVENUE
CLIFTON, NEW JERSEY
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NATIONAL DAM SAFETY REPORT
LAKE WINDSOR DAM FED ID NO NJ 00034

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PREFACE

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

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

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

SECTION 1 PROJECT INFORMATION

1.1 General

Authority to perform the Phase I Safety Inspection of Lake Windsor Dam was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 12 August 1980. This Authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and the US Army Engineers District, Philadelphia.

The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to safety of Lake Windsor Dam and appurtenances based upon available data and visual inspection, and determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted. The assessment is made using screening criteria established in Recommended Guidelines for Safety Inspection of Dams prepared by the Department of Army, Office of the Chief of Engineers. It is not the purpose of the inspection report to imply that a dam meeting or failing to meet the screening criteria is, per se, certainly adequate or inadequate.

1.2 Description of Project

a. Description of Dam and Appurtenances

Lake Windsor Dam is a 310 ft long, 32 ft high earthfill dam constructed during 1959 and 1960. The downstream embankment slope varies between 2H:1V to 3H:1V. The upstream slope is 3H:1V. The spillway is a 40 ft wide concrete overfall structure with a 3H:1V downstream slope. There is approximately 25 ft of boulder riprap beyond the toe of the spillway. An 18 inch diameter CMP low level outlet exists under the spillway structure. The outlet is controlled by a slide gate on the upstream end of the pipe. The control for the slide gate is reported to exist below pool elevation approximately 80 ft upstream of the spillway.

b. Location

Lake Windsor Dam is located at the northeastern end of Lake Windsor which is adjacent to Township Roadway off Route 23 in Wantage Township, Sussex County, New Jersey. It is at north latitude $41^{\circ}10.1'$ and west longitude $74^{\circ}38.4'$. A regional vicinity map and map of the area are given in Figures 1 & 2.

c. Size Classification

Lake Windsor Dam is classified as "small" based on its maximum storage capacity of 962 ac ft which is more than 50 ac ft and less than 1000 ac ft. The dam is also classified as "small" based on its maximum height of 32 feet which is less than 40 ft. Accordingly, the dam is classified as "small" in size.

d. Hazard Classification

In the National Inventory of Dams, Lake Windsor Dam has been classified as having "High Hazard Potential." Visual inspection of the downstream area shows that breach of the dam would cause little damage to downstream residences which are located on high ground, however it could be hazardous to people utilizing low lying secondary and dirt roads located approximately 3500 ft downstream of the dam. Accordingly, it is proposed to change the Hazard Potential Classification to "Significant".

e. Ownership

Ownership of Lake Windsor Dam is by Windsor Estates, Inc., care of H. F. Mayer, 267 Forest Street, Fort Lee, New Jersey 07025 as reported by the Wantage Township tax assessor.

f. Purpose of Dam

The purpose of the dam is "residential development" as listed on State of New Jersey, Division of Water Policy and Supply, Report on Dam Application No. 528, filed 26 February 1959.

g. Design and Construction History

Based on available information, the dam was engineered by Willis, Paul & Proctor, Inc. of Branchville, New Jersey. Permit for construction was issued on 29 June 1959. The dam was completed in mid 1960.

h. Normal Operational Procedures

No information has been found pertaining to operational procedures for the dam.

1.3 Pertinent Data

a.	<u>Drainage Areas</u>	1.01 sq. mi.
b.	<u>Discharge at Damsite</u>	
	Maximum known flood at damsite	unknown
	Ungated spillway capacity at max. pool elevation	1911 cfs (Assumes top of dam)
	Total spillway capacity at max. pool elevation	1911 cfs (Assumes top of dam)
c.	<u>Elevation</u> (Plan elevations, arbitrary datum)	
	Top Dam	536
	Maximum pool-design surcharge	unknown

	Recreation pool	530 (Design flow line)
	Spillway crest	530
	Maximum tailwater	unknown, dry at time of inspection
d.	<u>Reservoir</u>	
	Length of maximum pool	Approx 6200 ft (Assumes top of dam)
	Length of recreation pool	Approx 3100 ft
e.	<u>Storage (acre-feet)</u>	
	Recreation pool	602
	Top of dam	962
f.	<u>Reservoir Surface (acres)</u>	
	Top dam	92.5 @ el 536
	Maximum pool	92.5 (Assumes top of dam)
	Recreation pool	27.5 (Assumes spillway crest)
	Spillway crest	27.5
g.	<u>Dam</u>	
	Type	Earthfill
	Length	310 ft
	Height	32 ft
	Top Width	Approx 16 ft
	Side Slopes	U/S 3H:1V D/S varies between 3H:1V to 2H:1V
	Zoning	None indicated on plans
	Impervious Core	Reported to be compacted clay

Cutoff	Compacted Clay fill approx 5 ft below base of dam indicated on plans
Grout curtain	None indicated on plans
h. <u>Spillway</u>	
Type	Concrete overflow chute
Length of weir	40 ft
Crest elevation	El 530 (Arbitrary Datum)
Gates	None
U/S Channel	Concrete Apron
D/S Channel	Concrete chute, 3H:1V, boulder riprap at toe of chute
i. <u>Regulating Outlets</u>	18 in dia CMP low level outlet with slide gate

SECTION 2 ENGINEERING DATA

Essentially no information is available concerning the structural design, construction procedures or operational procedures pertaining to Lake Windsor Dam.

Limited information concerning hydrology and hydraulics, and copies of the construction specifications are in the NJ DEP, Division of Water Resources, Dam Application file No. 528, Lake Windsor.

Reports by James C. Riley, Principal Engineer, Hydraulic, New Jersey Division of Water Policy and Supply indicate that the dam was built in accordance with the approved drawings. The available information is inadequate to evaluate the dam.

SECTION 3 VISUAL INSPECTION

Lake Windsor Dam appears to be in fair overall condition. The low point of the crest of the dam is approximately 1 foot lower than the top of the spillway wing walls.

There is seepage of water and spongy ground at the downstream toe on both sides of the toe of the spillway chute. The embankments are vegetated with thick brush and numerous small diameter trees. A large diameter willow tree is growing on the north downstream embankment. There is erosion of the south upstream embankment adjacent to the spillway wing wall. The embankments have numerous areas of minor erosion due to footpaths on both the upstream and downstream faces. The upstream riprap is deteriorating and has become dislodged in areas.

The concrete forming the spillway wing walls has occasional thin cracks and areas of spalling. Many of these cracks have been filled with an epoxy like material. The concrete forming the bottom of the spillway channel has numerous cracks. The riprap at the toe of the spillway has become dislodged in areas and has accumulated soil sedimentation. Small amounts of debris have accumulated at the toe of the spillway at the time of our inspection.

The control to operate the slide gate on the upstream end of the 18 in CMP low level outlet could not be located during inspection. Plans of the dam show the control to be below pool elevation approximately 80 ft upstream of the dam crest in line with the spillway. The discharge of the low level outlet near the downstream end of the spillway discharge channel appears in satisfactory condition. The downstream channel is densely vegetated with trees and brush.

The shoreline of the reservoir is comprised of private yards on the south shore and forested hills on the north shore.

SECTION 4 OPERATIONAL PROCEDURES

No information concerning operational procedures for the dam have been found. No signs of recent maintenance were observed during our inspection. No warning system appears to be in effect.

SECTION 5 HYDRAULICS/HYDROLOGIC

Available information indicates the dam was designed for a 50-year flood with freeboard of 3.9 ft. The pertinent design data is included in Appendix 4.

Water marks on the spillway retaining walls indicate a past maximum water level of about 6 inches above the spillway crest has occurred.

The hydraulic/hydrologic evaluation is based on a Spillway Design Flood (SDF) equal to one-half of the Probable Maximum Flood chosen in accordance with the evaluation guidelines for dams classified as significant hazard and small in size. The PMF has been determined by developing a synthetic hydrograph based on the probable maximum precipitation of 22.0 inches (200 sq. mi. -24 hour). The Corps of Engineers has recommended the use of the SCS triangular unit hydrograph with the curvilinear transformation. Hydrologic computations are presented in Appendix 3. The 1/2 PMF peak inflow determined for the subject watershed is 2052 cfs.

The capacity of the spillway at maximum pool elevation 536 is 1911 cfs which is less than the SDF discharge. Routing for the 1/2 PMF indicates the dam can adequately pass the flood without overtopping.

The present drawdown facility consists of an 18 inch diameter corrugated metal low level outlet pipe with a slide gate at an invert elevation of approximately 506. Its operating condition is presently unknown. Drawdown of the reservoir has been evaluated assuming that the drawdown structure is operable. Our calculations indicate that the lake level could be lowered 6 ft in about 5 days and 24 ft in about 30 days.

SECTION 6 STRUCTURAL STABILITY

Based on visual observations, no immediate instability appears to exist in Lake Windsor Dam under normal conditions. However, there is seepage of water and spongy ground at the downstream toe of embankment. There is erosion on the embankments. Riprap is deteriorating on the upstream face and at the toe of the spillway discharge.

No information is available concerning the engineering properties of the foundation or dam materials. Consequently, analysis of the degree of stability of the dam cannot be made without gross assumptions concerning the properties of these materials.

No information is available concerning operating records or post construction changes of the dam.

Lake Windsor Dam is located in Seismic Zone 1 of the Seismic Zone Map of Contiguous States. As no information is available concerning the engineering properties of the foundation and dam materials, the degree of stability of the dam and appurtenances under more severe stress conditions than normal and its future performance cannot be evaluated without further investigation.

SECTION 7 ASSESSMENT, RECOMMENDATION/REMEDIAL MEASURES

7.1 Dam Assessment

Lake Windsor Dam is in fair overall condition. There is seepage of water and spongy ground at the downstream toe of the embankment and erosion on the embankments. The embankments are covered with thick brush and trees. The riprap on the upstream face and the toe of the spillway is deteriorating and becoming dislodged in areas. Numerous cracks exist in the concrete of the spillway chute. The control of the low level outlet slide gate is not visible and its operating condition is unknown.

There is essentially no available information concerning the design, construction and operation of the dam. Additional investigation is necessary to adequately evaluate the future performance of the dam.

The spillway capacity as determined by the Corps of Engineers Screening criteria is adequate.

7.2 Recommendations/Remedial Measures

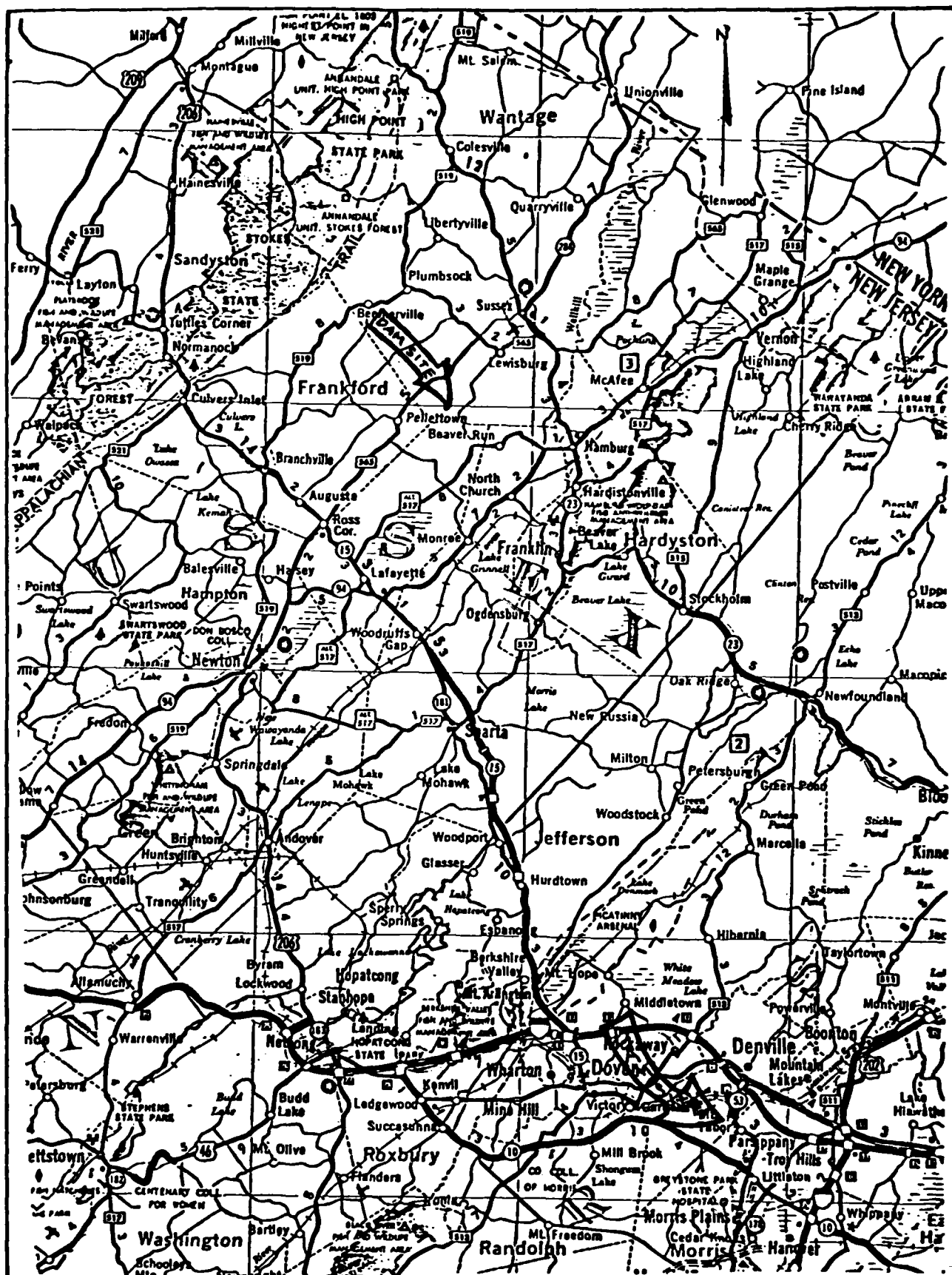
The following are recommended to be done soon:

1. Remove debris which has accumulated in the spillway discharge channel.
2. Investigate the operating condition of the low level outlet and repair if necessary.
3. Provide safe access to the control for operating the low level outlet.
4. Repair cracked and spalled concrete in the spillway structure.
5. Repair deteriorated or dislodged riprap on the upstream embankments and at the downstream toe of the spillway.
6. Repair eroded areas on the embankments of the dam.
7. Develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

The following are recommended to be done in the near future:

1. Perform additional investigation to determine seepage conditions through and under the dam, the engineering properties of the dam and foundation, and determine whether or not conventional safety margins exist under more severe stress conditions than those observed during our inspection, and what modifications may be required to achieve such safety margins.
2. Properly remove all trees and provide adequate filter coverage on the downstream face to prevent any piping which may occur as a result of future root decay.

FIGURES



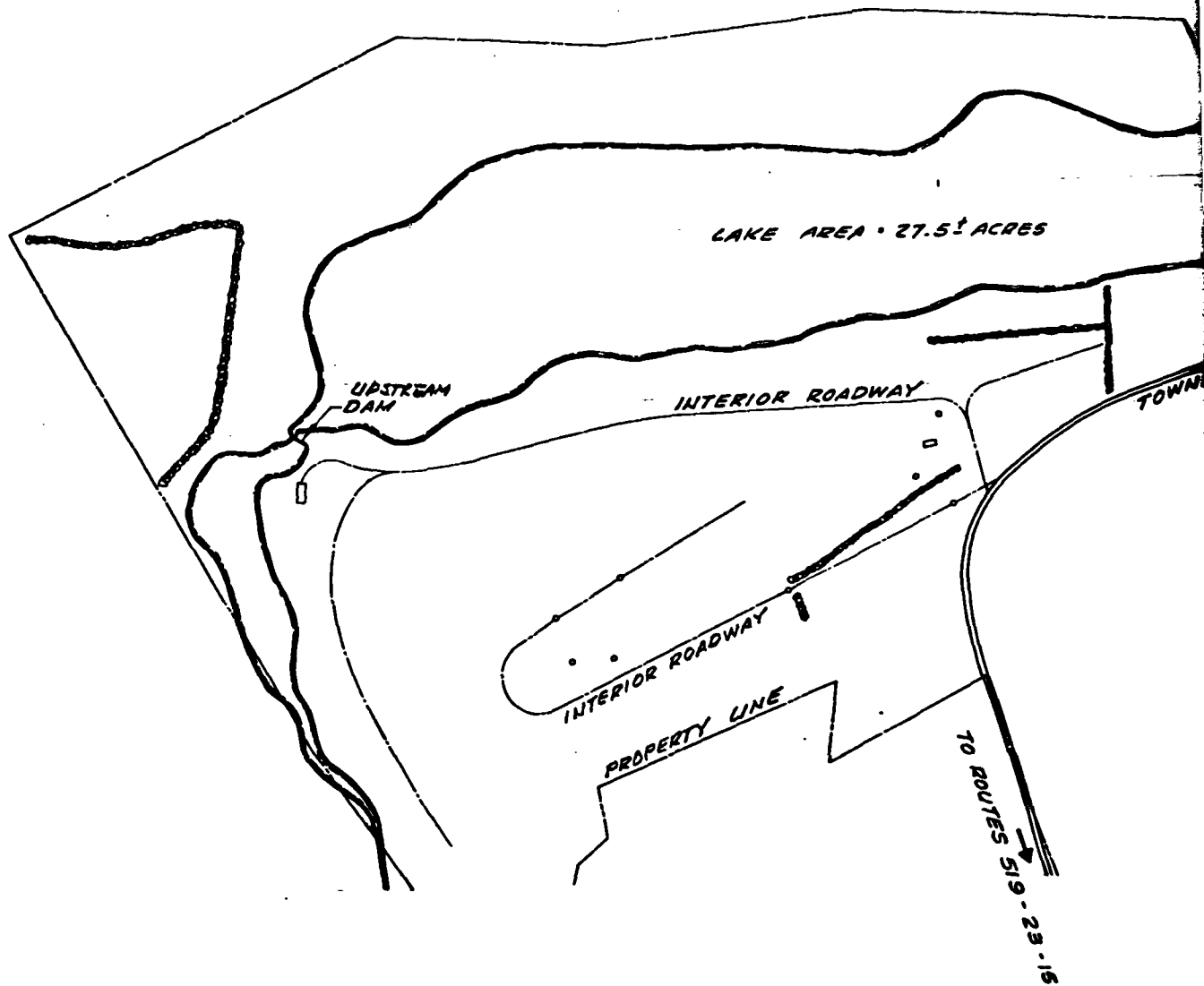
BY _____ DATE _____ REGIONAL VICINITY MAP JOB NO. 80145
 CKD _____ DATE _____ LAKE WINDSOR FIG. 1
 SCALE: 1" = 5 MILES

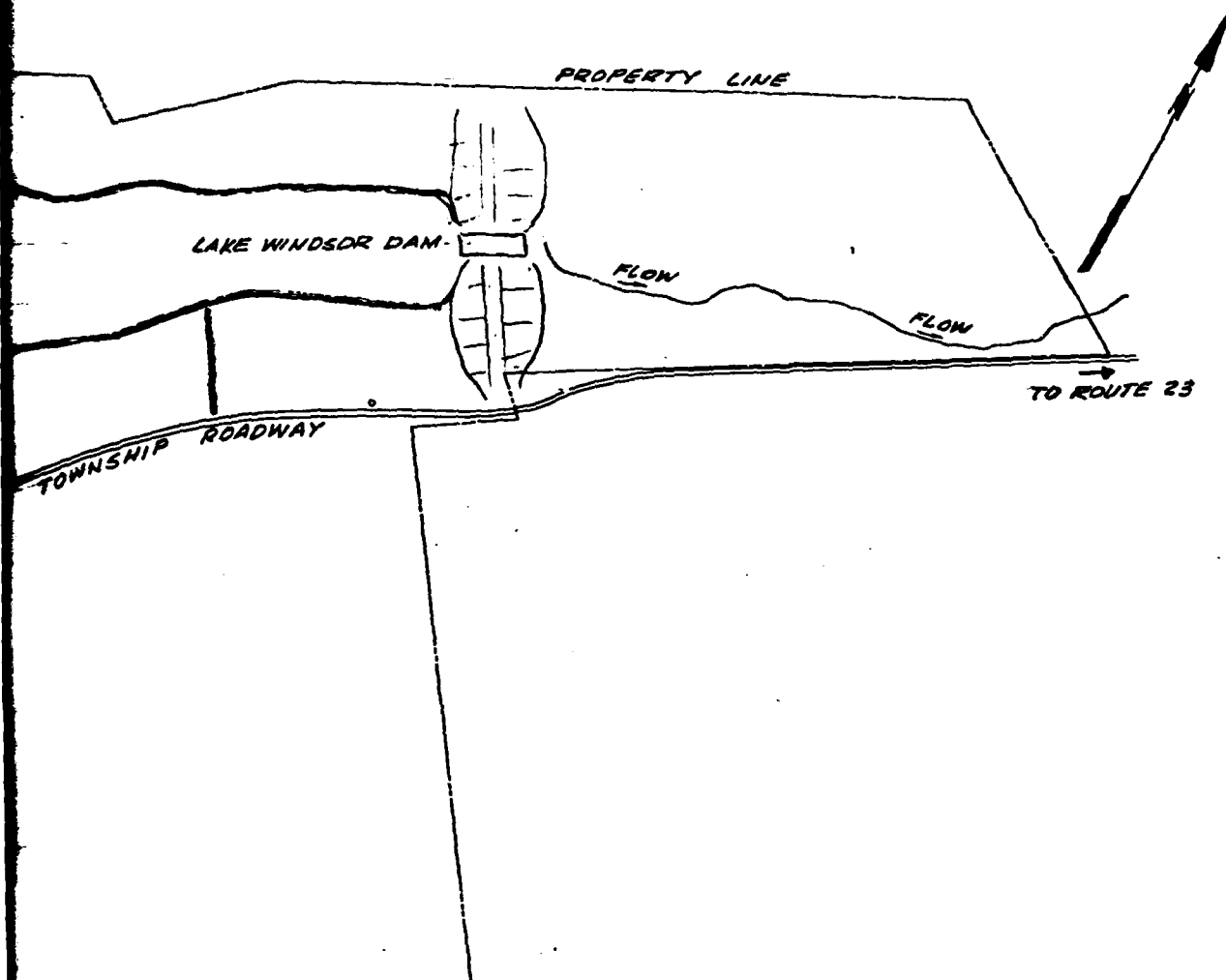
JOB NO. 80145

MAP SOURCE: USGS, BRANKHUISE, LAKE WINDSOR DAM

FIG. 2

SCALE 1" $\approx$ 2000 ft.





NOTE:

1. SKETCHES AND DATA ADAPTED FROM DRAWING
"PROPOSED LAKE SITE", BY WILLIS CONSTRUCTION,
BRANCHVILLE, NEW JERSEY, DATED JAN. 20, 1959

