

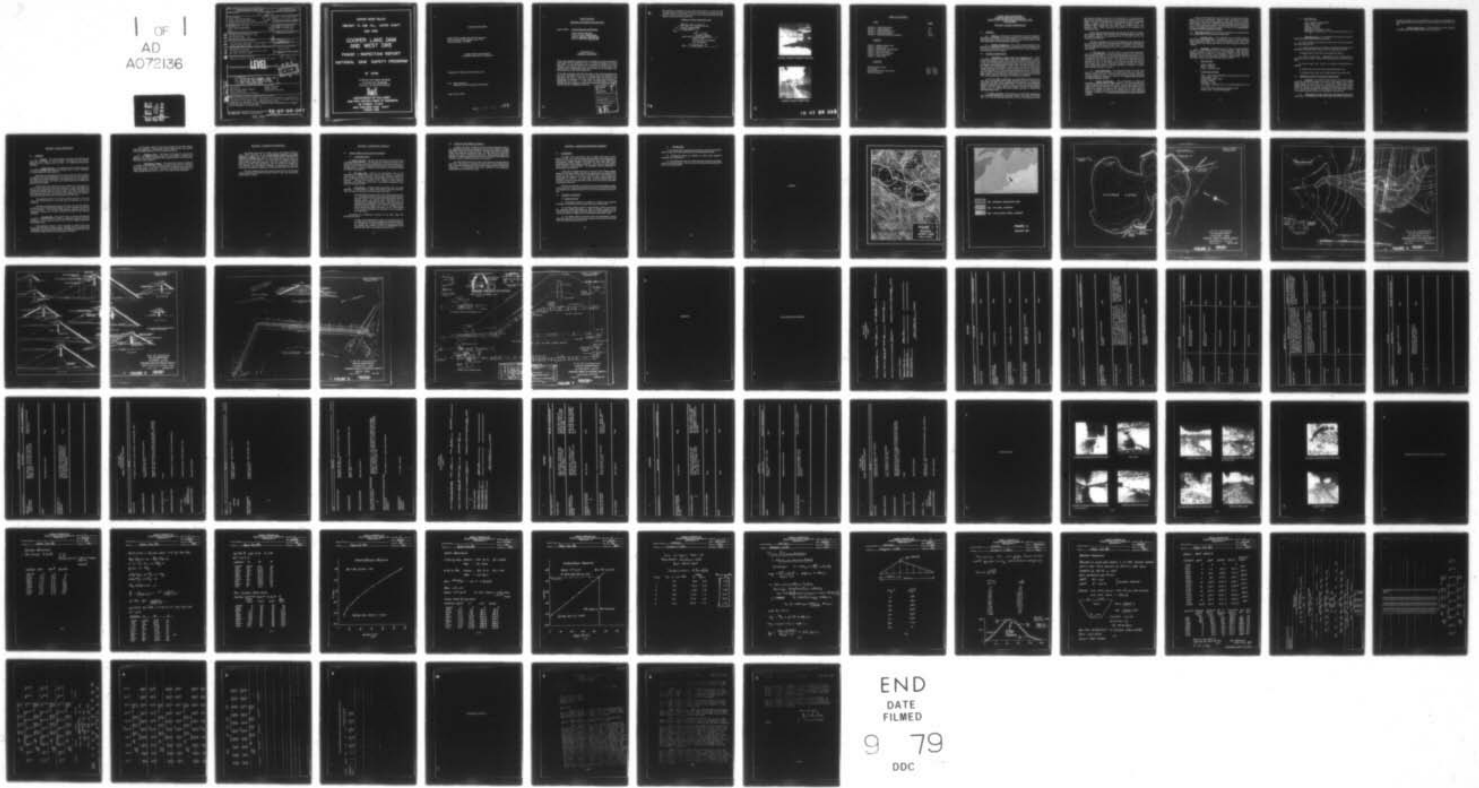
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NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/2
NATIONAL DAM SAFETY PROGRAM. COOPER LAKE DAM AND WEST DIKE (NYO--ETC(U)
SEP 78 J J WILLIAMS DACW51-78-C-0035

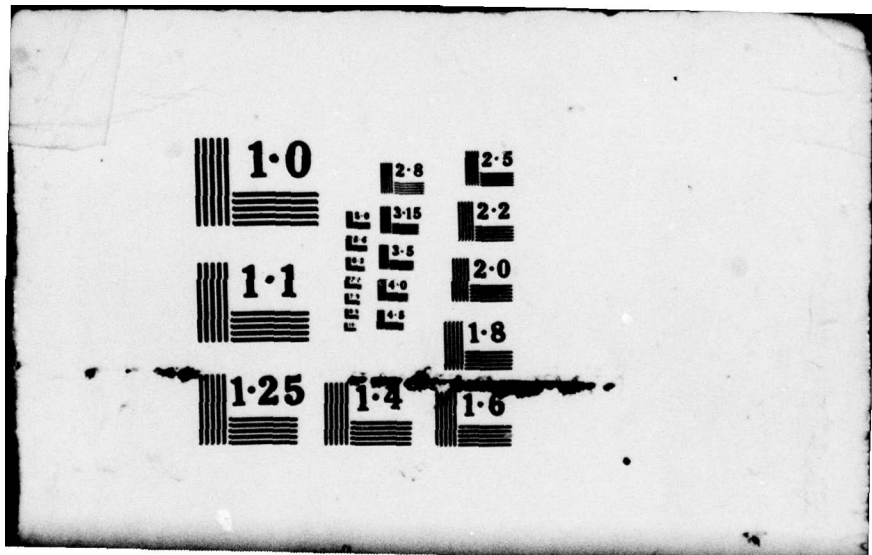
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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Inspection Report Cooper Lake Dam and West Dike Hudson River Basin, Ulster County, New York Inventory No. N.Y. 81		5. TYPE OF REPORT & PERIOD COVERED Phase I Inspection Report National Dam Safety Program
7. AUTHOR(s) John J. Williams, P.E.		6. CONTRACT OR GRANT NUMBER(s) DACW-51-78-C-70035
9. PERFORMING ORGANIZATION NAME AND ADDRESS O'Brien and Gere Engineers, Inc. 1301 Buckley Road Syracuse, New York 13221		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS New York State Department of Environmental Con- servation/ 50 Wolf Road Albany, New York 12233		12. REPORT DATE 21 September 1978
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety National Dam Safety Program Visual Inspection Hydrology, Structural Stability Cooper Lake Dam Ulster County Tributary to Saw Kill		
ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization. Cooper Lake Dam was found to safe, although further investigation of seepage in the embankment was recommended.		

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HUDSON RIVER VALLEY

TRIBUTARY TO SAW KILL, ULSTER COUNTY

NEW YORK

**COOPER LAKE DAM
AND WEST DIKE**

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NY 00081

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CONTRACT NO. DACW 51-78-C-0035



**DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007
AUGUST 1978**

HUDSON RIVER BASIN

Name of Dam: Cooper Lake Dam and West Dike
County and State: Ulster County, New York
Inventory Number: NY 00081

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by: O'Brien and Gere Engineers, Inc.

For: New York State
Department of Environmental Conservation

Date: July 27, 1978

79 07 30 033

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Cooper Lake Dam and West Dike

State Located: New York
County Located: Ulster County
Stream: Tributary to the Saw Kill
Date Of Inspection: June 27, 1978

ASSESSMENT OF
GENERAL CONDITIONS


During the inspection, isolated areas of seepage and water discoloration were evident at the downstream toe of the earth embankment of Cooper Lake Dam. At the West Dike, which is located at another area of the Reservoir near Cooper Lake Dam, a large area of ponded water with isolated areas of discoloration was evident along most of the length of the downstream toe of the earth embankment.

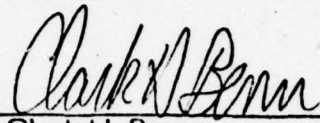
In the case of Cooper Lake Dam, the source of the isolated seepage areas and water discoloration may be from springs which are reported to be common in the area. In the case of the West Dike, the ponding at the downstream toe appears to be the result of beaver dams located just downstream of the site. In either case, the possibilities of excessive seepage and fines migration through the embankments should not be ruled out until further investigations are made.

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The spillway is adequate to pass flood flows equal to or less than the Probable Maximum Flood with .6 feet of freeboard still available between the PMF water surface elevation and the top of the embankment of both Cooper Lake Dam and the West Dike.

O'BRIEN & GERE ENGINEERS, INC.


John J. Williams, P.E.
Vice President

Approved by: 
Clark H. Benn
Colonel, Corps of Engineers
District Engineer

Date: 21 September 78



OVERALL VIEW OF COOPER LAKE DAM



OVERALL VIEW OF WEST DIKE

79 07 30 038

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM COOPER LAKE DAM AND WEST DIKE
ID # NY 00081

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. **Authority** - This report is authorized by the Dam Inspection Act, Public Law 92-367 and has been prepared in accordance with contract #1467.021 between O'Brien and Gere Engineers, Inc., and the State of New York, Department of Environmental Conservation.

b. **Purpose of Inspection** - The purpose of this inspection is to evaluate the structural, hydraulic and hydrologic conditions of Cooper Lake Dam and the West Dike and to determine if the dam or dike constitutes a hazard to human life or property.

1.2 PROJECT DESCRIPTION

a. **Description of Dam, Dike and Appurtenances** - (From information provided by the State of New York, Department of Environmental Conservation) Cooper Lake is located in Ulster County, New York, in the town of Woodstock, approximately three (3) miles northwest of the community of Bearsville (population 300 to 500). The lake is formed by two (2) rolled earth embankments: Cooper Lake Dam and the West Dike. Cooper Lake Dam is situated on the northeastern corner of the reservoir and the West Dike forms the northwestern border of the lake. The surface area of Cooper Lake accounts for approximately 35% of the total drainage basin. Water from the reservoir is discharged into a tributary of the Saw Kill which proceeds south through the community of Bearsville.

In the year 1800, a single dam was constructed at the site of the main dam. The original water surface elevation was 1092.3. Between the years 1899 and 1927, various modifications and additions were undertaken including construction of the West Dike. In later years (approximately 1959), a 10" high timber stoplog was added to the top of the concrete spillway crest to increase the water surface elevation to 1103.83 (see photographs, page #A2).

1) **Cooper Lake Dam** - The main dam is a rolled earth embankment with rock-lined upstream and downstream slopes. The grades of the slopes are 1 on 2 for the upstream face and 1 on 1½ for the downstream face.

The structural height of the dam is forty (40) feet. The present earth embankment was constructed over top of the original dam (built in the year 1800). The top of the original dam was excavated in order to expose the original corewall, which was then extended to elevation 1104. An additional earth embankment was placed to the present top of dam elevation 1180. Riprap protection was added to the upstream and downstream faces.

At the right (looking downstream) abutment of the dam is a concrete lined overflow spillway with a concrete weir and timber stoplog. Flow over the spillway passes by the downstream toe of the dam and into the tributary of the Saw Kill.

The dam is equipped with two (2) 20" pipes for water supply to the city of Kingston, New York. Discharge through these pipes is controlled by manually operated intake and outlet valves. According to the operator, who accompanied the inspection team, all valves are exercised at least twice a year.

2) The West Dike - The West Dike is a rolled earth embankment with a maximum height of 18 feet and an approximate length of 1,515 feet. The upstream face slope is 1 on 2½ and the downstream face slope is 1 on 2. The upstream face is lined with 14" thick rock and the downstream face is covered with 6" rock and gravel. Top width is ten (10) feet and top elevation is 1,108. At the northern end of the dike, 2 pipes, 24" and 12", enter Cooper Lake from the Mink Hollow System. Discharge into Cooper Lake through these pipes is manually controlled to maintain a constant water surface elevation in the lake.

b. Size Classification - The structural height of Cooper Lake Dam is forty (40) feet and that of the West Dike is 18 feet. Maximum storage is 3,683 acre-feet. Therefore, both the dam and West Dike are in the intermediate size category as defined by the Recommended Guidelines For Safety Inspection of Dams.

c. Hazard Classification - The communities of Shady and Bearsville are downstream of Cooper Lake Dam. The combined population of both communities is estimated to be 500. Cooper Lake is used for water supply for the city of Kingston. A failure of the dam would result in loss of human life, damage to property and partial loss of water supply to Kingston. Therefore, the main dam is considered to be in the high hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams.

Failure of the West Dike would also result in partial loss of water supply to the city of Kingston. However, only a few homes are located downstream of the dike and topography is such that failure of the dike would result in sheet flow. Damage to personal property would result but loss of human life is not probable. Therefore, the West Dike is considered to be in the significant hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams.

1.3 PERTINENT DATA (From information provided by the State of New York, Department of Environmental Conservation)

a. Drainage Area - The drainage area of Cooper Lake is approximately 0.7 square miles as determined from the U.S. Geological Survey Quadrangle Sheets (7.5 minute) for Bearsville, New York. The water surface of the lake is about 35% of the total drainage area (elevation 1103.83)

b. Discharges - Discharges from the reservoir are accomplished by means of two 20" pipes and an overflow spillway. With the water surface elevation at the top of the dam (elevation 1108), maximum discharge over the spillway is approximately 1,012 cfs and maximum discharge through the two pipes combined is approximately 148 cfs. Drawdown is also accomplished through these two pipes.

c. Reservoir Data

Length - 3,000 feet
Width - 3,500 feet
Volume - 3,683 acre-feet

d. Cooper Lake Dam Data

Type - rolled earth embankment with concrete cut-off wall
Top Elevation - 1,108
Tailwater Elevation - 1,065
Length - 460 feet
Top Width - 12 feet
Side Slopes - upstream face - 1 on 2; downstream face -1 on 1.5
Cutoff - concrete cutoff wall to elevation 1,104
Outlet Works - Two (2) 20" steel pipes

e. West Dike Data

Type - rolled earth embankment

Top Elevation - 1,108

Length - 1,515 feet

Top Width - 10 feet

Maximum Bottom Width - 91 feet

Side Slopes - upstream face - 1 on 2.5; downstream face - 1 on 2

f. Engineering Data - The information provided for review of Cooper Lake Dam and the West Dike included:

1) A set of seven (7) drawings for Cooper Lake Dam and the West Dike dated February, 1927.