DAM SITE PLAN
LAKE WINDSOR DAM

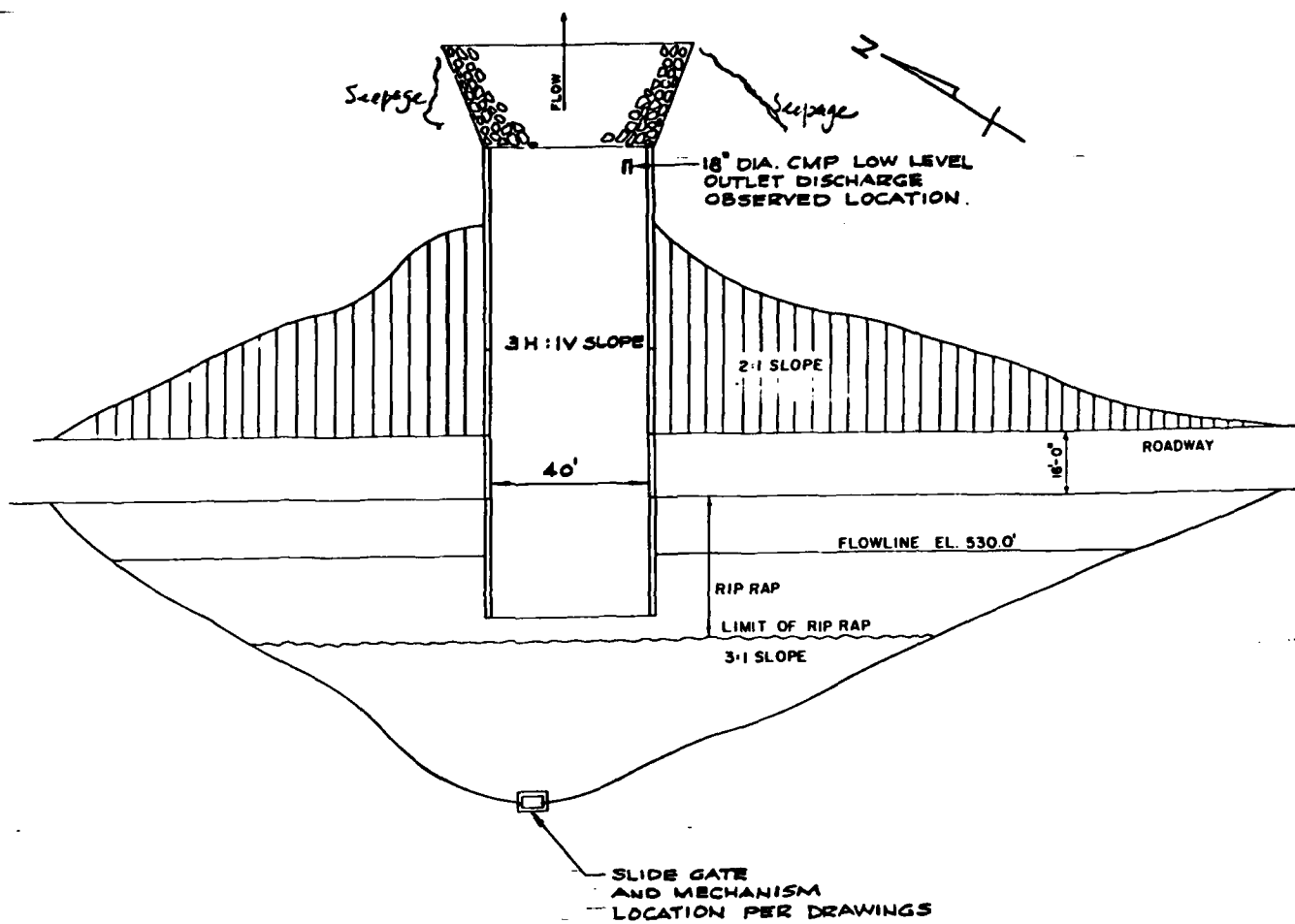
WANTAGE TOWNSHIP

SUSSEX COUNTY, N.J.

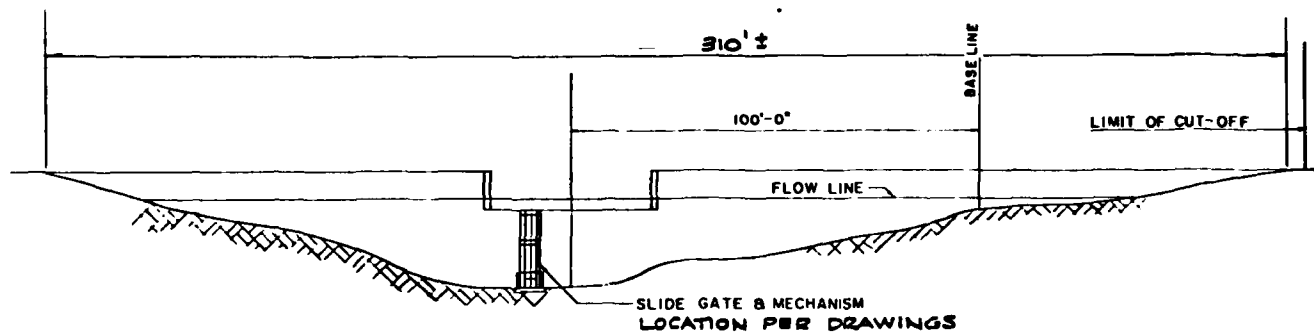
LANGAN ENGINEERING ASSOCIATES, INC.

990 CLIFTON AVENUE CLIFTON, N.J. 07013

DRN. BY: R.D.	SCALE: N.T.S.	JOB No. 80145
CK'D. BY: V.U.	DATE: 9-26-80	FIG. No. 3



PLAN VIEW



UPSTREAM ELEVATION

— 537.0'
— 530.0'
— 520.0'
— 510.0'
— 500.0'

NOTE:

1. SKETCHES AND DATA ADAPTED FROM DRAWING No. LW-1, REV. 1, "LAKE WINDSOR - PROPOSED DAM", BY WILLIS, PAUL AND PROCTOR, INC., BRANCHVILLE, NEW JERSEY, DATED MAY 28, 1959
2. LOW POINT OF TOP OF DAM IS ABOUT 1 FT LOWER THAN TOP OF SPILLWAY WING WALL FROM INSPECTION.

PLAN AND ELEVATION

LAKE WINDSOR DAM

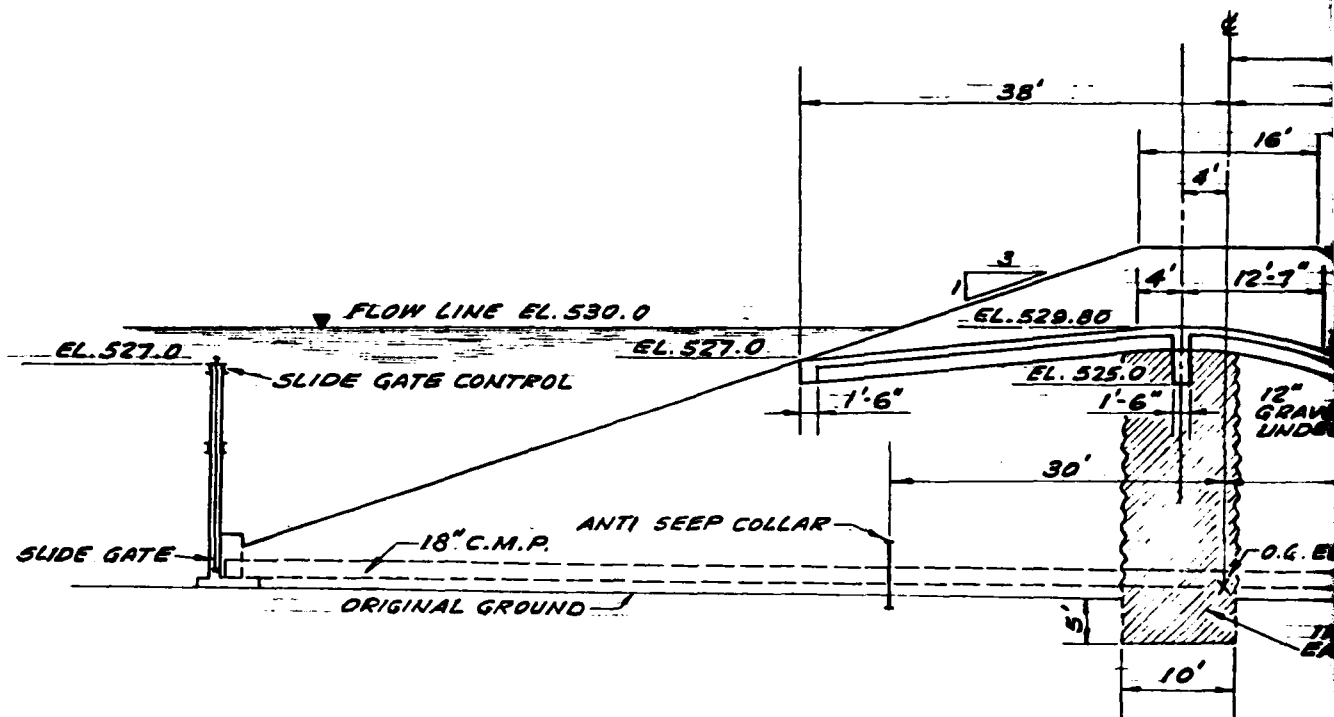
WANTAGE TOWNSHIP

SUSSEX COUNTY, N.J.

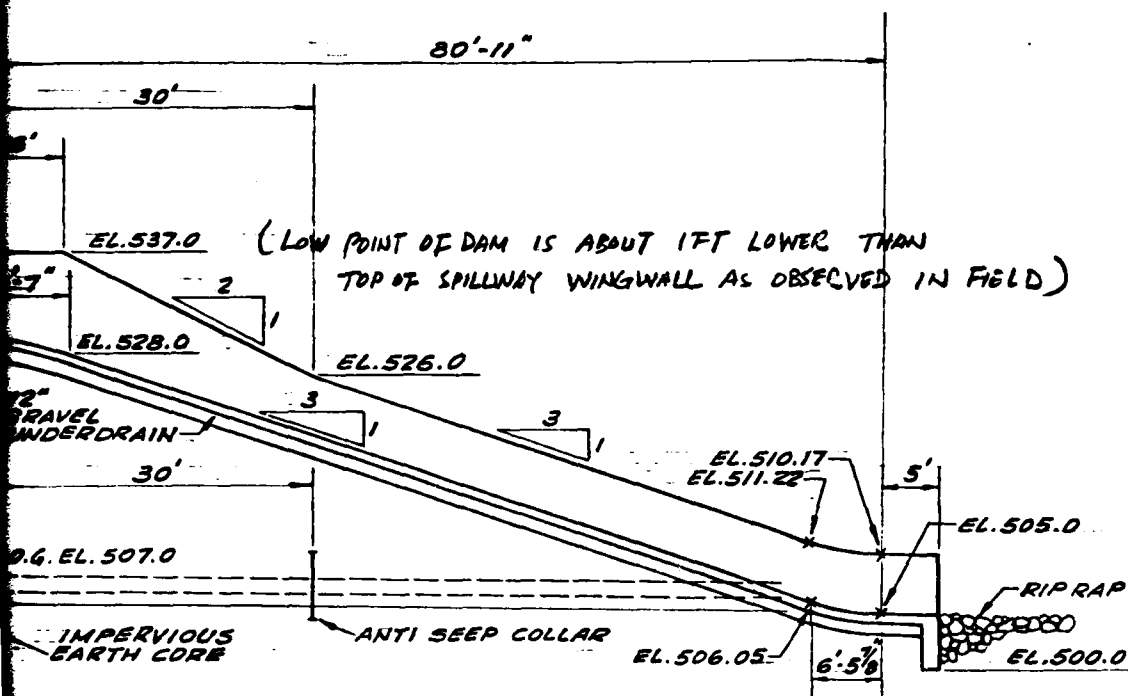
LANGAN ENGINEERING ASSOCIATES, INC.

990 CLIFTON AVENUE CLIFTON, N.J. 07013

DRN. BY: S.S.	SCALE: N.T.S.	JOB No. 80145
CK'D. BY: V.U.	DATE: 9-25-80	FIG. No. 4



SECTION



NOTE :

NOTE:
SKETCHES AND DATA ADAPTED FROM DRAWING NO. LW-2, REV. 1, "LAYOUT OF DAM AND SPILLWAY" BY WILLIS, PAUL AND PROCTOR, INC., BRANCHVILLE, NEW JERSEY, DATED MAY 26, 1959.

SECTION THRU DAM
LAKE WINDSOR DAM

WANTAGE TOWNSHIP SUSSEX COUNTY, N. J.

LANGAN ENGINEERING ASSOCIATES, INC.

990 CLIFTON AVENUE CLIFTON, N.J. 07013

DRN. BY: R.D.

SCALE: N.T.S.

JOB No. 80145

CK'D. BY: V.U.

DATE: 9-26-80

FIG. No. 5

2

APPENDIX I

CHECK LIST - HYDROLOGIC AND HYDRAULIC DATA

CHECK LIST - VISUAL INSPECTION

CHECK LIST - ENGINEERING DATA

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 1.01 sq. mi., avg slope 3.3%, wood or forest land

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 530 (602.4 ac ft)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 536 (962 ac ft) of dam (Assumes top

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: Approx 536 (lowest point on crest of dam)

CREST: Spillway

- a. Elevation 530
- b. Type Concrete overfall chute
- c. Width 16 ft - 7 in (pt to pt)
- d. Length 40 ft
- e. Location Spillover Approx center of dam
- f. Number and Type of Gates None

OUTLET WORKS: _____

- a. Type 18" CMP with slide gate
- b. Location Aligned under spillway
- c. Entrance inverts Approx 506
- d. Exit inverts Same
- e. Emergency draindown facilities _____

HYBROMETEOROLOGICAL GAGES: None known

- a. Type _____
- b. Location _____
- c. Records _____

MAXIMUM NON-DAMAGING DISCHARGE: 1911 cfs (maximum spillway discharge)

Note: Elevations taken from dam drawings prepared by Willis, Paul & Proctor, Inc., 1959

Check List
Visual Inspection
Phase 1

Name Dam Lake Windsor Dam County Sussex State N.J. Coordinators NJ DEP

Date(s) Inspection 9/26/80 Weather Clear Temperature High 60's F

Pool Elevation at Time of Inspection 529.7 NWSXX Approx Plan Datum
Tailwater at Time of Inspection 505 Extends

Water not flowing.

Inspection Personnel:

Richard Greene 9/26/80
Val Urban 9/26/80
Peter Yu 9/26/80

Richard Greene Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	NONE VISIBLE	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	NONE VISIBLE	
SLOUGHING OR EROSION OF EMBANKMENT AND ADJUTENT SLOPES	MODERATE EROSION ON UPSTREAM SOUTH EMBANKMENT NEXT TO SPILLWAY RETAINING WALL. MANY FOOT PATHS WITH MINOR EROSION ON BOTH EMBANKMENTS.	REPAIR EROSION.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	NO MISALIGNMENT OBSERVED.	
RIPRAP FAILURES	UPSTREAM - DETERIORATION & MINOR DISLODGE- MENT OF RIPRAP. DOWNSTREAM - SPILLWAY RIPRAP HAS ACCUMULATED SEDIMENTATION AND THERE IS SOME DISLODGE- MENT OF STONE.	REPAIR DISLODGED RIPRAP.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
	EMBANKMENT BRUSH COVERED WITH NUMEROUS SMALL DIAMETER TREES. LARGE DIAMETER WILLOW TREE ON NORTH EMBANKMENT.	REMOVE BRUSH AND TREES.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	NO APPARENT DEFICIENCY.	
ANY NOTICEABLE SEEPAGE	AT DOWNSTREAM TOE OF EMBANKMENT, APPROX 25 FT NORTH AND SOUTH OF TOE OF SPILLWAY. SEEPAGE OF WATER AND SPONGY GROUND.	INVESTIGATE SOURCE OF SEEPAGE AND PROVIDE REMEDIAL MEASURES IF NECESSARY.
STAFF GAGE AND RECORDER	NONE OBSERVED.	
DRAINS	NONE OBSERVED.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	MINOR SPALLING OF CONCRETE. NUMEROUS CRACKS IN CONCRETE SPILLWAY CHUTE.	REPAIR CRACKS.
APPROACH CHANNEL	PERPENDICULAR TO SPILLWAY. UNOBSTRUCTED.	
DISCHARGE CHANNEL	PERPENDICULAR TO SPILLWAY. CONCRETE LINED. UNOBSTRUCTED EXCEPT FOR MINOR ACCUMULATION OF DEBRIS AT TOE OF SPILLWAY. NUMEROUS CRACKS IN CONCRETE.	REPAIR CRACKS. REMOVE DEBRIS.
BRIDGE AND PIERS	NONE.	NOTCHED WING WALL APPEARS TO BE FOR FUTURE USE AS BRIDGE PIERS.
	CONCRETE WING WALLS HAVE OCCASIONAL CRACKS AND MINOR SPALLING - MANY CRACKS PATCHED WITH EPOXY LIKE MATERIAL.	REPAIR OPEN CRACKS.

OUTLET WORKS		
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	CONDUIT NOT OBSERVED.	CANNOT LOCATE CONTROLS.
INTAKE STRUCTURE	BELOW POOL SURFACE	CONDITION UNKNOWN.
OUTLET STRUCTURE	NO APPARENT DEFICIENCY	APPEARS SATISFACTORY.
OUTLET CHANNEL	SPILLWAY DISCHARGE CHANNEL. MINOR ACCUMULATION OF DEBRIS. SOME DISLODGE- MENT OF RIPRAP.	REMOVE DEBRIS. REPAIR RIPRAP.
EMERGENCY GATE	NONE OBSERVED.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	NORTH BANK, APPROX 3 or 4H:1V, DENSE TREES AND BRUSH. SOUTH BANK, APPROX 5 TO 8H:1V, TREES AND LAWNS.	
SEDIMENTATION	WATER CLOUDY- COULD NOT SEE LAKE BOTTOM. THERE APPEARS TO BE SOME SEDIMENTATION BASED ON CLOUDY WATER CONDITIONS FOLLOWING PREVIOUS NIGHT'S RAIN.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	SOFT SWAMPY GROUND. THICKLY VEGETATED STREAM BOTTOM. RIPRAP FOR APPROX 25 FT BEYOND END OF SPILLWAY. NO WATER MOVING. RIPRAP DISLODGED IN AREAS.	REPAIR RIPRAP.
SLOPES	VARIABLE, DENSE TREES AND BRUSH. APPROX 4 TO 8H:1V SIDE SLOPES.	
APPROXIMATE NO. OF HOMES AND POPULATION	NONE VISIBLE IMMEDIATELY DOWNSTREAM.	

CHECK LIST
-ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	LAKE WINDSOR - LAYOUT OF DAM AND SPILLWAY BY WILLIS, PAUL AND PROCTOR, INC. DATED JUNE 17, 1959
	Source: NJ DEP Dam Application File No. 528
REGIONAL VICINITY MAP. See Fig. 1 & 2	
CONSTRUCTION HISTORY	INFORMATION NOT AVAILABLE
TYPICAL SECTIONS OF DAM	LAKE WINDSOR - LAYOUT OF DAM AND SPILLWAY BY WILLIS, PAUL AND PROCTOR, INC. DATED JUNE 17, 1959
	SOURCE: NJ DEP DAM APPLICATION FILE NO. 528
HYDROLOGIC/HYDRAULIC DATA	NJ DEP DAM APPLICATION NO. 528
OUTLETS - PLAN	
- DETAILS	LAKE WINDSOR - LAYOUT OF DAM AND SPILLWAY BY WILLIS, PAUL AND PROCTOR, INC. DATED JUNE 17, 1959
-CONSTRAINTS	
-DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	INFORMATION NOT AVAILABLE
	SOURCE: NJ DEP DAM APPLICATION FILE NO. 528

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

DESIGN REPORTS	INFORMATION NOT AVAILABLE
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GEOLOGY REPORTS	INFORMATION NOT AVAILABLE
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DESIGN COMPUTATIONS	
HYDROLOGY & HYDRAULICS	SOURCE: NJ DEP
DAM STABILITY	INFORMATION NOT AVAILABLE
SEEPAGE STUDIES	INFORMATION NOT AVAILABLE

MATERIALS INVESTIGATIONS	
BORING RECORDS	
LABORATORY	INFORMATION NOT AVAILABLE
FIELD	

POST-CONSTRUCTION SURVEYS OF DAM	INFORMATION NOT AVAILABLE
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BORROW SOURCES.	INFORMATION NOT AVAILABLE
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ITEM REMARKS

MONITORING SYSTEMS NONE OBSERVED

MODIFICATIONS NONE OBSERVED

HIGH POOL RECORDS INFORMATION NOT AVAILABLE

POST CONSTRUCTION ENGINEERING INFORMATION NOT AVAILABLE
STUDIES AND REPORTS

PRIOR ACCIDENTS OR FAILURE OF DAM
DESCRIPTION NONE REPORTED
REPORTS

MAINTENANCE
OPERATION RECORDS INFORMATION NOT AVAILABLE

ITEM	REMARKS	SOURCE:
SPILLWAY PLAN	LAKE WINDSOR - LAYOUT OF DAM AND SPILLWAY	NJ DEP
	BY WILLIS, PAUL AND PROCTOR, INC.	DAM APPLICATION FILE NO. 528
SECTIONS DATED JUNE 17, 1959		
DETAILS		
OPERATING EQUIPMENT	LAKE WINDSOR - LAYOUT OF DAM AND SPILLWAY	NJ DEP
PLANS & DETAILS	BY WILLIS, PAUL AND PROCTOR, INC.	DAM APPLICATION FILE NO. 528
	DATED JUNE 17, 1959	

APPENDIX 2
PHOTOGRAPHS



North spillway discharge
wing wall.

26 September 1980



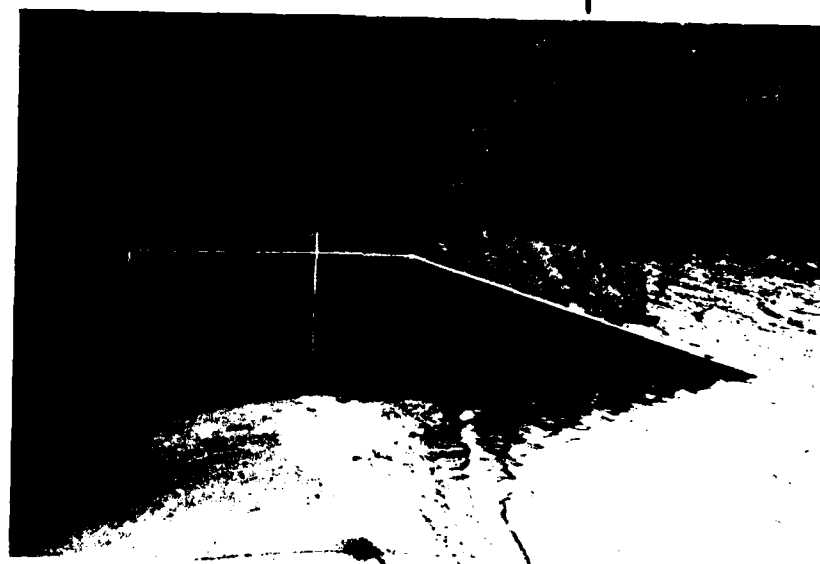
South spillway discharge
wing wall.

26 September 1980



View of north spillway wing wall
and spillway crest.

26 September 1980



View of south spillway wing wall,
spillway crest and south embankment.

26 September 1980



Erosion and deterioration of riprap 26 September 1980
at south upstream embankment and
spillway wing wall.



Erosion and deterioration of riprap 26 September 1980
at south upstream embankment and
spillway wing wall



Spillway discharge channel and
downstream channel viewed from
spillway crest.

26 September 198



Reservoir area viewed from
spillway crest.

26 September 1980

LAKE WINDSOR DAM

APPENDIX 3
HYDROLOGICAL COMPUTATIONS

HYDROLOGICAL COMPUTATIONS

LAKE WINDSOR DAM

A. Location: Sussex County, N.J., Papakating Creek

B. Drainage Area: 1.01 sq. mi (645 acres)

C. Lake Area: 27.5 acres $\pm$

D. Classification: Size - small
Hazard - SIGNIFICANT

E. Spillway Design Flood: $1/2$ PMF

F. PMP:

1. Dam located in Zone 1 (Near boundary to Zone 6)

PMP = 22.0 inches (for 200 sq. mi, 24 hr, "all season envelope")*

2. PMF must be adjusted by a factor of 0.8** to account for the basin size being < 10 sq. mi.

Duration, hr	% Factor (for 10 sq. mi.)		
	Zone 6	Zone 1	Avg
0-6	112	111	112
0-12	123	123	123
0-24	132	133	133
0-48	142	142	142

* HMR #33

** from pg 48 "Design of Small Dams"

BY RAU DATE _____ Lake Windsor Dam

JOB NO. 80195

CKD Py DATE 3/23/81

SHEET NO. 1 OF _____

G. DETERMINE TIME OF CONCENTRATION

Majority area of watershed is wood land.

Longest watercourse is about 6000 ft stream & 1000 ft overland flow

Estimated slope :

$$\text{overland} : \frac{160}{500} = 32\%$$

$$\text{Stream} = \frac{35}{6000} = 0.6\%$$



1. Estimate T_c based on average velocity and length

	<u>slope</u>	<u>velocity</u>	<u>remarks</u>
overland flow	32%	1.5 f/s	wooded
Stream	0.6%	1.5 f/s	waterway

$$T_c = \left[\frac{6500}{1.5} \right] \div 3600 = 1.2 \text{ hrs}$$

2. Estimate T_c from curve number method

From Table 2-2, SCS TR-55, Take $CN = 74$

$$S = \frac{1000}{CN} - 10 = \frac{1000}{74} - 10 = 3.51$$

$$\text{Average slope} = \left(\frac{32 \times 500 + 0.6 \times 6000}{6500} \right) \% = 3\%$$

BY Py DATE 3/23/81 Lake Windsor Dam JOB NO. 80145
 CKD RWA DATE 3/27/81 SHEET NO. 2 OF 2

$$\begin{aligned} \text{Lag time } L &= \frac{L^{0.6} (S+1)^{0.7}}{1900 (Y)^{0.5}} \quad \text{Eq 3-2 TR-55} \\ &= \frac{6500^{0.6} (4.51)^{0.7}}{1900 (3)^{0.5}} \\ &= 0.98 \text{ hr.} \end{aligned}$$

$$T_c = \frac{L}{0.6} = \frac{0.98}{0.6} = 1.6 \text{ hrs.}$$

Use Avg. T_c of 1.4 hrs,

$$\therefore \boxed{L = 0.84 \text{ hrs}}$$

BY Dy DATE 3/23/91 Lake Arrowhead Dam JOB NO. 80145
 CKD EWG DATE 3/27/91 SHEET NO. 3 OF

SPILLWAY CAPACITY

The spillway is a weir of trapezoidal cross section with both faces inclined. Its center line is located approximately 180 ft North of the south abutment and is made of reinforced concrete. The weir has an upstream slope of approx 11 horizontal to 1 vertical. The width of the weir (from PT to PT of the curved crest) is 16'-7". The downstream slope is 3 horizontal to 1 vertical. The flow discharges into a riprapped portion of channel approximately 25 ft in length.