2) Letter from Sanborn and Bogert Consulting Engineers to the Department of Public Works, Albany, New York dated April 14, 1927.

3) Department of Conservation, Dam Inspection Report.

4) State of New York - Applications for the Construction on Reconstruction of a Dam at Cooper Lake dated December, 1923 and March, 1927.

5) State of New York - Report of a Structure Impounding Water, undated.

6) State of New York Dam Report dated September, 1914.

7) Geologic Map of New York, Hudson-Mohawk Sheet dated 1961.

1.4 OPERATING AND MAINTENANCE PROCEDURES

a. Operation - The reservoir serves as part of the water supply system for the city of Kingston, New York. Water passes from the Mink Hollow System via a 24" pipe and a 12" pipe into Cooper Lake. Water passes through two (2) 20" pipes, from Cooper Lake to the city of Kingston. Valves for all lines are manually operated and exercised at least twice a year. The operator regulates the discharge from the Mink Hollow System to maintain a constant water surface elevation in the reservoir.

b. Maintenance of Dam, Reservoir, and Operating Facilities - Maintenance is performed on the main dam, West Dike, reservoir and

operating facilities on an "as needed basis". An operator is employed on a "year around" basis for the Cooper Lake System and is on call 24 hours per day.

c. Flood Warning System - No flood warning system has been established other than verbal warning from the operator.

SECTION 2 - VISUAL INSPECTION

2.1 FINDINGS

a. General - The field inspection of Cooper Lake Dam and the West Dike took place on June 27, 1978. The reservoir water surface elevation was at spillway crest (1103.83). No underwater areas were inspected.

b. Cooper Lake Dam - The upstream face of the dam is covered with uniformly graded rocks ranging in diameter from 2" to 18". No erosion or surface depressions were apparent.

Inspection of the downstream face, also covered with rock, indicated no apparent structural misalignment. At one area near the left abutment, the slope of the natural groundline at the downstream toe is steeper than the embankment slope. No erosion was evident and surface maintenance appeared to be adequate.

Flowing water and discoloration were observed at one location at the toe of the dam with an estimated discharge of 1 gpm. Discussion with the operator revealed that water from this point was tested for content and found to be different than the reservoir water. The owner concluded that this discharge was from a spring rather than seepage from the reservoir, since small springs of this type are characteristic of the area.

The gatehouse interior and exterior, visible portions of the inlet tower, and visible portions of the outlet pipes all appeared to be in good condition.

The timber stoplog installed above the crest of the concrete spillway is deteriorating and considerable seepage is evident between the concrete and the timber. The concrete lined spillway approach channel and downstream channel are in good condition with only minor concrete cracking.

c. The West Dike - The upstream face of the West Dike and the surface of the top of the dike exhibit no significant signs of structural instability. A few trees and a thick cover of ferns or aquatic plants line the upstream face.

The downstream face of most of the dike is covered with trees, heavy brush and ferns or aquatic plants. Standing water is present at the downstream toe along most of the length of the dike and some of this water is discolored. Beaver dams exist downstream of the dike.

The concrete exterior of the inlet manhole for the Mink Hollow Lines was inspected. Considerable concrete deterioration has occurred with the headwall broken into two (2) separate sections.

d. Reservoir Area - The banks of the reservoir are heavily wooded. The slopes are fairly steep and well defined. Sediment was apparent in the spillway approach channel approximately 5 to 6 feet below the water surface elevation.

e. Downstream Channel - The downstream channel is adjacent to the toe of the main dam. Debris is present in the form of tree trunks and fallen trees. A small foot bridge is also present allowing access to fields downstream of the dam. The debris is sufficiently concentrated to cause considerable obstruction to flow in the event of high discharges.

SECTION 3 - HYDROLOGY/HYDRAULICS

The design flood used for Cooper Lake is the Probable Maximum Flood (PMF) according to the Recommended Guidelines for Safety Inspection of Dams. The reservoir water surface area at spillway crest accounts for approximately 35% of the drainage basin and the slopes are fairly steep and well defined. U.S. Army Corps of Engineers computer program HEC-1 was used to determine the PMF. Peak inflow and outflow rates for the PMF were calculated as 3,434 cfs and 905 cfs respectively. The maximum non-overtopping discharge is approximately 1,108 cfs. Therefore, the spillway is adequate for discharges associated with the PMF.

The time required to draw the reservoir down from the normal water surface elevation of 1103.83 to elevation 1068 is 57 days, (see computation sheets #A-27 & #A28).

SECTION 4 - STRUCTURAL STABILITY

4.1 VISUAL OBSERVATION AND DATA REVIEW

a. Visual Observation

1) Cooper Lake Dam - Cooper Lake Dam shows no significant signs of embankment instability. The upstream and downstream faces of the embankments indicate no apparent misalignment. Wet spots downstream of the dam may be attributed to springs characteristic of this area or seepage through the dam. Conclusive analysis of this condition is beyond the scope of a Phase I investigation.

2) The West Dike - Most of the downstream face of the embankment is wooded indicating extensive root systems. In addition, standing water is present along most of the length of the West Dike at its toe. As discussed in Section 2 above, Beaver Dams may have caused this condition. Although the elevation of the roadway is fairly uniform, numerous small depressions were noted. No abnormal depressions were noted on the upstream face.

b. Data Review - Original design calculations were not made available. A brief report by Sanborn and Bogert Consulting Engineers, 1927, revealed the following concerning Cooper Lake Dam:

"It is proposed to raise the water of the Lake a little less than 11'. The proposed design of the dam contemplates raising the corewall which is to be carried across the existing masonry spillway section and placing earth embankment on the existing slopes and parallel with them. The earth slopes are thoroughly well established. The downstream slope stands at present somewhat steeper than 1 on 1½. Soundings on the water side show the slope to be about 1 on 1½. The material of the existing embankment of this dam is well compacted and impervious."

Concerning the embankment material at the West Dike, the following was noted:

"in view of the slight depth of water, we understood that the corewall could be omitted, particularly since the material for this embankment is ideal, consisting of sandy loam carrying just enough clay material so that the embankment packs perfectly and makes a thoroughly impervious dam."

4.2 GEOLOGY AND SEISMIC STABILITY

Coopers Lake Dam is located within the Catskill Mountain area of the Appalachian Uplands physiographic province in moderate to rugged topography formed by stream dissecting the underlying, nearly horizontal shales and sandstones of Devonian age. The dam rests on till and drift deposits, the result of Pleistocene glaciation. These materials have been described in design documents as hard clay and hardpan with cobbles and boulders. Depth to bedrock at the dam is not known.

No fault zones are known to exist in the vicinity of the main dam or west lake. The structure is located in Seismic Zone 1 of the Seismic Zone Map of Contiguous States, and it appears that static stability conditions are satisfactory. No earthquakes have been recorded of any significant magnitude within 50 miles of the dam.

SECTION 5 - ASSESSMENT/REMEDIAL MEASURES

5.1 ASSESSMENT

The slope of the downstream face of Cooper Lake Dam is fairly steep (1 on $1\frac{1}{2}$). At one area, the natural groundline at the downstream toe falls off more steeply than does the downstream slope of the embankment. Nevertheless, neither Cooper Lake Dam nor the West Dike shows significant signs of embankment instability. Rock cover on both embankments appears in good condition: No significant erosion, settlement or deterioration was observed.

In the case of Cooper Lake Dam, the source of the isolated seepage areas and water discoloration may be from springs which are reported to be common in the area. In the case of the West Dike, the ponding at the downstream toe appears to be the result of beaver dams located just downstream of the site. In either case, excessive seepage and fines migration through the embankments should not be ruled out until further investigations are made.

The concrete spillway and downstream channel are adequate to pass a flood equal to or less than the Probable Maximum Flood with two (2) feet of freeboard still available between the water surface elevation and top of dam.

5.2 REMEDIAL MEASURES

a) Cooper Lake Dam

- 1) Piezometers should be installed to monitor pore pressures throughout the embankments of Cooper Lake Dam and West Dike.
- 2) A boring program should be implemented in order to determine the necessary design parameters to make a stability analysis of the downstream slope of Cooper Lake Dam especially at the section where the natural groundline is steeper than the downstream embankment slope.
- 3) All debris should be removed from the downstream channel, especially near the toe of the dam where fallen trees and tree trunks could cause considerable obstruction to flow.

b. The West Dike

1) The beaver dams, located just downstream, should be removed in order to allow for further examination of the downstream toe area.

2) Piezometers should be installed to monitor pore pressures throughout the embankment.

3) The downstream face of the dike should be cleared of the heavy growth of trees and brush. The few trees on the upstream face should also be cut near the groundline.

FIGURES

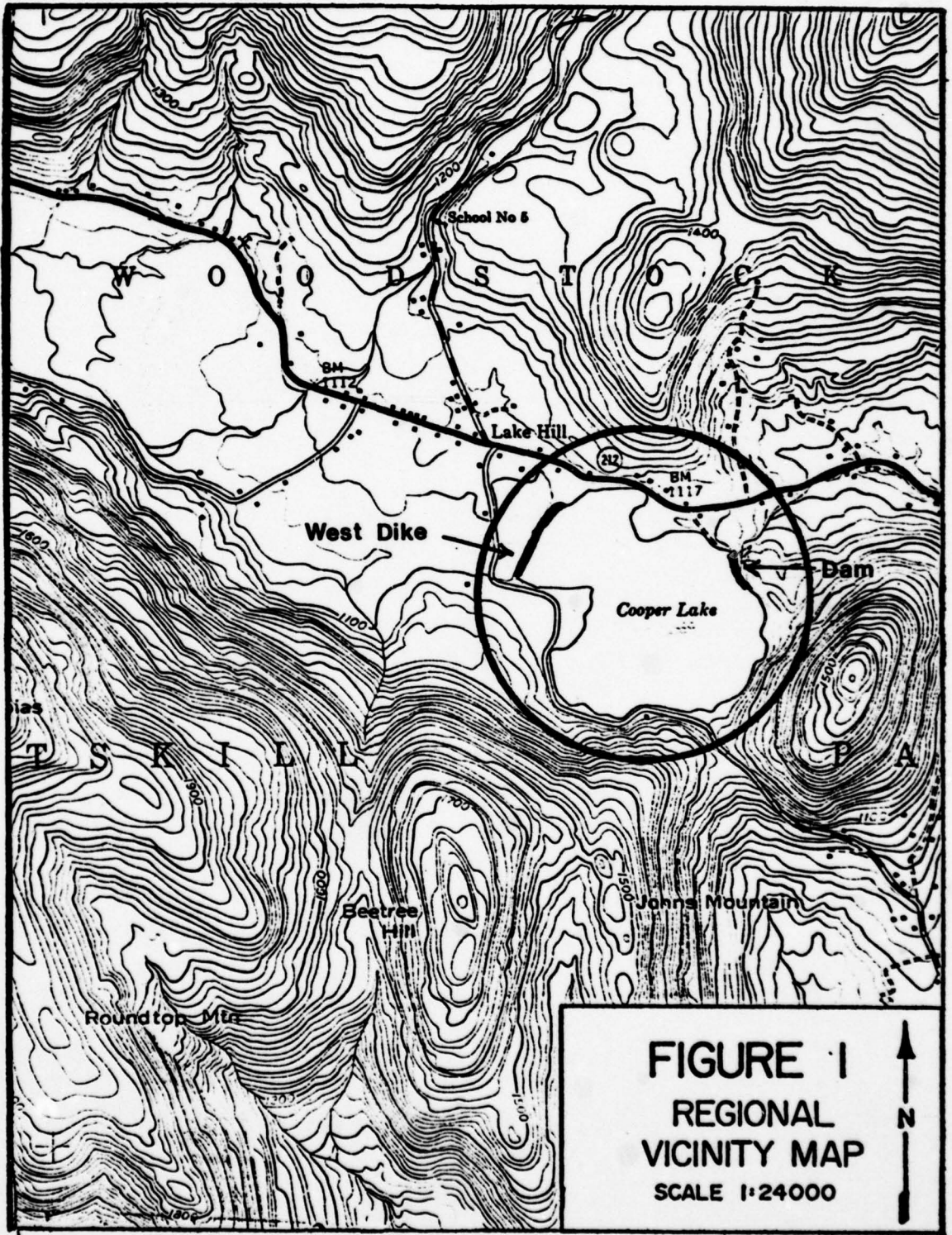
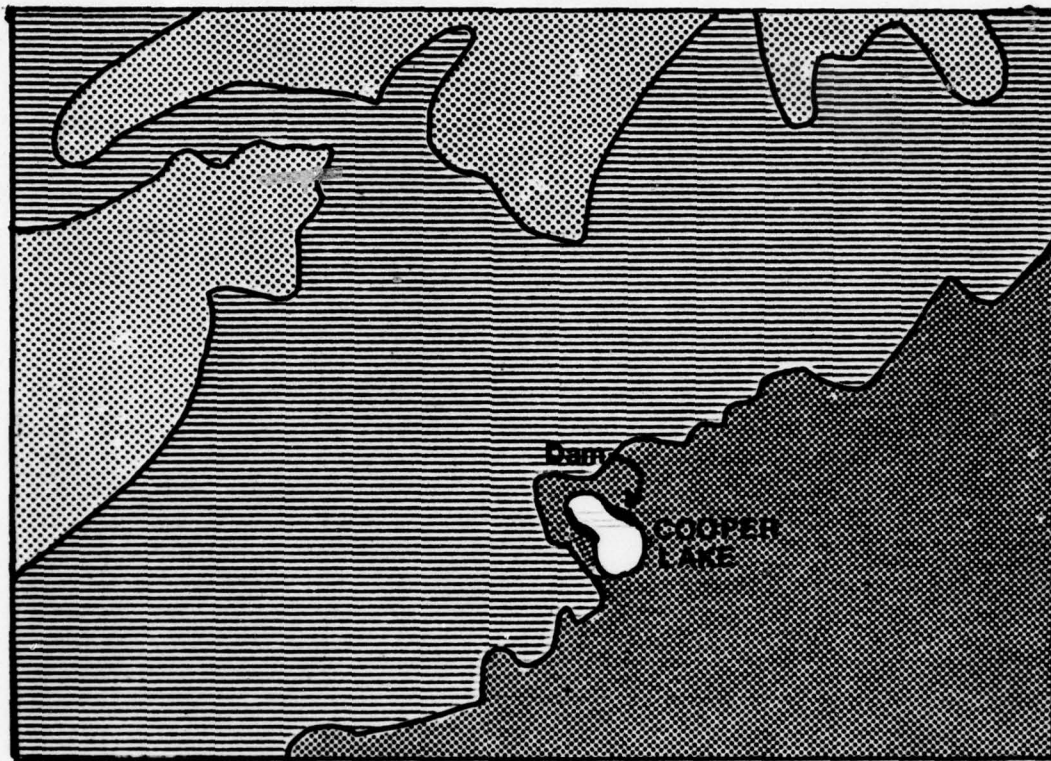