The dam is an earth embankment type with upstream slopes 3H:1V and downstream slopes variable between 3H:1V to 2H:1V. It has a 16 ft crest width.

BY YAU DATE 7-27-80 L. Windsor

JOB NO. 2045

CKD. Py DATE 3/23/81

SHEET NO. 4 OF

All weir calculations will be based
on the equation $Q = CLH^{3/2}$ with
weir coefficients extracted from
original design calculations by SA,
Willis (26 Feb. 1959)

SEE FIGS 4 & 5 FOR DAM PLANS
SECTIONS & ELEVATIONS

BY <u>VIA</u>	DATE <u>9-19-80</u>	<u>Luke Windsor</u>	JOB NO. <u>80195</u>
CKD <u>py</u>	DATE <u>3/3/81</u>		SHEET NO. <u>5</u> OF <u> </u>

Elev (ft)	SPILLWAY L=40' w=16'-7"			EMBAKMENT w=16'				ΣQ
	H (ft)	C	Q (cfs)	H	C	L	Q	
530	0	3.25	0					0
532	2		368					368
534	4		1640					1040
535	5		1453					1453
536	6		1911	0	3.25	0	1911	1911
536.1	6.1		1959	.1		21	2	1961
536.2	6.2		2007	.2		34	10	2017
536.3	6.3		2056	.3		54	29	2085
536.5	6.5		2154	.5		104	120	2274
536.7	6.7		2255	.7		166	316	2571
537	7		2408	1		210	683	3091
537.3	7.3		2564	1.3	3.25	270	1301	3865
538	8		2942	2		270	2482	5424
540	10		4111	4		270	7020	11131
542	12		5404	6		270	12897	18301
544	14		6810	8		270	19856	26666
546	16		8320	10		270	27749	36069

BY VM

DATE 9-30-80

Lake Windsor

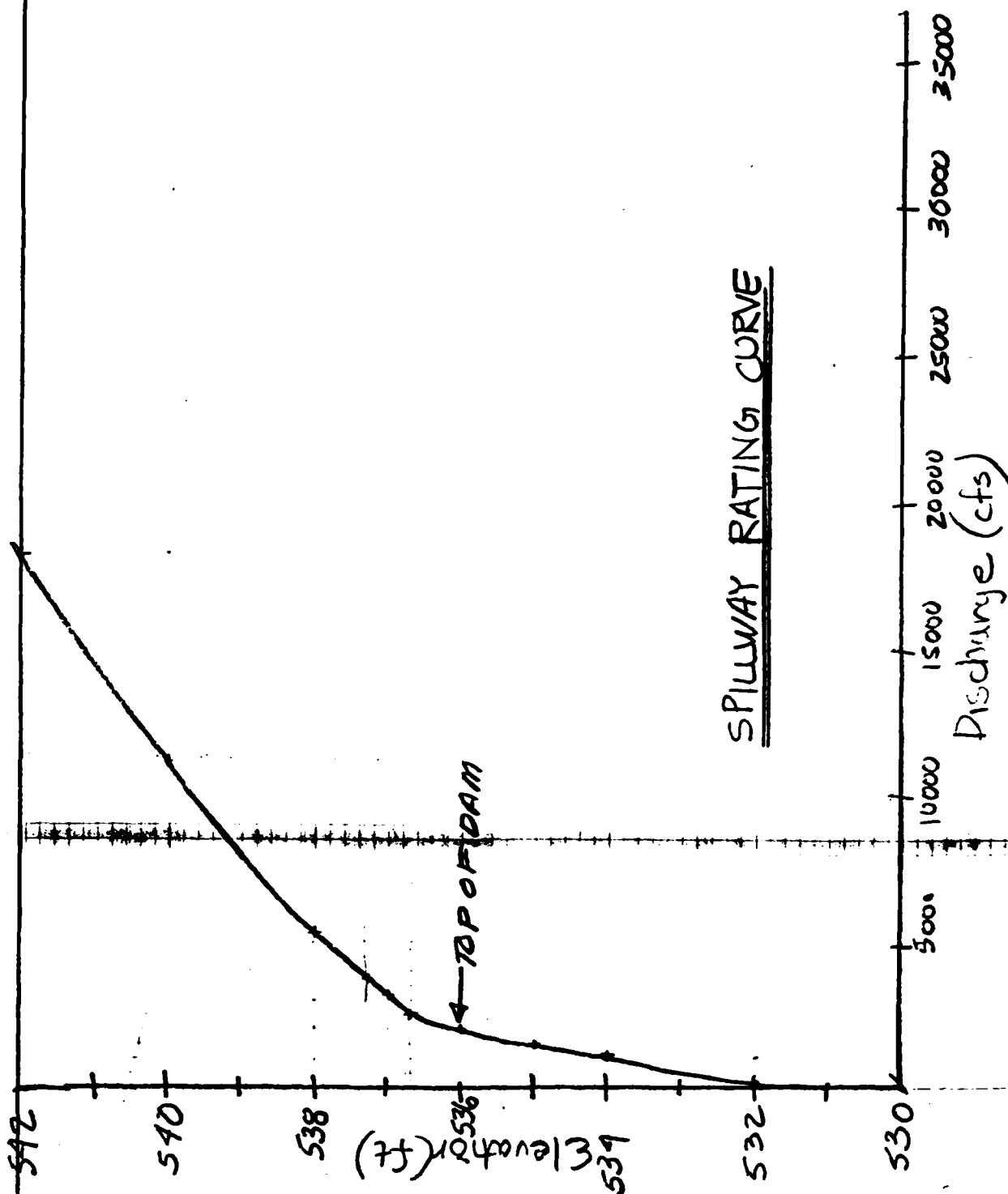
JOB NO. 80145

CKD PJ

DATE 3/23/81

Spmy Capacity

SHEET NO. 6 OF



BY VU DATE 9-29-80 Lake Windsor

JOB NO. 80145

CKD Py DATE 3/23/81

SHEET NO. 7 OF 7

RESERVOIR STORAGE CAPACITY

Area of lake at Elev. 530 & Elev 540 were measured planimetrically to areas of 27.5 acres & 135.9 acres respectively.

Assuming a linear distribution of area over 10 ft of vertical elevation we derive an increment area of:

$$\frac{135.9 \text{ ac} - 27.5 \text{ ac}}{10 \text{ ft}} = 10.84 \text{ ac./ft}$$

Elev. (ft.)	SURFACE AREA OF LAKE (AC.)
530	27.5
531	38.34
532	49.18
533	60.02
534	70.86
535	81.70
536	92.54
537	103.38
538	114.22
539	125.06
540	135.90
542	157.58

Storage capacity vs. elevation will be calculated by HEC-1

BY VM DATE 9/24/80 Lake Windsor JOB NO. 80195
 CKD. py DATE 3/23/81 SHEET NO. 8 OF

SUMMARY OF HYDROGRAPH AND FLOOD ROUTING

- 1) Hydrograph & routing calculated using HEC-1.
- 2) PMF for LAKE WINDSOR
is 2052 cfs (routed to 1111 cfs).
- 3) Routing of $\frac{1}{2}$ PMF indicates the dam
can adequately pass the flood without
overtopping.

BY KN DATE HEC-1 Summary JOB NO. 10145
CKD py DATE 3/23/81 SHEET NO. 9 OF

DRAWDOWN ANALYSISStructure

There presently exists an 18" Corrugated metal pipe low level outlet structure. The outflow is controlled by a slide gate. The operating condition is unknown.

Capacity

Pipe diam = 18"

Invert = 506.05

Length = 164'

Area = 1.77 f²Flow will be calculated using $Q = C_p H^{1/2}$ Where $C_p = A_p \sqrt{\frac{2g}{1 + K_m + K_p L}}$ $A_p = 1.77$, $K_m = .90$, K_p (for $n = .025$) = .0674∴ $C_p = 3.95$

Elev. = 506.8

 $Q = 3.95 H^{1/2}$

Elev ft	Head ft	Q cfs	Elev ft	Head ft	Q cfs
530	23.2	19	516	9.2	12
528	21.2	18	514	7.2	10.6
526	19.2	17	512	5.2	9
524	17.2	16	510	3.2	7
522	15.2	15	508	1.2	4
520	13.2	14	506	0	0
518	11.2	13			

BY MM DATE 9.29-80 Lake WindsorJOB NO. 80115CKD Py DATE 3/23/81SHEET NO. 10 OF

STORAGE

Storage will be calculated using the method of equivalent squares for sideslopes of 2H to 1V and an area at elevation 530 of 27.5 acres

Elev. (ft)	Equiv square (ft)	Area (ac)	Δh	Increment volume ac ft	Volume ac ft
530	1094.48	27.5			
528	1086.48	27.1	2	54.6	602.4
526	1078.48	26.7	2	53.8	547.8
524	1070.48	26.3	2	53.0	494.0
522	1062.48	25.9	2	52.2	441.0
520	1054.48	25.5	2	51.4	388.8
518	1046.48	25.1	2	50.6	337.4
516	1038.48	24.7	2	49.8	286.8
514	1030.48	24.4	2	49.1	237
512	1022.48	24.0	2	48.4	187.9
510	1014.48	23.6	2	47.6	139.5
508	1006.48	23.3	2	46.9	91.9
506.05	998.68	22.9	1.95	45.0	45

BY VK DATE 9-29-80 Lake WindsorJOB NO. 80195CKD my DATE 3/23/81 drawdownSHEET NO. 11 OF

Elevation (ft.)	Q _{out} (cfs)	Q _{avg} (cfs)	Q _{net} * (cfs)	Volume ac ft	Δ Time (hr)	Σ Time (hr)	Σ Time (days)
530	19	18.5	16.5	54.6	40	40	1.7
528	18	17.5	15.5	53.8	42	82	3.4
526	17	16.5	14.5	53.0	44.2	126.2	5.3
524	16	15.5	13.5	52.2	46.8	173.0	7.2
522	15	14.5	12.5	51.4	49.7	222.7	9.3
520	14	13.5	11.5	50.6	53.2	275.9	11.5
518	13	12.5	10.5	49.8	57.4	333.3	13.9
516	12	11.3	9.3	49.1	63.9	397.2	16.6
514	10.6	9.8	7.8	48.4	75.1	472.3	19.7
512	9	8	6	47.6	96	568.3	23.7
510	7	5.5	3.5	46.9	102.1	730	30.4
508	4	2	0	45.0	—**		
506.05	0						

* Q_{net} = Q_{avg} - Q_{in} where Q_{in} = 2 cfs / sq mi × 1.0 sq mi = 2 cfs

** where Q_{in} > Q_{avg}, not considered

Lake can be lowered 24 feet in 30 days ±.

BY KJA DATE 9/29/80 Lake Windsor
CKD B DATE 3/23/81 drawdown

JOB NO. 80195
SHEET NO. 12 OF 12



DRAINAGE BASIN	MAP SOURCE: USGS	PROJ NO 80145
LAKE WINDSOR DAM	BRANKVILLE, Scale: 1"=2000'	SHEET _____ OF _____

LANGAN ENGINEERING ASSOCIATES, INC.

HEC-1 OUTPUTS
WINDSOR LAKE DAM

1A1 A2 A3 B B1 J J1 K K1 M P T W2 X X K1 Y Y1 Y4 Y4 Y5 Y5 \$A \$A \$E \$E \$E \$D K A A A A A A

290	0	10	0	0	0	0
5						
1	1	1				
.5						
0	1					
IMPUTE HYDROGRAPH						
1	2	1.01		.80		
0	22.0	112	123	133	142	
	0.84					.15
-2		1				
1	2					
ROUTING COMPUTATIONS						
1			1			
530	532	534	535	536	536.1	536.2
537	537.5	538	540	542	544	546
0	368	1040	1453	1911	1961	2017
1091	38.5	5424	11131	18301	26666	36069
17.5	38.54	49.18	60.02	76.86	81.70	92.54
5.9	157.58					
530	531	532	533	534	535	536
540						
542						
530						
536						
99						

81/04/06. 16.07.03. NOS 1.3 - L485. ELAVJIKU STANDARD MCAUTO .. CYBER 175-3 1007.

STANDARD

ΕΛΛΑΣ

NOB 1.3 - L485.

81/04/06. 16.07.03.

[illegible]

00000000 MM MM MM 00000000

[illegible]

RUNOFF HYDROGRAPH AT 1
 ROUTE HYDROGRAPH TO 2
 END OF NETWORK

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

RUN DATE: 01/04/06.
 TIME: 16.08.09.

LAKE WINDSOR DAM (00034)
 INFLOW HYDROGRAPHY AND ROUTING
 N.J. DAM INSPECTION

JOB SPECIFICATION
 NO NHR NHIN IDAY IMR IMIN METRC IPLT IPRT NSTAN
 290 0 10 0 0 0 0 0 0 0
 JUPEK 5 0 0 0 0 0 0 0 0 0
 LKOPT TRACE

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 1 NRTIO= 1 LRTIO= 1
 RTIOS= .50

SUB-AREA RUNOFF COMPUTATION

COMPUTE HYDROGRAPH

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

HYDROGRAPH DATA
 INYDO IUNGS TAKEA SNAP TRSDA TRSPC NRTIO ISNOW ISAME LOCAL
 1 2 1.01 0.00 1.01 .80 0.000 0 0 0

PRECIP DATA
 SPFE PMS R6 R12 R24 R48 R72 R96
 0.00 22.00 112.00 123.00 133.00 142.00 0.00 0.00 0.00

LOSS DATA
 LRUPT STRKR DLTKR RTIOL -ERAIN STRKS RTIOK STRTL CNUIL ALSMX RTIMP
 0 0.00 0.00 1.00 1.00 0.00 0.00 1.00 1.00 .35 0.00 0.00

UNIT HYDROGRAPH DATA
 TC= 0.00 LAD= .04

RECESION DATA
 STATU= -2.00 UNCEM= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 27 END OF PERIOD UNDAINFEH, TC= 0.00 MUURH, LAU= .84 VOL= 1.00
 46. 139. 290. 446. 523. 523. 467. 388. 203. 204.
 182. 116. 84. 48. 34. 24. 20. 13. 11.
 8. 0. 0. 0. 0. 0. 0. 0. 0.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP U	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP U
1.01	1.10	1	.00	0.00	.00	2.	1.02	.20	146	.02	0.00	.02	2.
1.01	.20	2	.00	0.00	.00	2.	1.02	.30	147	.02	0.00	.02	2.
1.01	.30	3	.00	0.00	.00	2.	1.02	.40	148	.02	0.00	.02	2.
1.01	.40	4	.00	0.00	.00	2.	1.02	.50	149	.02	0.00	.02	2.
1.01	.50	5	.00	0.00	.00	2.	1.02	1.00	150	.02	0.00	.02	2.
1.01	1.00	6	.00	0.00	.00	2.	1.02	1.10	151	.02	0.00	.02	2.
1.01	1.10	7	.00	0.00	.00	2.	1.02	1.20	152	.02	0.00	.02	2.
1.01	1.20	8	.00	0.00	.00	2.	1.02	1.30	153	.02	0.00	.02	2.
1.01	1.30	9	.00	0.00	.00	2.	1.02	1.40	154	.02	0.00	.02	2.
1.01	1.40	10	.00	0.00	.00	2.	1.02	1.50	155	.02	0.00	.02	2.
1.01	1.50	11	.00	0.00	.00	2.	1.02	2.00	156	.02	0.00	.02	2.
1.01	2.00	12	.00	0.00	.00	2.	1.02	2.10	157	.02	0.00	.02	2.
1.01	2.10	13	.00	0.00	.00	2.	1.02	2.20	158	.02	0.00	.02	2.
1.01	2.20	14	.00	0.00	.00	2.	1.02	2.30	159	.02	0.00	.02	2.
1.01	2.30	15	.00	0.00	.00	2.	1.02	2.40	160	.02	0.00	.02	2.
1.01	2.40	16	.00	0.00	.00	2.	1.02	2.50	161	.02	0.00	.02	2.
1.01	2.50	17	.00	0.00	.00	2.	1.02	3.00	162	.02	0.00	.02	2.
1.01	3.00	18	.00	0.00	.00	2.	1.02	3.10	163	.02	0.00	.02	2.
1.01	3.10	19	.00	0.00	.00	2.	1.02	3.20	164	.02	0.00	.02	2.
1.01	3.20	20	.00	0.00	.00	2.	1.02	3.30	165	.02	0.00	.02	2.
1.01	3.30	21	.00	0.00	.00	2.	1.02	3.40	166	.02	0.00	.02	2.
1.01	3.40	22	.00	0.00	.00	2.	1.02	3.50	167	.02	0.00	.02	2.
1.01	3.50	23	.00	0.00	.00	2.	1.02	4.00	168	.02	0.00	.02	2.
1.01	4.00	24	.00	0.00	.00	2.	1.02	4.10	169	.02	0.00	.02	2.
1.01	4.10	25	.00	0.00	.00	2.	1.02	4.20	170	.02	0.00	.02	2.
1.01	4.20	26	.00	0.00	.00	2.	1.02	4.30	171	.02	0.00	.02	2.
1.01	4.30	27	.00	0.00	.00	2.	1.02	4.40	172	.02	0.00	.02	2.
1.01	4.40	28	.00	0.00	.00	2.	1.02	4.50	173	.02	0.00	.02	2.
1.01	4.50	29	.00	0.00	.00	2.	1.02	5.00	174	.02	0.00	.02	2.
1.01	5.00	30	.00	0.00	.00	2.	1.02	5.10	175	.02	0.00	.02	2.
1.01	5.10	31	.00	0.00	.00	2.	1.02	5.20	176	.02	0.00	.02	2.
1.01	5.20	32	.00	0.00	.00	2.	1.02	5.30	177	.02	0.00	.02	2.
1.01	5.30	33	.00	0.00	.00	2.	1.02	5.40	178	.02	0.00	.02	2.
1.01	5.40	34	.00	0.00	.00	2.	1.02	5.50	179	.02	0.00	.02	2.
1.01	5.50	35	.00	0.00	.00	2.	1.02	6.00	180	.02	0.00	.02	2.
1.01	6.00	36	.00	0.00	.00	2.	1.02	6.10	181	.05	.03	.03	3.
1.01	6.10	37	.00	0.00	.00	2.	1.02	6.20	182	.05	.03	.03	7.
1.01	6.20	38	.00	0.00	.00	2.	1.02	6.30	183	.05	.03	.03	16.
1.01	6.30	39	.00	0.00	.00	2.	1.02	6.40	184	.05	.03	.03	28.
1.01	6.40	40	.00	0.00	.00	2.	1.02	6.50	185	.05	.03	.03	44.
1.01	6.50	41	.00	0.00	.00	2.	1.02	7.00	186	.05	.03	.03	59.
1.01	7.00	42	.00	0.00	.00	2.	1.02	7.10	187	.05	.03	.03	72.
1.01	7.10	43	.00	0.00	.00	2.	1.02	7.20	188	.05	.03	.03	83.
1.01	7.20	44	.00	0.00	.00	2.	1.02	7.30	189	.05	.03	.03	91.
1.01	7.30	45	.00	0.00	.00	2.	1.02	7.40	190	.05	.03	.03	97.
1.01	7.40	46	.00	0.00	.00	2.	1.02	7.50	191	.05	.03	.03	102.
1.01	7.50	47	.00	0.00	.00	2.	1.02	8.00	192	.05	.03	.03	105.
1.01	8.00	48	.00	0.00	.00	2.	1.02	8.10	193	.05	.03	.03	107.
1.01	8.10	49	.00	0.00	.00	2.	1.02	8.20	194	.05	.03	.03	109.
1.01	8.20	50	.00	0.00	.00	2.	1.02	8.30	195	.05	.03	.03	111.
1.01	8.30	51	.00	0.00	.00	2.	1.02	8.40	196	.05	.03	.03	112.
1.01	8.40	52	.00	0.00	.00	2.	1.02	8.50	197	.05	.03	.03	112.
1.01	8.50	53	.00	0.00	.00	2.	1.02	9.00	198	.05	.03	.03	113.
1.01	9.00	54	.00	0.00	.00	2.	1.02	9.10	199	.05	.03	.03	113.
1.01	9.10	55	.00	0.00	.00	2.	1.02	9.20	200	.05	.03	.03	114.
1.01	9.20	56	.00	0.00	.00	2.	1.02	9.30	201	.05	.03	.03	114.
1.01	9.30	57	.00	0.00	.00	2.	1.02	9.40	202	.05	.03	.03	114.
1.01	9.40	58	.00	0.00	.00	2.	1.02	9.50	203	.05	.03	.03	114.
1.01	9.50	59	.00	0.00	.00	2.	1.02	10.00	204	.05	.03	.03	114.
1.01	10.00	60	.00	0.00	.00	2.	1.02	10.10	205	.05	.03	.03	114.
1.01	10.10	61	.00	0.00	.00	2.	1.02	10.20	206	.05	.03	.03	114.
1.01	10.20	62	.00	0.00	.00	2.	1.02	10.30	207	.05	.03	.03	115.