FIGURE 1
REGIONAL
VICINITY MAP
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Dss - sandstone, conglomerate, shale



Dgk - red shale, sandstone



Dha - red and green shales, sandstone

FIGURE 2

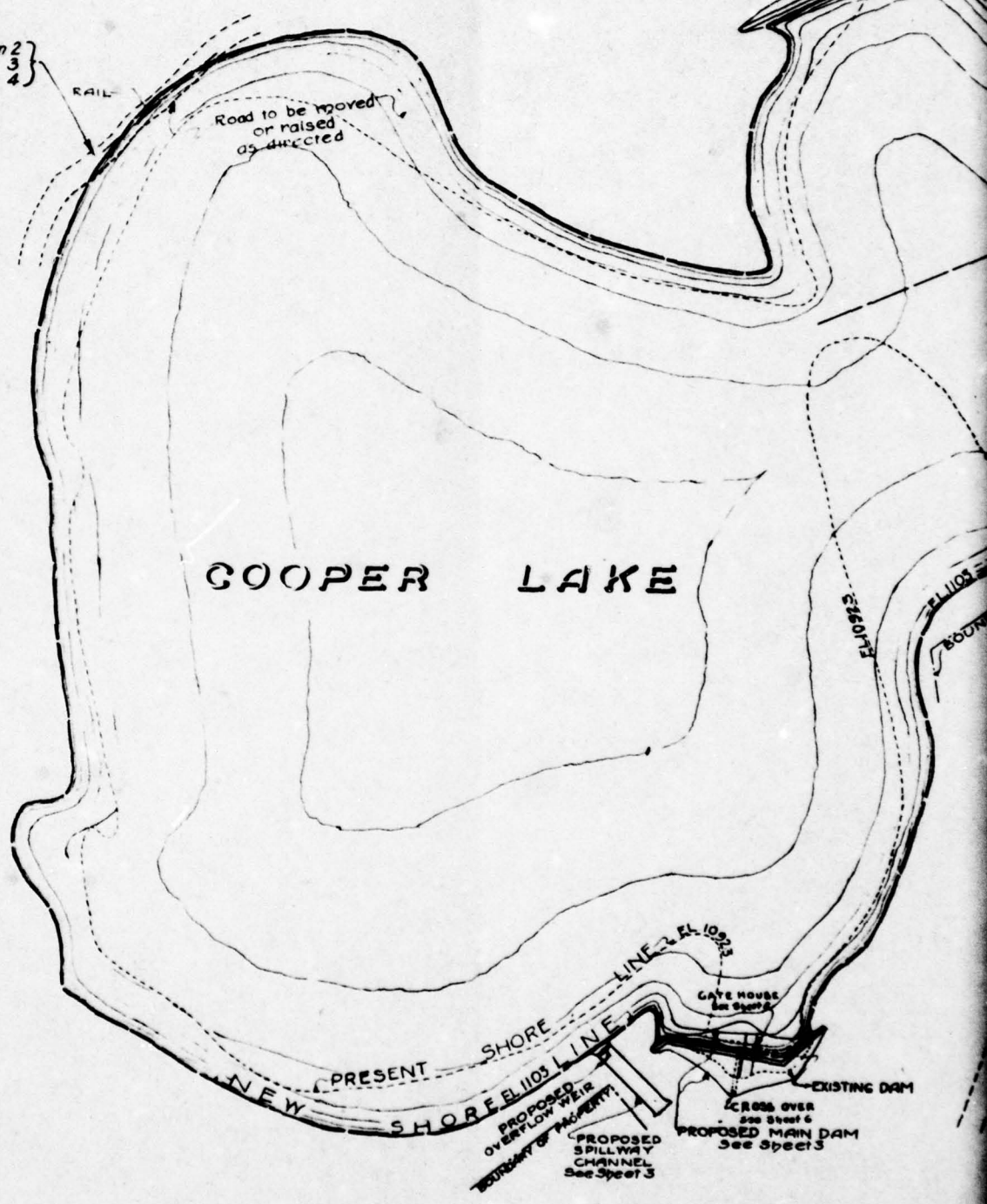
GEOLOGIC MAP

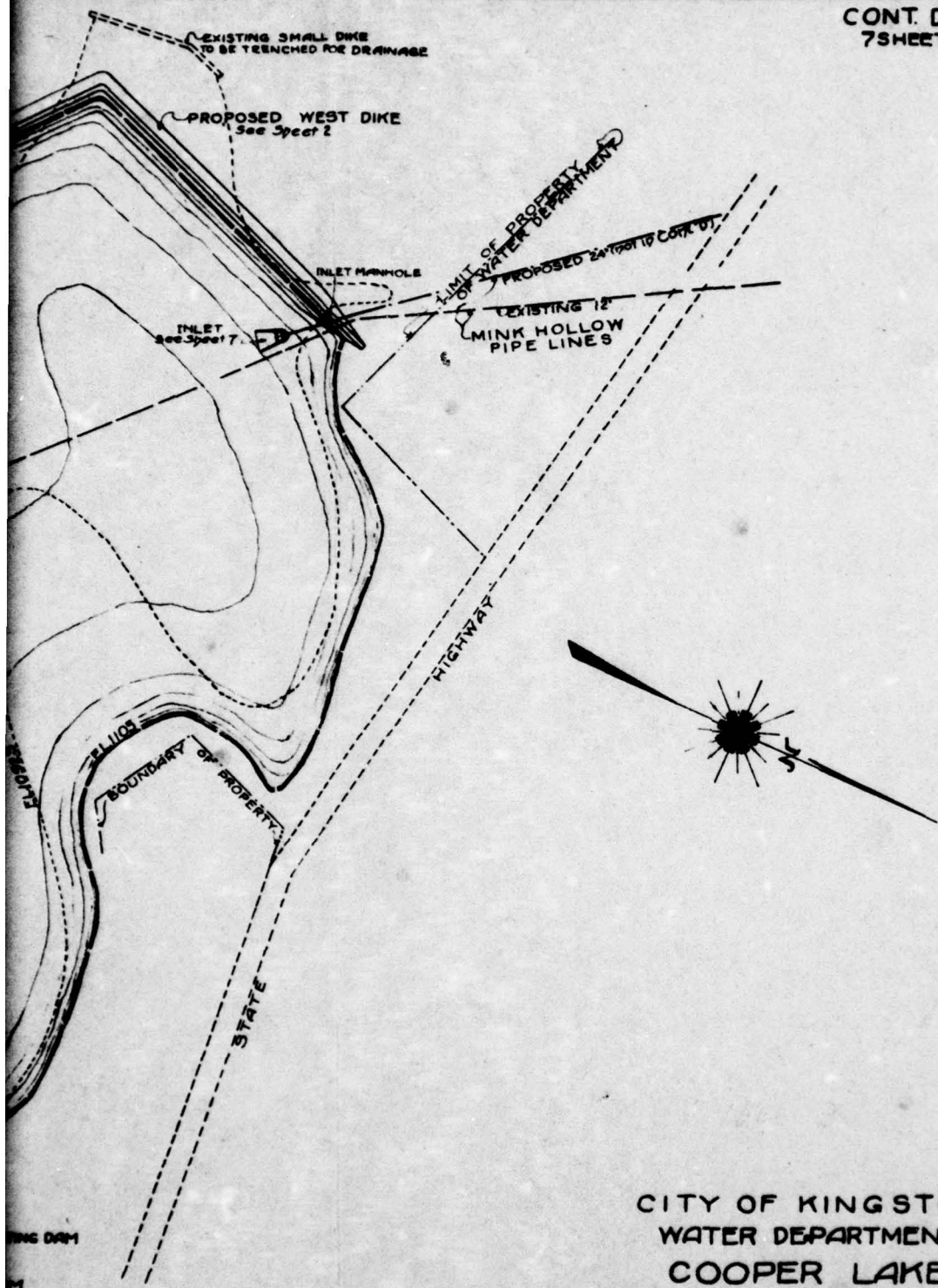
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- " Embankment " 3
- " Rock refill " 4

RAIL

Road to be moved
or raised
as directed

COOPER LAKE

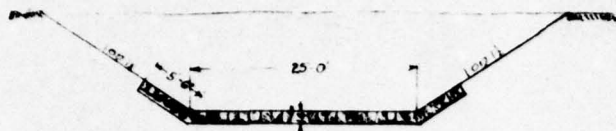




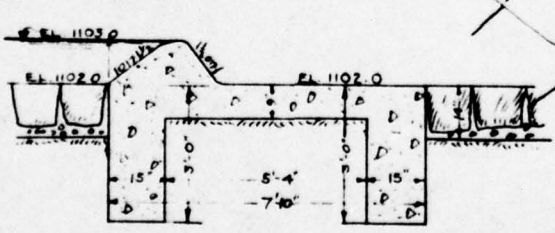
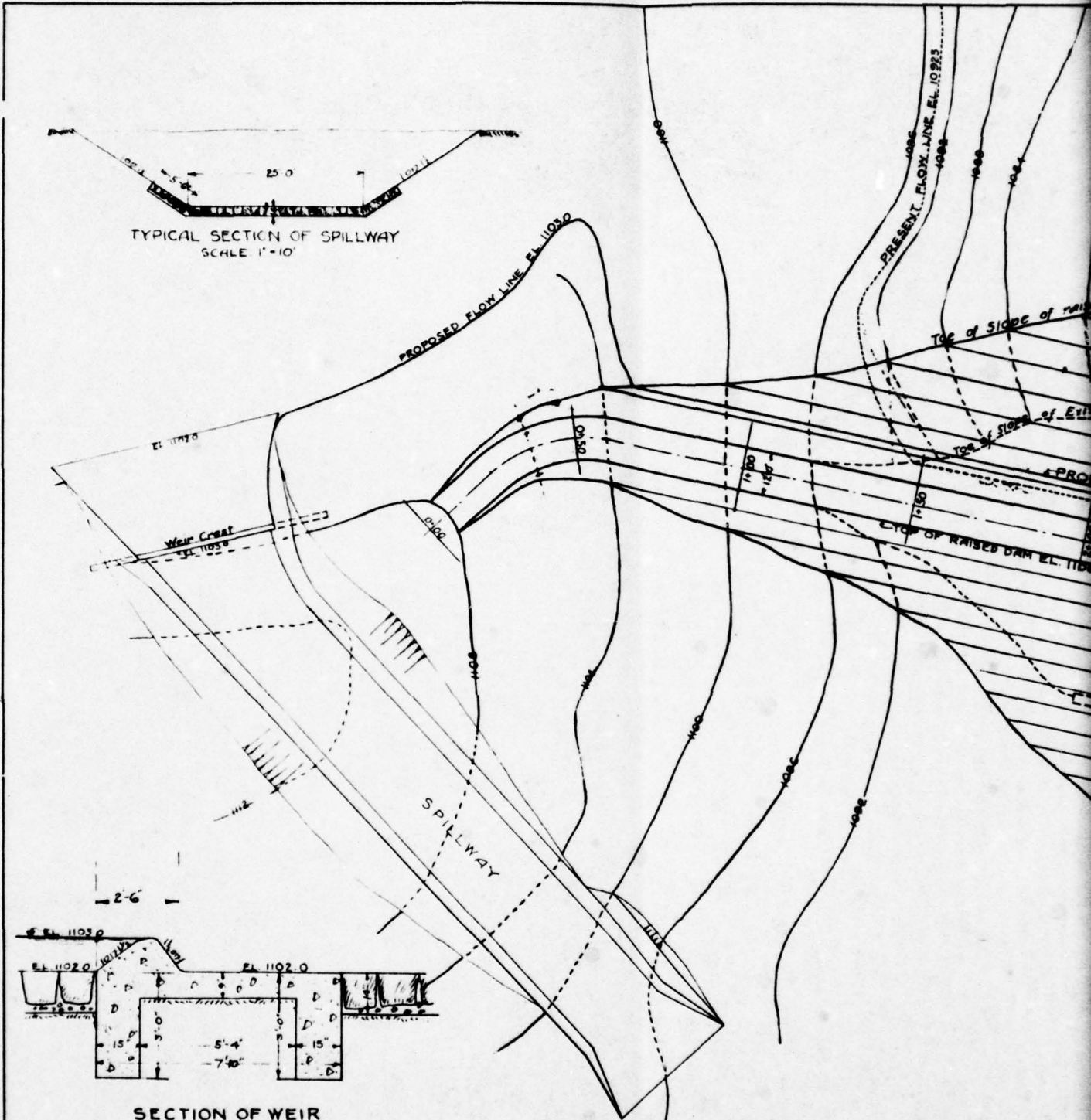
CITY OF KINGSTON
WATER DEPARTMENT
COOPER LAKE
PROPOSED WORKS TO INCREASE CAPACITY
GENERAL PLAN
SCALE: 1"=200 FEBRUARY 1927

FIGURE 3

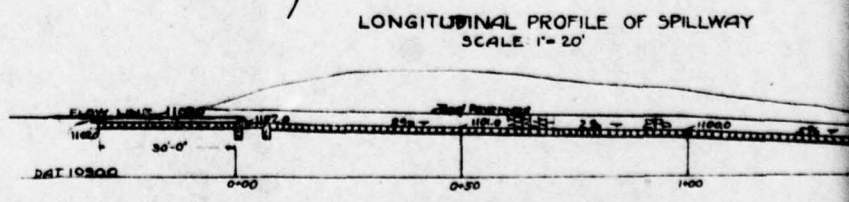
Snyder & Dyer
Consulting Engineers
New York City



TYPICAL SECTION OF SPILLWAY
SCALE: 1"=10'

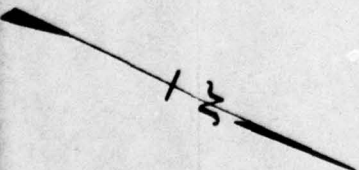
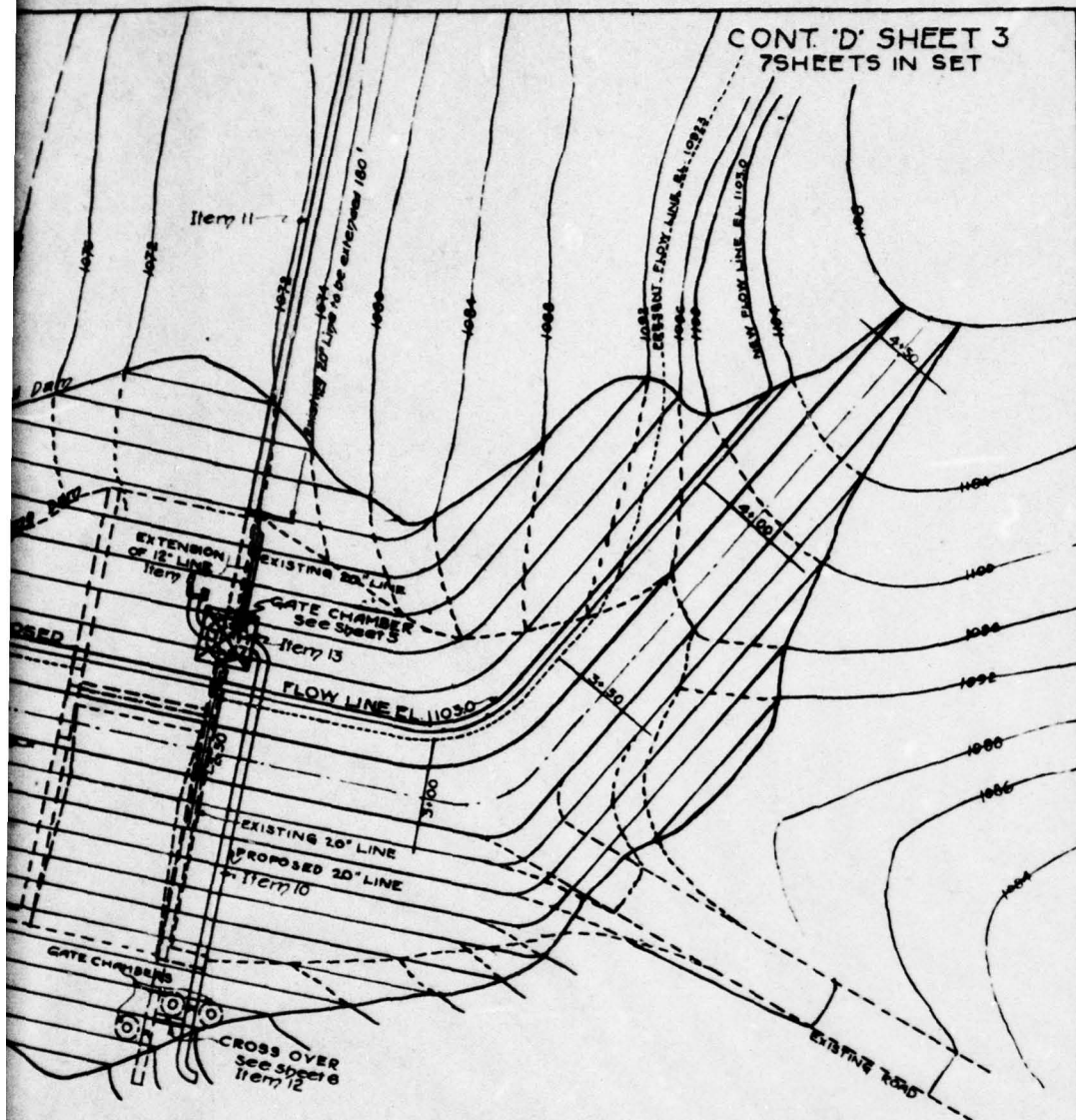


SECTION OF WEIR
SCALE: 1"=2'-0"



LONGITUDINAL PROFILE OF SPILLWAY
SCALE: 1"=20'

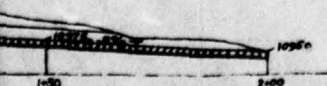
CONT. 'D' SHEET 3
7 SHEETS IN SET



CITY OF KINGSTON
WATER DEPARTMENT
COOPER LAKE
PROPOSED WORKS TO INCREASE CAPACITY
PLAN OF MAIN DAM

SCALE: 1"=20'

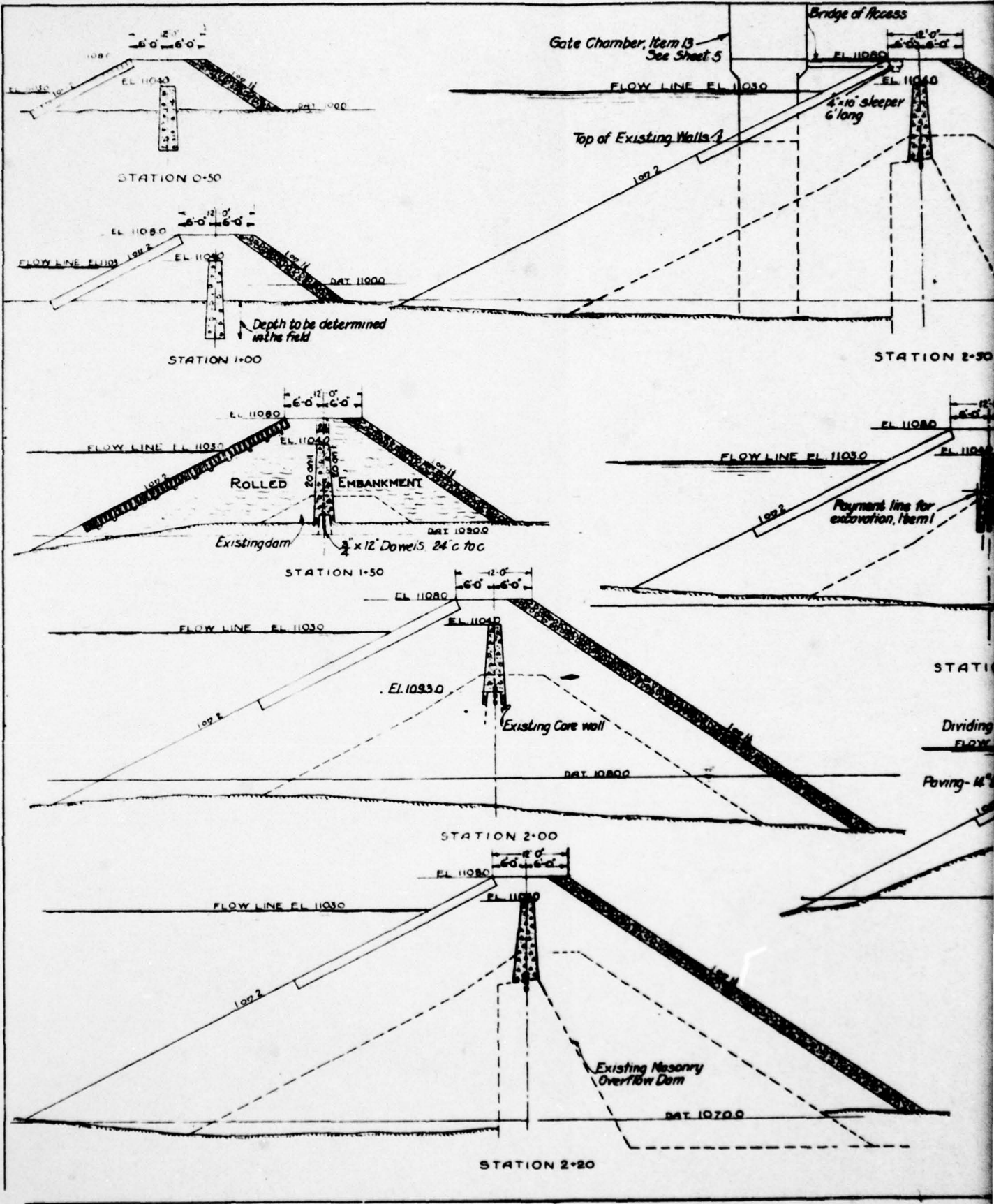
FEBRUARY 1927



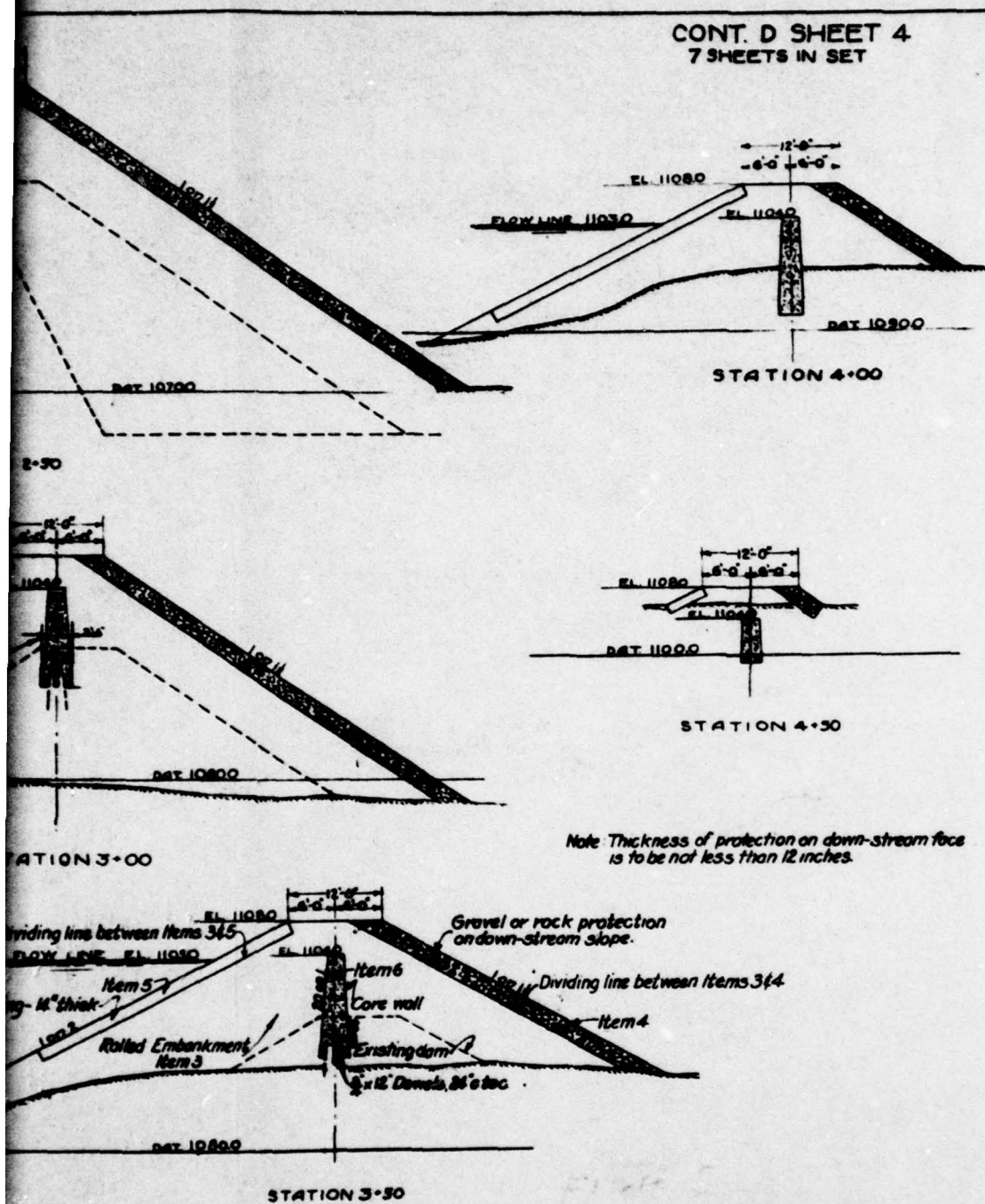
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FIGURE 4