1.01	10.30	43	.00	.00	.00	2.	1.02	10.50	209	.05	.03	.03	115.
1.01	10.40	44	.00	.00	.00	2.	1.02	11.00	210	.05	.03	.03	115.
1.01	10.50	45	.00	.00	.00	2.	1.02	11.10	211	.05	.03	.03	115.
1.01	11.00	46	.00	.00	.00	2.	1.02	11.20	212	.05	.03	.03	115.
1.01	11.10	47	.00	.00	.00	2.	1.02	11.30	213	.05	.03	.03	115.
1.01	11.20	48	.00	.00	.00	2.	1.02	11.40	214	.05	.03	.03	115.
1.01	11.30	49	.00	.00	.00	2.	1.02	11.50	215	.05	.03	.03	115.
1.01	11.40	50	.00	.00	.00	2.	1.02	12.00	216	.05	.03	.03	115.
1.01	11.50	51	.00	.00	.00	2.	1.02	12.10	217	.33	.30	.30	127.
1.01	12.00	52	.02	.00	.02	2.	1.02	12.20	218	.33	.30	.30	165.
1.01	12.10	53	.02	.00	.02	2.	1.02	12.30	219	.33	.30	.30	245.
1.01	12.20	54	.02	.00	.02	2.	1.02	12.40	220	.33	.30	.30	367.
1.01	12.30	55	.02	.00	.02	2.	1.02	12.50	221	.33	.30	.30	511.
1.01	12.40	56	.02	.00	.02	2.	1.02	13.00	222	.33	.30	.30	655.
1.01	12.50	57	.02	.00	.02	2.	1.02	13.10	223	.39	.37	.37	786.
1.01	13.00	58	.03	.00	.03	2.	1.02	13.20	224	.39	.37	.37	902.
1.01	13.10	59	.03	.00	.03	2.	1.02	13.30	225	.39	.37	.37	999.
1.01	13.20	60	.03	.00	.03	2.	1.02	13.40	226	.39	.37	.37	1084.
1.01	13.30	61	.03	.00	.03	2.	1.02	13.50	227	.39	.37	.37	1160.
1.01	13.40	62	.03	.00	.03	2.	1.02	14.00	228	.39	.37	.37	1226.
1.01	13.50	63	.03	.00	.03	2.	1.02	14.10	229	.49	.47	.47	1285.
1.01	14.00	64	.03	.00	.03	2.	1.02	14.20	230	.49	.47	.47	1342.
1.01	14.10	65	.03	.00	.03	2.	1.02	14.30	231	.49	.47	.47	1402.
1.01	14.20	66	.03	.00	.03	2.	1.02	14.40	232	.49	.47	.47	1469.
1.01	14.30	67	.03	.00	.03	2.	1.02	14.50	233	.49	.47	.47	1538.
1.01	14.40	68	.03	.00	.03	2.	1.02	15.00	234	.49	.47	.47	1603.
1.01	14.50	69	.03	.00	.03	2.	1.02	15.10	235	.45	.42	.42	1656.
1.01	15.00	70	.03	.00	.03	2.	1.02	15.20	236	.75	.72	.72	1709.
1.01	15.10	71	.03	.00	.03	2.	1.02	15.30	237	1.35	1.32	1.32	1799.
1.01	15.20	72	.05	.00	.05	2.	1.02	15.40	238	3.37	3.35	3.35	2066.
1.01	15.30	73	.09	.00	.09	2.	1.02	15.50	239	.97	.95	.95	2540.
1.01	15.40	74	.23	.06	.16	3.	1.02	16.00	240	.60	.57	.57	3191.
1.01	15.50	75	.07	.04	.03	13.	1.02	16.10	241	.46	.43	.43	3799.
1.01	16.00	76	.04	.02	.03	27.	1.02	16.20	242	.46	.43	.43	4104.
1.01	16.10	77	.03	.01	.03	45.	1.02	16.30	243	.46	.43	.43	4093.
1.01	16.20	78	.03	.01	.03	60.	1.02	16.40	244	.46	.43	.43	3838.
1.01	16.30	79	.03	.01	.03	67.	1.02	16.50	245	.46	.43	.43	3461.
1.01	16.40	80	.03	.01	.03	67.	1.02	17.00	246	.46	.43	.43	3019.
1.01	16.50	81	.03	.01	.03	63.	1.02	17.10	247	.36	.34	.34	2663.
1.01	17.00	82	.03	.01	.03	55.	1.02	17.20	248	.36	.34	.34	2400.
1.01	17.10	83	.02	.00	.02	47.	1.02	17.30	249	.36	.34	.34	2196.
1.01	17.20	84	.02	.00	.02	41.	1.02	17.40	250	.36	.34	.34	2015.
1.01	17.30	85	.02	.00	.02	35.	1.02	17.50	251	.36	.34	.34	1861.
1.01	17.40	86	.02	.00	.02	29.	1.02	18.00	252	.36	.34	.34	1733.
1.01	17.50	87	.02	.00	.02	24.	1.02	18.10	253	.03	.00	.03	1614.
1.01	18.00	88	.02	.00	.02	19.	1.02	18.20	254	.03	.00	.03	1487.
1.01	18.10	89	.00	.00	.00	15.	1.02	18.30	255	.03	.00	.03	1331.
1.01	18.20	90	.00	.00	.00	11.	1.02	18.40	256	.03	.00	.03	1140.
1.01	18.30	91	.00	.00	.00	9.	1.02	18.50	257	.03	.00	.03	933.
1.01	18.40	92	.00	.00	.00	7.	1.02	19.00	258	.03	.00	.03	735.
1.01	18.50	93	.00	.00	.00	6.	1.02	19.10	259	.03	.00	.03	562.
1.01	19.00	94	.00	.00	.00	5.	1.02	19.20	260	.03	.00	.03	420.
1.01	19.10	95	.00	.00	.00	4.	1.02	19.30	261	.03	.00	.03	316.
1.01	19.20	96	.00	.00	.00	3.	1.02	19.40	262	.03	.00	.03	240.
1.01	19.30	97	.00	.00	.00	3.	1.02	19.50	263	.03	.00	.03	182.
1.01	19.40	98	.00	.00	.00	3.	1.02	20.00	264	.03	.00	.03	138.
1.01	19.50	99	.00	.00	.00	3.	1.02	20.10	265	.03	.00	.03	105.
1.01	20.00	100	.00	.00	.00	2.	1.02	20.20	266	.03	.00	.03	82.
1.01	20.10	101	.00	.00	.00	2.	1.02	20.30	267	.03	.00	.03	66.
1.01	20.20	102	.00	.00	.00	2.	1.02	20.40	268	.03	.00	.03	53.
1.01	20.30	103	.00	.00	.00	2.	1.02	20.50	269	.03	.00	.03	44.
1.01	20.40	104	.00	.00	.00	2.	1.02	21.00	270	.03	.00	.03	37.
1.01	20.50	105	.00	.00	.00	2.	1.02	21.10	271	.03	.00	.03	32.
1.01	21.00	106	.00	.00	.00	2.	1.02	21.20	272	.03	.00	.03	28.
1.01	21.10	107	.00	.00	.00	2.	1.02	21.30	273	.03	.00	.03	25.
1.01	21.20	108	.00	.00	.00	2.	1.02	21.40	274	.03	.00	.03	22.

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HYDROGRAPH ROUTING

MO. DA	HR. MN	PERIOD	HOURS	INFLW	OUTFLW	STORAGE	STAGE
1.01	.10	1	.17	1.	0.	0.	530.0
1.01	.20	2	.33	1.	0.	0.	530.0
1.01	.30	3	.50	1.	0.	0.	530.0
1.01	.40	4	.67	1.	0.	0.	530.0
1.01	.50	5	.83	1.	0.	0.	530.0
1.01	1.00	6	1.00	1.	0.	0.	530.0
1.01	1.10	7	1.17	1.	0.	0.	530.0
1.01	1.20	8	1.33	1.	1.	0.	530.0
1.01	1.30	9	1.50	1.	1.	0.	530.0
1.01	1.40	10	1.67	1.	1.	0.	530.0
1.01	1.50	11	1.83	1.	1.	0.	530.0
1.01	2.00	12	2.00	1.	1.	0.	530.0
1.01	2.10	13	2.17	1.	1.	0.	530.0
1.01	2.20	14	2.33	1.	1.	0.	530.0
1.01	2.30	15	2.50	1.	1.	0.	530.0
1.01	2.40	16	2.67	1.	1.	0.	530.0

1901	1.01	3.00	18	3.00	1.	1.	0.	530.0
1902	1.01	3.10	19	3.17	1.	1.	0.	530.0
1903	1.01	3.20	20	3.33	1.	1.	0.	530.0
1904	1.01	3.30	21	3.50	1.	1.	0.	530.0
1905	1.01	3.40	22	3.67	1.	1.	0.	530.0
1906	1.01	3.50	23	3.83	1.	1.	0.	530.0
1907	1.01	4.00	24	4.00	1.	1.	0.	530.0
1908	1.01	4.10	25	4.17	1.	1.	0.	530.0
1909	1.01	4.20	26	4.33	1.	1.	0.	530.0
1910	1.01	4.30	27	4.50	1.	1.	0.	530.0
1911	1.01	4.40	28	4.67	1.	1.	0.	530.0
1912	1.01	4.50	29	4.83	1.	1.	0.	530.0
1913	1.01	5.00	30	5.00	1.	1.	0.	530.0
1914	1.01	5.10	31	5.17	1.	1.	0.	530.0
1915	1.01	5.20	32	5.33	1.	1.	0.	530.0
1916	1.01	5.30	33	5.50	1.	1.	0.	530.0
1917	1.01	5.40	34	5.67	1.	1.	0.	530.0
1918	1.01	5.50	35	5.83	1.	1.	0.	530.0
1919	1.01	6.00	36	6.00	1.	1.	0.	530.0
1920	1.01	6.10	37	6.17	1.	1.	0.	530.0
1921	1.01	6.20	38	6.33	1.	1.	0.	530.0
1922	1.01	6.30	39	6.50	1.	1.	0.	530.0
1923	1.01	6.40	40	6.67	1.	1.	0.	530.0
1924	1.01	6.50	41	6.83	1.	1.	0.	530.0
1925	1.01	7.00	42	7.00	1.	1.	0.	530.0
1926	1.01	7.10	43	7.17	1.	1.	0.	530.0
1927	1.01	7.20	44	7.33	1.	1.	0.	530.0
1928	1.01	7.30	45	7.50	1.	1.	0.	530.0
1929	1.01	7.40	46	7.67	1.	1.	0.	530.0
1930	1.01	7.50	47	7.83	1.	1.	0.	530.0
1931	1.01	8.00	48	8.00	1.	1.	0.	530.0
1932	1.01	8.10	49	8.17	1.	1.	0.	530.0
1933	1.01	8.20	50	8.33	1.	1.	0.	530.0
1934	1.01	8.30	51	8.50	1.	1.	0.	530.0
1935	1.01	8.40	52	8.67	1.	1.	0.	530.0
1936	1.01	8.50	53	8.83	1.	1.	0.	530.0
1937	1.01	9.00	54	9.00	1.	1.	0.	530.0
1938	1.01	9.10	55	9.17	1.	1.	0.	530.0
1939	1.01	9.20	56	9.33	1.	1.	0.	530.0
1940	1.01	9.30	57	9.50	1.	1.	0.	530.0
1941	1.01	9.40	58	9.67	1.	1.	0.	530.0
1942	1.01	9.50	59	9.83	1.	1.	0.	530.0
1943	1.01	10.00	60	10.00	1.	1.	0.	530.0
1944	1.01	10.10	61	10.17	1.	1.	0.	530.0
1945	1.01	10.20	62	10.33	1.	1.	0.	530.0
1946	1.01	10.30	63	10.50	1.	1.	0.	530.0
1947	1.01	10.40	64	10.67	1.	1.	0.	530.0
1948	1.01	10.50	65	10.83	1.	1.	0.	530.0
1949	1.01	11.00	66	11.00	1.	1.	0.	530.0
1950	1.01	11.10	67	11.17	1.	1.	0.	530.0
1951	1.01	11.20	68	11.33	1.	1.	0.	530.0
1952	1.01	11.30	69	11.50	1.	1.	0.	530.0
1953	1.01	11.40	70	11.67	1.	1.	0.	530.0
1954	1.01	11.50	71	11.83	1.	1.	0.	530.0
1955	1.01	12.00	72	12.00	1.	1.	0.	530.0
1956	1.01	12.10	73	12.17	1.	1.	0.	530.0
1957	1.01	12.20	74	12.33	1.	1.	0.	530.0
1958	1.01	12.30	75	12.50	1.	1.	0.	530.0
1959	1.01	12.40	76	12.67	1.	1.	0.	530.0
1960	1.01	12.50	77	12.83	1.	1.	0.	530.0
1961	1.01	13.00	78	13.00	1.	1.	0.	530.0
1962	1.01	13.10	79	13.17	1.	1.	0.	530.0
1963	1.01	13.20	80	13.33	1.	1.	0.	530.0
1964	1.01	13.30	81	13.50	1.	1.	0.	530.0
1965	1.01	13.40	82	13.67	1.	1.	0.	530.0

1.01	13.50	83	13.83	1.	1.	0.	530.0
1.01	14.00	84	14.00	1.	1.	0.	530.0
1.01	14.10	85	14.17	1.	1.	0.	530.0
1.01	14.20	86	14.33	1.	1.	0.	530.0
1.01	14.30	87	14.50	1.	1.	0.	530.0
1.01	14.40	88	14.67	1.	1.	0.	530.0
1.01	14.50	89	14.83	1.	1.	0.	530.0
1.01	15.00	90	15.00	1.	1.	0.	530.0
1.01	15.10	91	15.17	1.	1.	0.	530.0
1.01	15.20	92	15.33	1.	1.	0.	530.0
1.01	15.30	93	15.50	1.	1.	0.	530.0
1.01	15.40	94	15.67	2.	1.	0.	530.0
1.01	15.50	95	15.83	6.	1.	0.	530.0
1.01	16.00	96	16.00	14.	1.	0.	530.0
1.01	16.10	97	16.17	23.	3.	1.	530.0
1.01	16.20	98	16.33	30.	5.	1.	530.0
1.01	16.30	99	16.50	34.	8.	1.	530.0
1.01	16.40	100	16.67	34.	10.	1.	530.1
1.01	16.50	101	16.83	32.	12.	2.	530.1
1.01	17.00	102	17.00	28.	13.	2.	530.1
1.01	17.10	103	17.17	24.	14.	2.	530.1
1.01	17.20	104	17.33	20.	15.	2.	530.1
1.01	17.30	105	17.50	17.	15.	2.	530.1
1.01	17.40	106	17.67	15.	15.	2.	530.1
1.01	17.50	107	17.83	12.	15.	2.	530.1
1.01	18.00	108	18.00	9.	15.	2.	530.1
1.01	18.10	109	18.17	7.	14.	2.	530.1
1.01	18.20	110	18.33	6.	14.	2.	530.1
1.01	18.30	111	18.50	5.	13.	2.	530.1
1.01	18.40	112	18.67	4.	12.	2.	530.1
1.01	18.50	113	18.83	3.	11.	2.	530.1
1.01	19.00	114	19.00	2.	11.	2.	530.1
1.01	19.10	115	19.17	2.	10.	2.	530.1
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1.01	19.30	117	19.50	2.	9.	1.	530.0
1.01	19.40	118	19.67	1.	8.	1.	530.0
1.01	19.50	119	19.83	1.	7.	1.	530.0
1.01	20.00	120	20.00	1.	7.	1.	530.0
1.01	20.10	121	20.17	1.	6.	1.	530.0
1.01	20.20	122	20.33	1.	6.	1.	530.0
1.01	20.30	123	20.50	1.	6.	1.	530.0
1.01	20.40	124	20.67	1.	5.	1.	530.0
1.01	20.50	125	20.83	1.	5.	1.	530.0
1.01	21.00	126	21.00	1.	5.	1.	530.0
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1.01	21.20	128	21.33	1.	4.	1.	530.0
1.01	21.30	129	21.50	1.	4.	1.	530.0
1.01	21.40	130	21.67	1.	3.	1.	530.0
1.01	21.50	131	21.83	1.	3.	0.	530.0
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1.02	.10	145	24.17	1.	2.	0.	530.0
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1.02	2.30	159	26.50	1.	1.	0.	530.0
1.02	2.40	160	26.67	1.	1.	0.	530.0
1.02	2.50	161	26.83	1.	1.	0.	530.0
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1.02	3.20	164	27.33	1.	1.	0.	530.0
1.02	3.30	165	27.50	1.	1.	0.	530.0
1.02	3.40	166	27.67	1.	1.	0.	530.0
1.02	3.50	167	27.83	1.	1.	0.	530.0
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1.02	4.30	171	28.50	1.	1.	0.	530.0
1.02	4.40	172	28.67	1.	1.	0.	530.0
1.02	4.50	173	28.83	1.	1.	0.	530.0
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1.02	7.00	186	31.00	29.	6.	1.	530.0
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1.02	7.20	188	31.33	42.	11.	2.	530.1
1.02	7.30	189	31.50	46.	13.	2.	530.1
1.02	7.40	190	31.67	49.	16.	2.	530.1
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1.02	8.40	196	32.67	56.	31.	5.	530.2
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1.02	9.10	199	33.17	57.	37.	6.	530.2
1.02	9.20	200	33.33	57.	38.	6.	530.2
1.02	9.30	201	33.50	57.	40.	6.	530.2
1.02	9.40	202	33.67	57.	41.	6.	530.2
1.02	9.50	203	33.83	57.	43.	7.	530.2
1.02	10.00	204	34.00	57.	44.	7.	530.2
1.02	10.10	205	34.17	57.	45.	7.	530.2
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1.02	10.30	207	34.50	57.	47.	7.	530.3
1.02	10.40	208	34.67	57.	47.	7.	530.3
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1.02	11.00	210	35.00	57.	49.	8.	530.3
1.02	11.10	211	35.17	57.	50.	8.	530.3
1.02	11.20	212	35.33	57.	50.	8.	530.3
1.02	11.30	213	35.50	57.	51.	8.	530.3
1.02	11.40	214	35.67	57.	51.	8.	530.3

1.02	12.00	214	36.00	57.	52.	530.3
1.02	12.10	217	36.17	64.	53.	530.3
1.02	12.20	218	36.33	83.	54.	530.3
1.02	12.30	219	36.50	122.	58.	530.3
1.02	12.40	220	36.67	184.	65.	530.4
1.02	12.50	221	36.83	255.	77.	530.4
1.02	13.00	222	37.00	327.	94.	530.5
1.02	13.10	223	37.17	393.	113.	530.6
1.02	13.20	224	37.33	451.	135.	530.7
1.02	13.30	225	37.50	499.	158.	530.9
1.02	13.40	226	37.67	542.	182.	531.0
1.02	13.50	227	37.83	580.	206.	531.1
1.02	14.00	228	38.00	613.	230.	531.2
1.02	14.10	229	38.17	642.	253.	531.4
1.02	14.20	230	38.33	671.	276.	531.5
1.02	14.30	231	38.50	701.	299.	531.6
1.02	14.40	232	38.67	735.	322.	531.7
1.02	14.50	233	38.83	769.	344.	531.9
1.02	15.00	234	39.00	801.	367.	532.0
1.02	15.10	235	39.17	828.	406.	532.1
1.02	15.20	236	39.33	855.	444.	532.2
1.02	15.30	237	39.50	900.	480.	532.3
1.02	15.40	238	39.67	1033.	521.	532.5
1.02	15.50	239	39.83	1270.	572.	532.6
1.02	16.00	240	40.00	1595.	639.	532.8
1.02	16.10	241	40.17	1899.	723.	533.1
1.02	16.20	242	40.33	2052.	813.	533.3
1.02	16.30	243	40.50	2046.	898.	533.6
1.02	16.40	244	40.67	1919.	970.	533.8
1.02	16.50	245	40.83	1731.	1025.	534.0
1.02	17.00	246	41.00	1509.	1048.	534.1
1.02	17.10	247	41.17	1331.	1095.	534.1
1.02	17.20	248	41.33	1200.	1107.	534.2
1.02	17.30	249	41.50	1098.	1111.	534.2
1.02	17.40	250	41.67	1007.	1106.	534.2
1.02	17.50	251	41.83	931.	1096.	534.1
1.02	18.00	252	42.00	867.	1081.	534.1
1.02	18.10	253	42.17	807.	1062.	534.1
1.02	18.20	254	42.33	743.	1040.	534.0
1.02	18.30	255	42.50	666.	1019.	533.9
1.02	18.40	256	42.67	570.	993.	533.9
1.02	18.50	257	42.83	467.	962.	533.8
1.02	19.00	258	43.00	367.	926.	533.7
1.02	19.10	259	43.17	281.	886.	533.5
1.02	19.20	260	43.33	210.	842.	533.4
1.02	19.30	261	43.50	158.	796.	533.3
1.02	19.40	262	43.67	120.	749.	533.1
1.02	19.50	263	43.83	91.	701.	533.0
1.02	20.00	264	44.00	69.	655.	532.9
1.02	20.10	265	44.17	53.	609.	532.7
1.02	20.20	266	44.33	41.	564.	532.6
1.02	20.30	267	44.50	33.	521.	532.5
1.02	20.40	268	44.67	27.	480.	532.3
1.02	20.50	269	44.83	22.	442.	532.2
1.02	21.00	270	45.00	19.	405.	532.1
1.02	21.10	271	45.17	16.	371.	532.0
1.02	21.20	272	45.33	14.	351.	531.9
1.02	21.30	273	45.50	13.	334.	531.8
1.02	21.40	274	45.67	12.	317.	531.7
1.02	21.50	275	45.83	11.	300.	531.6
1.02	22.00	276	46.00	10.	284.	531.5
1.02	22.10	277	46.17	10.	269.	531.5
1.02	22.20	278	46.33	9.	254.	531.4
1.02	22.30	279	46.50	9.	240.	531.3
1.02	22.40	280	46.67	9.	226.	531.2

APPENDIX 4

**HYDROLOGY AND HYDRAULIC DESIGN CALCULATIONS
FROM
STATE OF NEW JERSEY
DIVISION OF WATER POLICY AND SUPPLY**

Dam Application No. 528Map No. 22-169

State of New Jersey
Division of Water Policy and Supply

REPORT ON DAM APPLICATION

Application of Hantage Corporation, Box 196, Branchville, New Jersey

Filed February 26, 1959 for approval of plans and for a permit to construct

a dam for the impoundment of Lake Windsor across a tributary of Papakating Creek
tributary to Wallkill River in Hantage Township

Sussex County, New Jersey, has been examined by W. J. Galley, Principal Engineer,
Hydraulic

PRINCIPAL FEATURES

Purpose of dam residential development

Type of dam earth fill

Site inspected ---

Foundation material ----

Location: 22.27.1.9.f

Maximum height 32 feet

Drainage area 0.90 sq. mi.

Length of dam 310 feet

Elevation of flow line 530.0

Top width of dam 16 feet

Area of lake 30 acres

Downstream slope 2:1 & 3:1

Capacity of lake 9.2 million gallons

Upstream slope 3:1

Type of spillway overflow chute

Length of spillway 16 feet

Design flood flow 693 cubic feet per second = 770 sec. ft. per sq. mi.

Head on spillway for design flood flow 3.1 feet

Freeboard 3.9 feet

Maximum spillway capacity (dam breach) = 2350 cubic feet per second

= 2610 sec. ft. per sq. mi.

Outlet other than spillway 18" diameter D.W.P. drain

Drawings filed by S. A. Willis, License No. 6905

Pertinent Information

The proposed dam embankment section meets all the requirements of the Division as to slope and top width. Rip rap will be placed along the upstream slope from the top of the embankment to approximately 3 feet below normal water level.

A 40-foot bottom width rip rapped trapezoidal channel with 2:1 side slopes will be constructed for a distance of 25 feet downstream from the end of spillway apron.

Hydrology

Encroachment Application No. 3129 located approximately 0.6 miles downstream used 150% Central Jersey Curve as an estimate of a 15-year flood.

by Rational Method ----- 50 year flood

$$\begin{aligned}C &= C_1a & C_2 &= 0.40 \\C &= 0.40 \times 576 \times 2.60 & A &= 576 \text{ ac} \\C &= 596 \text{ sec. ft.} & i &= 2.60 \text{ "/hr} \\150\% \text{ Central Jersey} &= 567 \text{ sec. ft.} \\ \text{North Jersey} &= 693 \text{ sec. ft.}\end{aligned}$$

Use North Jersey Curve Run-off as an estimate of a 50-yr flood.

Hydraulics

Determine head on spillway for $C = 693$ sec. ft.

$$\begin{aligned}C &= C_1 L H^{3/2} & L &= 39 \text{ ft. (effective)} \\693 &= 3.25 \times 39 \times H^{3/2} & C_2 &= 3.25 \text{ (Kings)} \\H &= 3.10 \text{ ft.}\end{aligned}$$

Spillway Crest Elevation	533.00
"	3.10 ft.
Water Level Elevation	533.10
Top of Dam Embankment Elevation	537.00
Freeboard	3.90 ft.

It has been found that the site for the dam is suitable and the plans adequate to insure the construction of a structure which will not be a menace to life or property under design flood conditions. It is therefore recommended that the plans be approved and that a permit be issued subject to standard conditions and to the following special conditions:

10. The drawings and specifications hereby approved were prepared by Ellis, Paul & Proctor, Inc.,

specifications entitled,

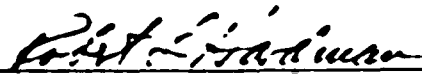
"Lake Windsor Dam
Specifications for Construction of Dam",
dated June 17, 1959.

drawings entitled,

"Lake Windsor Proposed Dam",
dated May 28, 1959;

"Lake Windsor Layout of Dam Spillway",
dated May 26, 1959;

"Lake Windsor Dam Spillway Reinforcing Details",
dated June 16, 1959.



Chief, Bureau of Water Control



Chief Engineer & Acting Director

Trenton, New Jersey

June 22, 19 59

APPENDIX 5
REFERENCES

APPENDIX 5

REFERENCES

1. Brater, Ernest F. and Kings, Horace W., Handbook of Hydraulics 5th Edition, McGraw-Hill Book Company 1963.
2. United States Department of Agriculture, Soil Conservation Service, Somerset, N. J. Urban Hydrology for Small Watersheds, Technical Release No. 55 January 1975.
3. United States Department of Commerce Weather Bureau, April 1956, Hydrometeorological Report #33, Washington, D.C.
4. United States Department of Interior, Bureau of Reclamation Design of Small Dams, Second Edition 1973, Revised print 1977.
5. United States Department of Agriculture, Soil Conservation Service, Soil Survey of Sussex and Morris County, August 1975.
6. United States Army Corps of Engineers, Flood Hydrograph Package (HEC-1), Davis, Calif. September 1978.
7. United States Department of Agriculture, SCS, A Method for Estimating Volume and Rate of Runoff in Small Watersheds, SCS-TP-149, Revised April 1973.
8. United States Army Corps of Engineers, Recommended Guidelines for Safety Inspection, Washington, D.C.
9. Sauls, G. A., Additional Hydrology and Hydraulics Guidance, 12 September 1978.
10. Dam Application File No. 528, Lake Windsor Dam, New Jersey Department of Environmental Protection, Division of Water Resources.