*Seaborg & Bogert
Consulting Engineers
New York City*



CONT. D SHEET 4
7 SHEETS IN SET



CITY OF KINGSTON
WATER DEPARTMENT
COOPER LAKE
PROPOSED WORKS TO INCREASE CAPACITY
SECTIONS OF MAIN DAM

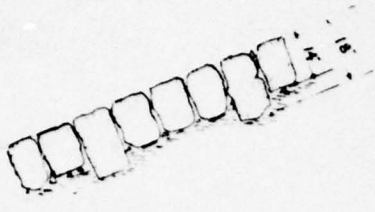
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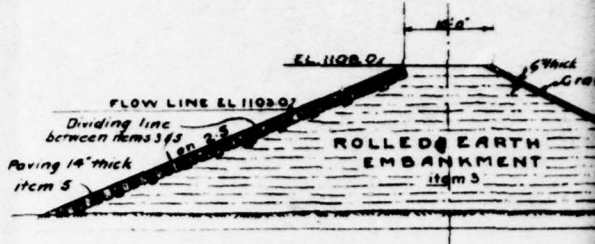
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FIGURE 5

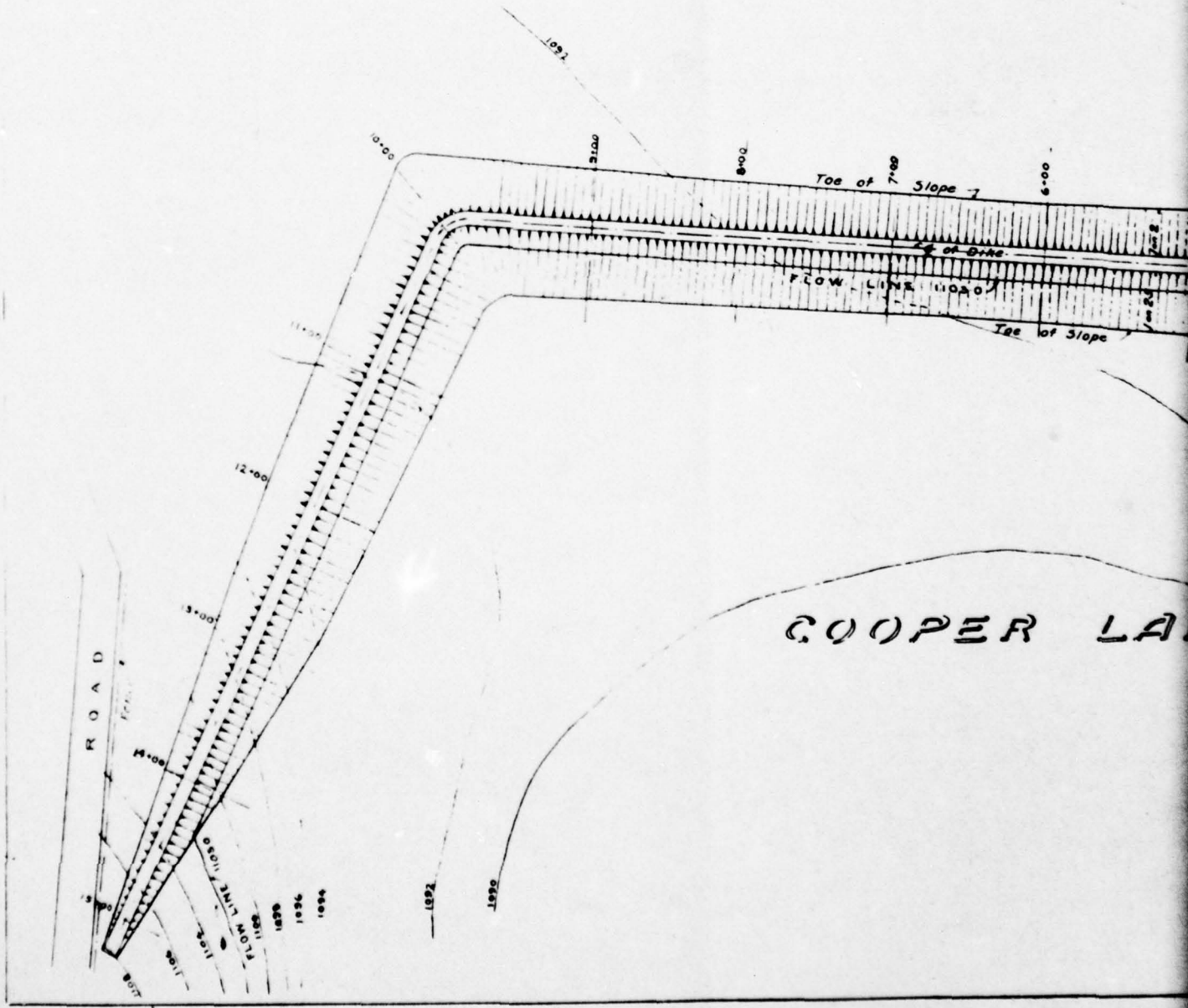
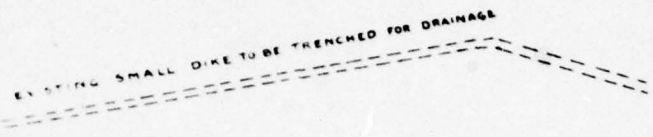
Seaborg & Degeert
Consulting Engineers
New York City



DETAIL OF PAVING

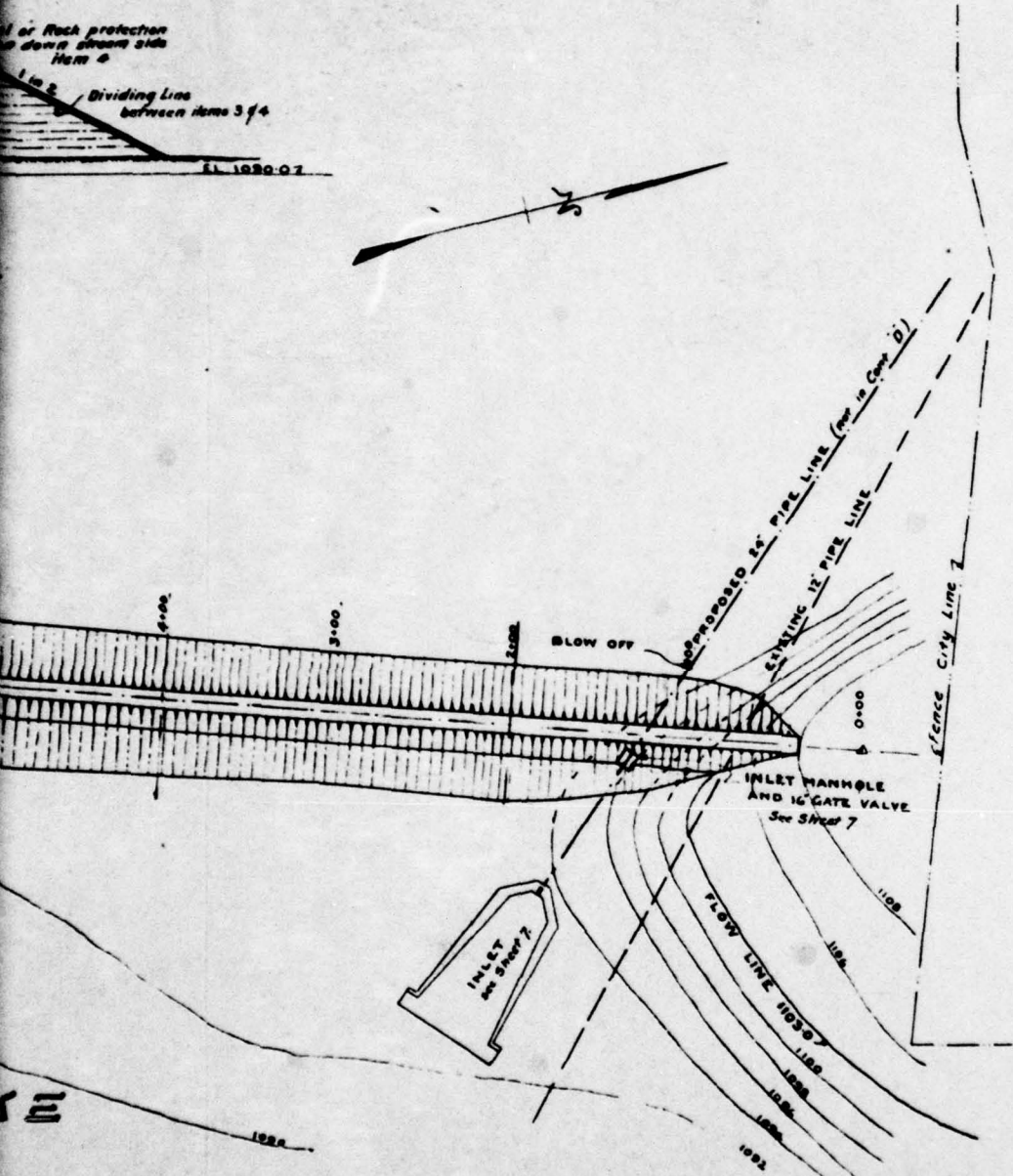


TYPICAL SECTION OF DIKE
SCALE: 1"=10'



CONT. D SHEET 2A
7 SHEETS IN SET

of Rock protection
to down stream side
Ham 4
Dividing Line
between Hams 3 & 4
EL. 1089.07

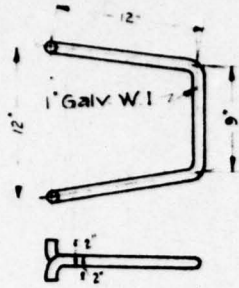


CITY OF KINGSTON
WATER DEPARTMENT
COOPER LAKE
PROPOSED WORKS TO INCREASE CAPACITY
WEST DIKE

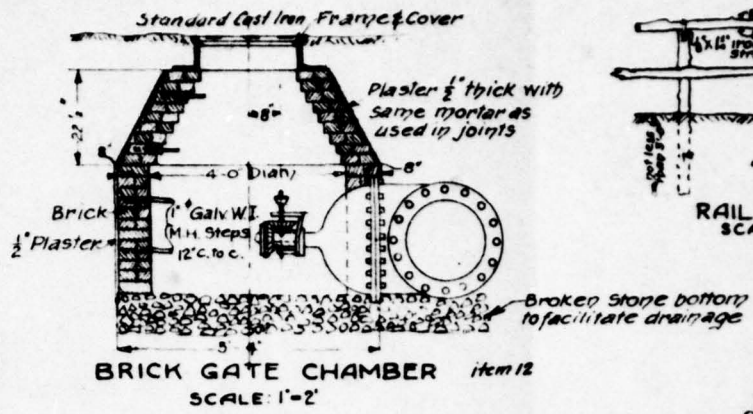
SCALE: 1" = 50' MAY 1927

Sanborn & Bogert
Consulting Engineers
New York City

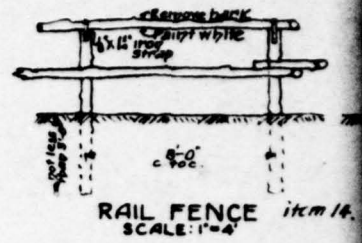
2 FIGURE 6



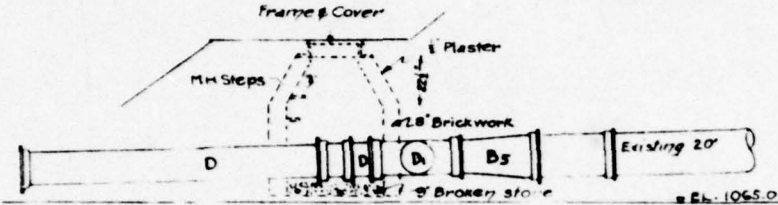
MANHOLE STEP
SCALE 1 1/2" = 1'-0"



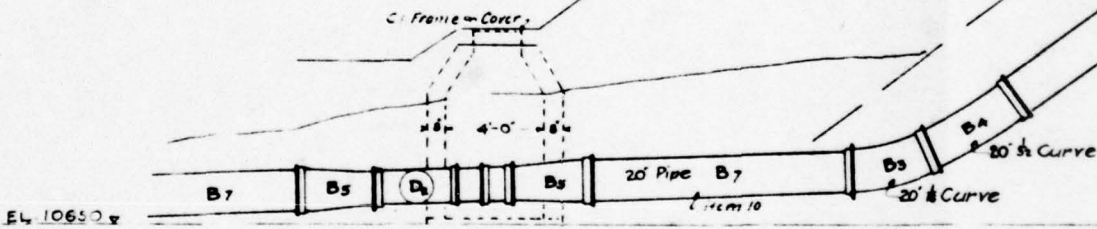
BRICK GATE CHAMBER item 12
SCALE 1" = 2'



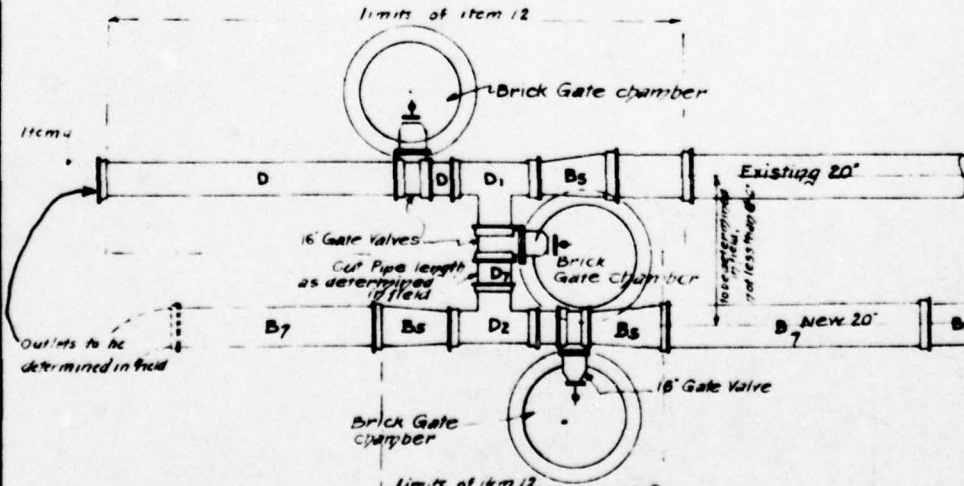
RAIL FENCE item 16
SCALE 1" = 4'



SECTION ON LINE OF EXISTING 20" PIPE

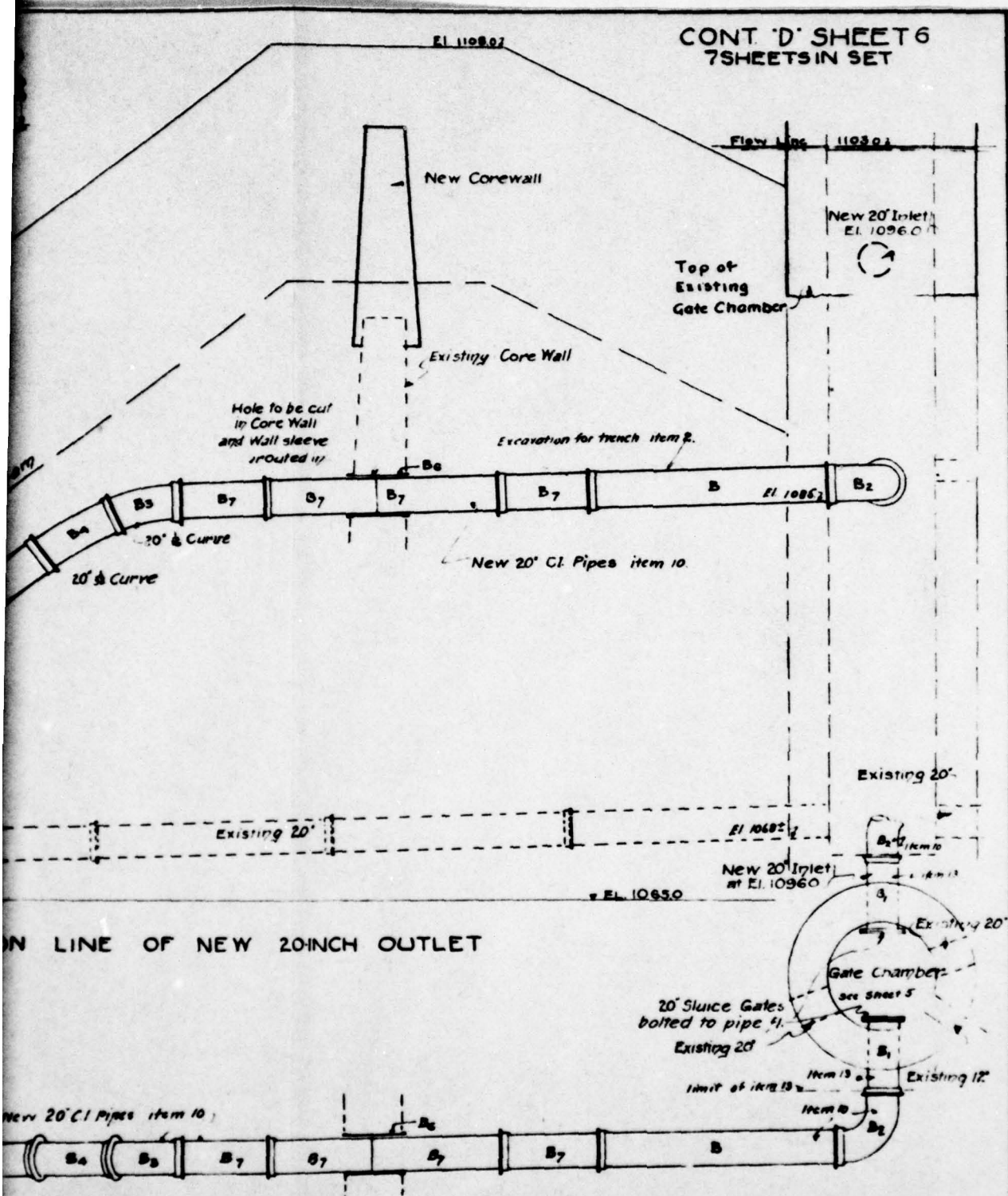


SECTION



PLAN OF CROSS-OVER

ITEM	MARK	DESCR
10	B	20' Straight Bell & Spigol
10	B7	20' "
10	B2	20' 1/4 Curve Bell & Spigol
10	B3	20' 1/2 Curve Bell & Spigol
10	B4	20' 3/4 Curve Bell & Spigol
12	B5	20' 16" Reducer Bell & Spigol
10	B6	20' Wall Sleeve 3'-6" long
12	D	16" Straight C.I. Bell & Spigol
12	D1	16" T. 2 Bells spigol on
12	D2	16" T. 3 Bells
12	D7	16" Gate Valves, double Bell & Spigol
12	D7	Manhole Cover C.I.
12	D7	16" Straight Bell & Spigol



VALVES ETC.

DESCRIPTION	QUANTITY
12 lengths (Class B) Cut to fit	2
	2
	2
	2
	2
	2
1 Bell large end	3
1 pipes 12 lengths Class B	1
1 wrench	1
1 double disk, horizontally geared	3
1 pipes Cut to fit	3
	1

CITY OF KINGSTON
WATER DEPARTMENT
COOPER LAKE
PROPOSED WORKS TO INCREASE CAPACITY
CROSS-OVER

SCALE: 1"=4' FEBRUARY 1927

Sagbary & Bogert
Consulting Engineers
New York City

FIGURE 7

2

APPENDIX

33

FIELD INSPECTION REPORT

Check List
Visual Inspection
Phase 1

Name Dam Cooper Lake Dam County Ulster State New York Coordinators _____

Date(s) Inspection June 26, 1978 Weather Fair Temperature 80°

Pool Elevation at Time of Inspection 1103.83 M.S.L. Tailwater at Time of Inspection 1065 M.S.L.

Inspection Personnel:

A-1 George C. Elias, P.E. _____
Charles A. Richardson, P.E. _____
Frank E. Falcone, P.E. _____
James G. Ryan _____
Frank E. Falcone, P.E. Recorder

EMBANKMENT

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

SURFACE CRACKS

None observed.

None.

**UNUSUAL MOVEMENT OR
CRACKING AT OR BEYOND
THE TOE**

None observed.

None.

**SLOUGHING OR EROSION OF
EMBANKMENT AND ADJACENT
SLOPES**

No erosion observed.

None.

A-2

**VERTICAL AND HORIZONTAL
ALIGNMENT OF THE CREST**

No unusual vertical or horizontal
alignment observed.

None.

RIPRAP FAILURES

None observed.

None.

EMBANKMENT

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

FUNCTION OF EMBANKMENT
AND ABUTMENT, SPILLWAY
AND DAM

No cracking or misalignment
observed.

None.

ANY NOTICEABLE SEEPAGE

Seepage is occurring at one location at the
toe of the dam. The water is clear and was
tested for its composition. According to the
operator, the reported composition of this
water is not similar to reservoir water. It
has been concluded that this water is from a
spring characteristic of this region.

Flow should be monitored
frequently to make sure that
it remains clear, exhibits
the same characteristics and
does not increase.

STAFF GAGE AND RECORDER

None observed.

None.

DRAINS

Sections of pipes observed during visual
inspection appeared to be in good
condition.

None.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None observed (underwater section was not observed).	None.
INTAKE STRUCTURE	Appears to be well-maintained and in good condition.	None.
OUTLET STRUCTURE A-4	Below ground level.	None.
OUTLET CHANNEL	Below ground level.	None.
EMERGENCY GATE	None observed.	None.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The top of the concrete weir is at elevation 1103. The spillway was raised to an elevation of 1103.83 by adding a 10" high timber stoplog. Considerable seepage passes between the stoplog and top of concrete weir. The concrete is in good condition with minor cracking being observed.	Condition of the concrete should be frequently monitored as well as the condition of the timber stoplog.
APPROACH CHANNEL	Clear and well-maintained, minor cracking in the concrete lining the channel. This concrete is not structural, but rather used to prevent bank erosion.	Cracks should be filled in.
DISCHARGE CHANNEL A-5	Clear and well-maintained, minor debris present as well as minor concrete cracking in the apron.	Cracks should be filled in and debris removed.
BRIDGE AND PIERS	None.	None.

RESERVOIR

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

SLOPES

Heavily wooded, stable and clear of debris.

None.

SEDIMENTATION

Sediment present approximately 3' below the water surface elevation at spillway approach channel.

None.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

CONDITION
(OBSTRUCTIONS,
DEBRIS, ETC.)

Good condition, tree trunks and other debris present, as well as a small foot bridge. These could cause obstructions in high flows.

Remove all tree trunks and other debris.

SLOPES

Well-defined and stable.

None.

APPROXIMATE NO.
OF HOMES AND
POPULATION

40 to 50 homes and approximately 200 residents within one mile downstream of the reservoir. The community of Bearsville (population approximately 500) 3 miles downstream.

None.

**CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION**

ITEM	REMARKS
PLAN OF DAM	* Blueprint provided in good condition, dated February, 1927.
REGIONAL VICINITY MAP	U. S. Geological Survey Quadrangle Sheet "Bearsville, New York".
CONSTRUCTION HISTORY	Original dam constructed in or about the year 1800. Extensive repairs took place in 1899-1900 and approximately 1924 to 1927.
TYPICAL SECTIONS OF DAM A-B	* Same.
HYDROLOGIC/HYDRAULIC DATA	No hydrologic or hydraulic data was made available.
OUTLETS - PLAN	Blueprint provided, dated February, 1927.
- DETAILS	
- CONSTRAINTS	
- DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	None made available.

ITEM

REMARKS

MONITORING SYSTEMS

None made available. Operator on call 24 hours a day, resides at the dam site.

MODIFICATIONS

Various modifications, reconstruction and additions from 1899 to 1927.

HIGH POOL RECORDS

None made available.

POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS

Letter dated April 14, 1927, from Sanborn & Bogert Consulting Engineers, New York, to the Department of Public Works, Albany, New York, commenting on the application and plans for increasing the capacity of Cooper Lake.

A-10

PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS

None reported or no reports made available.

MAINTENANCE OPERATION RECORDS

None made available.

Check List
Visual Inspection
Phase 1

Name Dam Cooper Lake West Dike County Ulster State New York Coordinators _____

Date(s) Inspection June 26, 1978 Weather Fair Temperature 80°

Pool Elevation at Time of Inspection 1103.83 M.S.L. Tailwater at Time of Inspection 1065 M.S.L.

A-11

Inspection Personnel:

- George C. Elias, P.E. _____ James G. Ryan _____
- Charles A. Richardson, P.E. _____ _____
- Frank E. Falcone, P.E. _____

Frank E. Falcone, P.E. Recorder

EMBANKMENT

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

SURFACE CRACKS

None observed - Downstream face heavily wooded and covered with brush. Upstream face covered with aquatic plants.

The West Dike should be inspected for surface cracks after the banks are cleared of heavy brush.

UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE

Standing water is present along most of the toe of the dike - cracking or unusual movement could not be observed.

Beaver dams should be breached to allow for proper drainage of the area downstream of the toe.

SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES

None observed.

None.

A-12

VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST

Minor variations in the elevation of the top of the dike.

Operator should check for swells or depressions occasionally.

RETAIN FAILURES

None observed.

None.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No spillway.	None.
ANY NOTICEABLE SEEPAGE	Standing water and marshy areas are present downstream of the dike. Small springs are common to the area, but seepage should not be ruled out.	Implement a program to identify the source of the wet areas, place piezometer throughout the embankment to monitor pore pressures.
STAFF GAGE AND RECORDER	None.	None.
DRAINS	None.	None.

RESERVOIR

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

SLOPES

Heavily wooded, stable, clear of debris.

None.

SEDIMENTATION

Sedimentation not observed.

None.

INLET FROM MINK HOLLOW

Inlet concrete headwall badly deteriorated and broken in two sections.

Repair concrete headwall.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

REMARKS

ITEM

PLAN OF DAM

* Blueprints provided in good condition, dated February, 1927.

REGIONAL VICINITY MAP

U. S. Geological Survey Quadrangle Sheet, Bearsville, New York.

CONSTRUCTION HISTORY

Dike constructed as part of major revisions which took place approximately 1927 for the purpose of raising the normal pool elevation from 1092.3 to 1103.

TYPICAL SECTIONS OF DAM

* Same.

A-15

HYDROLOGIC/HYDRAULIC DATA

None made available.

OUTLETS - PLAN

Blueprints for inlet from Mink Hollow provided in good condition, dated February, 1927.

- DETAILS

-CONSTRAINTS
 -DISCHARGE RATINGS

RAINFALL/RESERVOIR RECORDS

None made available.

PHOTOGRAPHS

○



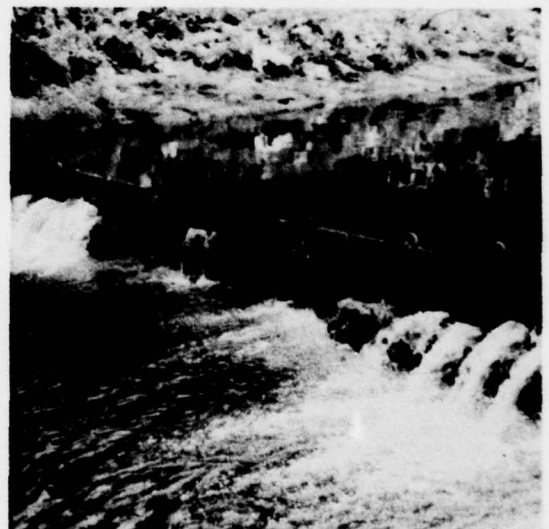
CHANNEL DOWNSTREAM OF SPILLWAY



SPILLWAY



○ VIEW UPSTREAM AND DOWNSTREAM OF SPILLWAY



CLOSE-UP VIEW OF SPILLWAY



VIEW OF WEST DIKE



POND IMMEDIATELY DOWNSTREAM
OF WEST DIKE



DOWNSTREAM FACE OF WEST DIKE



VIEW OF WEST DIKE



CHANNEL DOWNSTREAM OF SPILLWAY



VIEW OF TOP OF DAM

HYDROLOGIC AND HYDRAULIC CALCULATIONS

NAME OF CLIENT _____
 PROJECT COOPER LAKE DAM

DISCHARGE DETERMINATION

1. OVER SPILLWAY - $Q = CLH^{3/2}$

$C = 3.3$

$L = 76'$

SPILLWAY CREST EL. = $1103' + 10''$ TIMBER
 STOP LOG.

$= 1103.83'$

ELEVATION	HEAD	HEAD $^{3/2}$	DISCHARGE
1103.83	0	0	0
1104	0.17	0.07	8
1104.5	0.67	0.55	65
1105	1.17	1.27	151
1105.5	1.67	2.16	257
1106	2.17	3.20	380
1106.5	2.67	4.36	518
1107	3.17	5.64	670
1107.5	3.67	7.03	835
1108	4.17	8.52	1012

NAME OF CLIENT _____

PROJECT COOPER LAKE DAM

DETERMINATION OF DISCHARGE THROUGH 2 20" CAST IRON PIPES.

$$P_1/\gamma + V_1^2/2g + Z_1 - h_m = P_2/\gamma + V_2^2/2g + Z_2$$

$$0 + 0 + Z_1 - h_m = 0 + V_2^2/2g + 0$$

$$h_f + h_m = Z_1 - V_2^2/2g$$

$$5(40) V_2^2/2g + 2.5 V_2^2/2g = Z_1 - V_2^2/2g$$

$$5(40) V_2^2/2g + 3.5 V_2^2/2g = Z_1$$

$$V_2^2/2g [5(40) + 3.5] = Z_1$$

$$\frac{V_2^2}{2g} = \frac{Z_1}{[5(40) + 3.5]}; \quad V_2^2 = \frac{64.4 Z_1}{5(40) + 3.5}$$

$$V_2^2 = Q^2/A^2; \quad Q^2 = \frac{64.4 A^2 Z_1}{5(40) + 3.5}$$

FOR PIPE #1, $4/D = 59.88$, $A = 2.182 \text{ Ft}^2$, $A^2 = 4.76$, $Ave. f = .038$

$$Q^2 = 53 Z_1$$

ELEVATION	Z_1	Q^2	Q
1103.83	38.83	2058	45
1104	39	2067	45
1104.5	39.5	2099	46
1105	40	2120	46
1105.5	40.5	2147	46
1106	41	2173	47
1106.5	41.5	2200	47
1107	42	2226	47
1107.5	42.5	2253	47
1108	43	2279	48

A-20

NAME OF CLIENT _____

PROJECT COOPER LAKE DAM

FOR PIPE #2, $L/D = 56.29$ $f = .038$

$Q_2^2 = 54.35 Z_1$

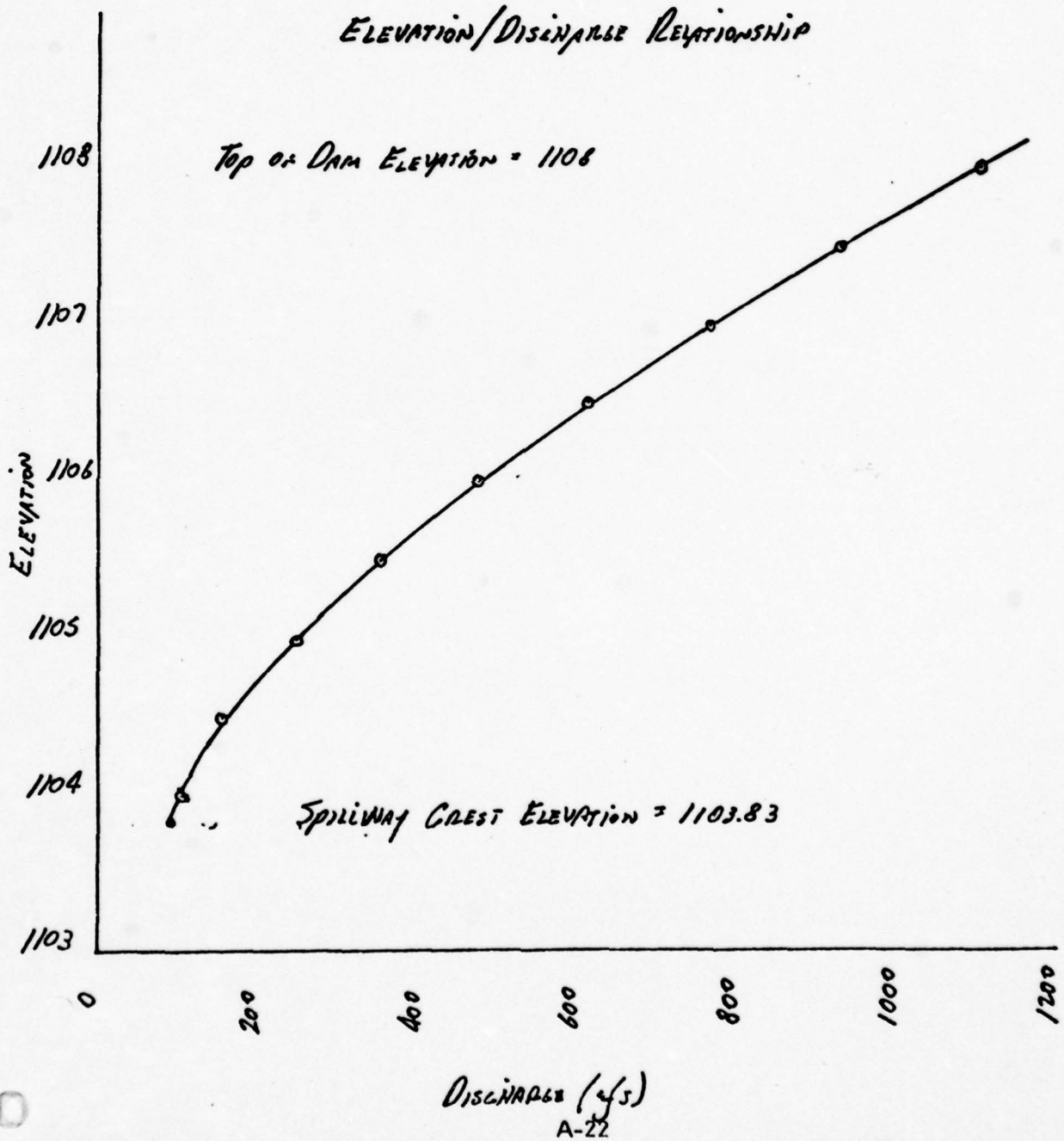
ELEVATION	Z_1	Q_2	Q
1103.83	38.83	2110	46
1104	39	2120	46
1104.5	39.5	2147	46
1105	40	2174	47
1105.5	40.5	2201	47
1106	41	2228	47
1106.5	41.5	2254	47
1107	42	2283	48
1107.5	42.5	2310	48
1108	43	2337	48

TOTAL DISCHARGE DETERMINATION

ELEVATION	Q SPILLWAY & DAM (cfs)	Q PIPE #1 (cfs)	Q PIPE #2 (cfs)	Q TOTAL (cfs)
1103.83	0	45	46	91
1104	8	45	46	99
1104.5	65	46	46	157
1105	151	46	47	244
1105.5	257	46	47	350
1106	280	47	47	474
1106.5	518	47	47	612
1107	670	47	48	765
1107.5	835	47	48	930
1108	1012	48	48	1108

NAME OF CLIENT _____

PROJECT COOPER LAKE DAM



NAME OF CLIENT _____

PROJECT COOPER LAKE DAM

STORAGE DETERMINATION

@ SPILLWAY CREST, STORAGE = 3683 AC. FT. (EL = 1103.83)
 AREA = 120 ACRES

@ TOP OF DAM, STORAGE = 4201 AC. FT. (EL = 1108)
 AREA = 128 ACRES

RISE: $8 \text{ ACRES} / 4.17 = 1.92 \approx 2 \text{ ACRES/FT.}$

AREA = $2D + 120$

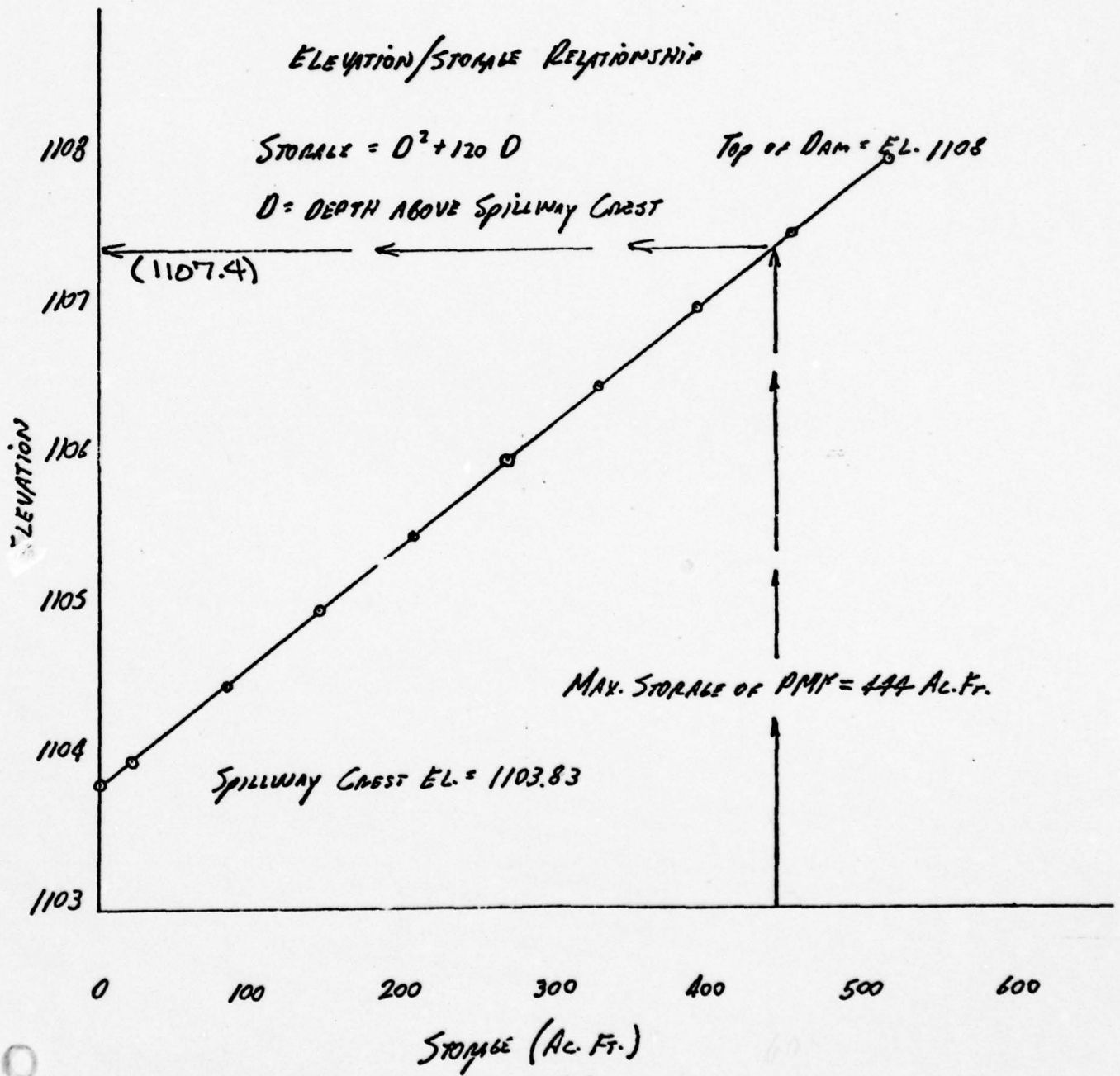
STORAGE = $D^2 + 120D$ $D = 4.17$, STORAGE = $17.39 + 500.4 = 517.79 \approx 518$

STORAGE ABOVE SPILLWAY CREST

ELEVATION	DEPTH	D^2	$120D$	STORAGE
1103.83	0	0	0	0
1104	0.17	.03	20.4	20.4
1104.5	0.67	.45	80.4	80.9
1105	1.17	1.37	140.4	141.8
1105.5	1.67	2.79	200.4	203.2
1106	2.17	4.71	260.4	265.1
1106.5	2.67	7.13	320.4	327.5
1107	3.17	10.05	380.4	390.5
1107.5	3.67	13.47	440.4	453.9
1108	4.17	17.39	500.4	517.8

NAME OF CLIENT _____

PROJECT COOPER LAKE DAM



NAME OF CLIENT NYSDEC

PROJECT Cooper Lake

6 hr. 10-sq. mi PMP = 23"
 Storm Misfit reduction = 20%
 Net PMP = 18.4"

Distribution of Rainfall

Time	% of 6 HR PMP	Σ PMP	Incr
1	49	9.0	9.0
2	65	12.0	3.0
3	75	13.8	1.8
4	84	15.5	1.7
5	92	17.0	1.5
6	100	18.4	1.4

Third quartil

1.4
1.7
1.8
9.0
3.0
1.5

NAME OF CLIENT NYEDEC
PROJECT Cooper Lake

Time of Concentration

1. SCS Curve Number Method

$$L = 3700' \quad Y = 15\%_{\text{ave.}} \quad S = \frac{1000}{CN} - 10 \quad (CN = 55)$$

$$t_{lag} = \frac{L^{.8} \times (S+1)^{.7}}{1900 \times Y^{.5}} = .46 \text{ hrs.} \approx 28 \text{ min}$$

2. SCS Overland Flow Method

Average overland flow velocity

$$V_o \approx 1.25 \text{ ft/sec} \quad \left[\text{forested (some ground cover, } \& 15\% \text{ slope)} \right]$$

$$L_o = 3700' \quad T_t = 3700 \text{ ft} / 1.25 \text{ ft/sec} = 2960 \text{ sec}$$

$$T_c = T_t = 2960 \text{ sec} \approx \underline{\underline{49.5 \text{ min}}} \leftarrow \text{use}$$

$$\text{Let } D = 12 \text{ min}$$

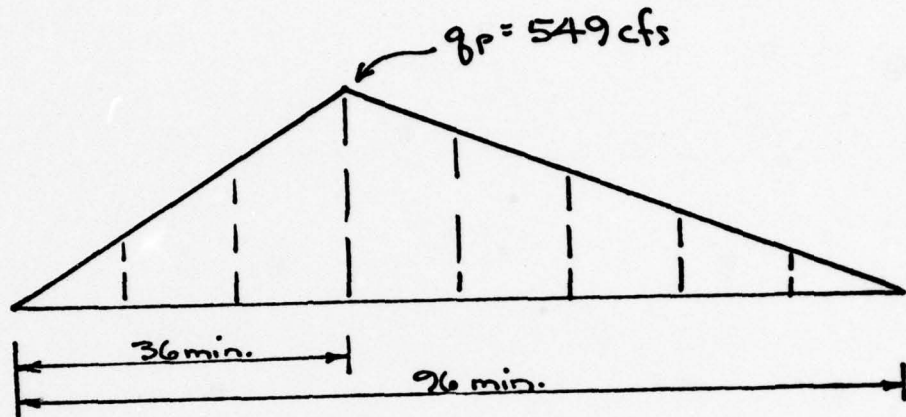
$$T_p = \frac{12}{2} + .6 \times 50 \approx 36 \text{ min}$$

$$T_b = 2.67 \times T_p = 96 \text{ min.}$$

$$Q_p = \frac{DA \times 5280^{.75}}{(T_b/2) \times 60} \approx 549 \text{ cfs/in}$$

NAME OF CLIENT NYSDEC

PROJECT Cooper Lake



t (min)	q (cfs)
0	0
12	183
24	366
36	549
48	439
60	329
72	220
84	110
96	0

NAME OF CLIENT NYSDEC

COMP. BY DBC

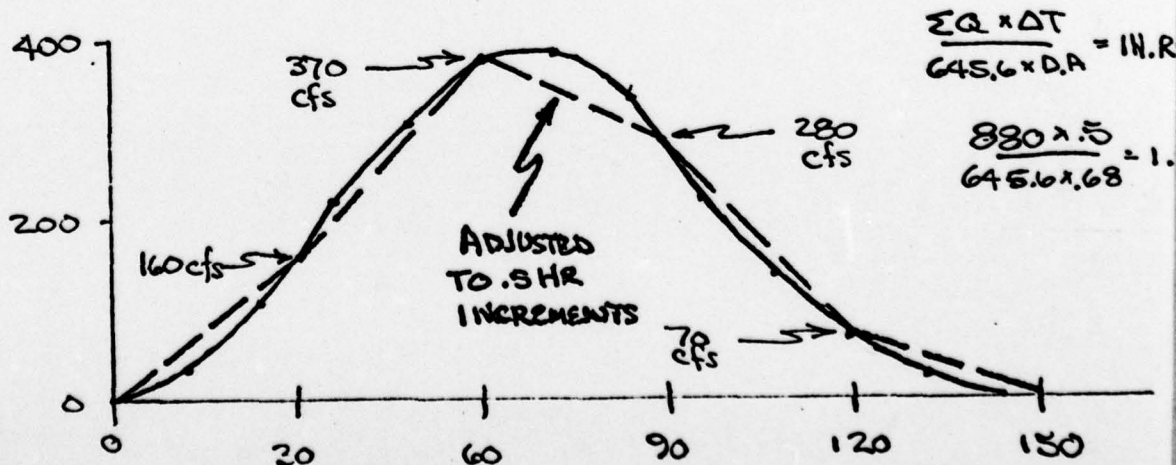
PROJECT Cooper Lake

CHECKED BY REH

Develop 1hr. unit graph from 12 min. unit graph (using calculator program)

1 hour unit graph

Time (min)	Q (cfs)
0	0
12	37
24	110
36	220
48	307
60	373
72	381
84	329
96	220
108	132
120	66
132	22
144	0



NAME OF CLIENT _____

PROJECT COOPER LAKE DAM

DRAWDOWN COMPUTATIONS

DRAWDOWN IS ACCOMPLISHED THROUGH 2 20" PIPE. TAILWATER ELEVATION
 BORN IS 1065. INLET ELEVATION FOR PIPE #1 IS 1085. INLET
 ELEVATION FOR PIPE #2 IS 1068.

(FROM COMPUTATION INLET #2 & 3)

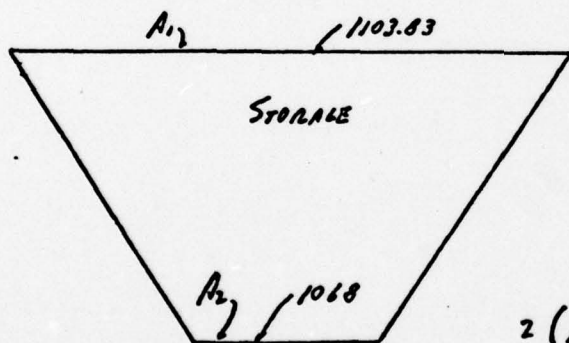
PIPE #1 $Q^2 = 53Z_1$

PIPE #2 $Q^2 = 54.35Z_2$

} DISCHARGE EQUATIONS

(STORAGE) @ EL. 1103.83, STORAGE = 3683 ACRES FT., AREA = 120 ACRES

@ EL. 1068, STORAGE = 0 (ASSUME)



$$STORAGE = \left(\frac{A_1 + A_2}{2} \right) \times D$$

$$3683 = \left(\frac{120 + A_2}{2} \right) \times 35.83$$

$$2(102.79) = 120 + A_2$$

$$205.58 - 120 = A_2$$

$$A_2 = 85.58 \text{ ACRES}$$

$$RISE = (120 - 85.58) / 35.83 = .96 \text{ ACRES/FT. (BELOW 1103.83)}$$

$$AREA = .960 + 85.58$$

A-27

$$STORAGE = .480^2 + 85.580$$

.....
 4-C-1 VERSION DATED JAN 1973
 UPDATED AUG 76
 CHANGE NO. 01

COOPER LAKE DAM
 PMF HYDROLOGY
 NATIONAL DAM INSPECTION PROGRAM

JOB SPECIFICATION
 NO NHR NNIN IDAY IHR IMIN MEYRC IPLT IPRT NSTAN
 50 0 30 1 0 0 0 0 0 0 0
 JOPER MNT
 5 0

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 1 RTIO= 5 LRTIO= 1
 RTIOS= .20 .40 .60 .80 1.00

.....
 SUB-AREA RUNOFF COMPUTATION
 ISTAQ ICOMP IEGON IIAPE JPLT JPRT INAME
 1 0 0 0 0 0 0 0

HYDROGRAPH DATA
 IHYG IJMG YAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LOCAL
 0 -1 .65 0.00 0.00 0.00 0.000 0 0 0
 NP STORM DAJ DAK
 11 0.00 0.00 0.00
 PRECIP PATTERN
 1.40 0.00 1.70 0.00 1.60 0.00 9.00 0.00 3.00 0.00
 1.50

LOSS DATA
 STPKR DLTKR RTIOL ERAIN STRKS RTIOK STRTL CNSTL ALSMY RTIMP
 0.00 0.00 1.00 0.00 0.00 1.00 0.00 .10 0.00 0.00
 0. 160. 370. 260. 70. 0.
 UNIT GRAPH TOTALS 800. CFS OR 1.00 INCHES OVER THE AREA

PECESSION DATA
 STRTO= 0.00 ORCSN= 0.00 RTTOR= 1.00

END-OF-PERIOD FLOW
 TIME RAIN EXCS COMP O
 1 0 30 1.40 1.35 0.
 1 0 60 0.00 0.00 216.
 1 1 30 1.70 1.55 500.
 1 1 60 0.00 0.00 642.
 1 2 30 1.60 1.75 705.

STATION	1 5 30	1 6 30	1 7 30	1 8 30	1 9 30	1 10 30	1 11 30	1 12 30	1 13 30	1 14 30	1 15 30	1 16 30	1 17 30	1 18 30	1 19 30	1 20 30	1 21 30	1 22 30	1 23 30	2 0 30	2 0 60
PEAK	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL VOLUME	1718.	1058.	406.	102.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

SUM 18.40 15.10 15927.

CFS	INCHES	AC-FT	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
343.	1301.	17.90	312.	18.16	312.	15927.
43.	129.	645.	141.	659.	148.	384.
212.	81.	20.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

CFS	INCHES	AC-FT	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
637.	260.	3.56	66.	1.63	64.	3186.
43.	129.	129.	132.	132.	132.	3.63
212.	81.	20.	0.	0.	0.	132.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 1374. 520. 133. 127. 6371.
 INCHES 7.12 7.26 7.26
 AC-FT 258. 263. 263. 263.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

0. 130. 300. 385. 423. 445. 458. 1153. 2060. 1747.
 1031. 635. 446. 244. 61. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 2060. 781. 199. 191. 9557.
 INCHES 10.68 10.89 10.89
 AC-FT 387. 395. 395.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

0. 173. 400. 514. 564. 594. 610. 1538. 2747. 2382.
 1374. 846. 594. 325. 81. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 2747. 1041. 265. 255. 12742.
 INCHES 14.24 14.53 14.53
 AC-FT 516. 527. 527.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

0. 216. 499. 642. 705. 742. 763. 1922. 3436. 2974.
 1714. 1054. 743. 406. 102. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 3436. 1301. 332. 319. 15928.
 INCHES 17.80 18.16 18.16
 AC-FT 645. 659. 659.

HYDROGRAPH ROUTING

ISTAQ 2 ICOMP 1 IECON 0 ITAPP 0 JPLY 0 JPRY 0 INAMF 0

ROUTING DATA
 GLOSS 0.0 0.000 0.00 1 1
 CROSS 0.000 0.00 1 1
 AVG 0.00 1 1
 IRES ISAME

NSTPS 0 NSTOL 0 LAG 0 ANSKK X TSK STORA -1.

STORAGE= 0. 20. 81. 142. 203. 265. 328. 391. 454. 518.
 OUTFLOW= 0. 99. 157. 244. 350. 474. 612. 765. 930. 1108.

STATION 17. 35. 53. 70. 85. 103. 120. 140.
 PLAN 1, RTIO 1 167. 181. 196. 216.

0.	1.	3.	7.	11.	14.	17.	24.	42.	63.
76.	81.	82.	81.	76.	71.	65.	59.	53.	48.
43.	30.	33.	29.	24.	20.	17.	13.	11.	9.
7.	6.	5.	4.	3.	3.	2.	2.	1.	1.
1.	1.	1.	1.	0.	0.	0.	0.	0.	0.

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 159. 143. 66. 1142.
 SFS INCHES 3.63 3.63
 AC-FT 71. 132. 132.

STATION 2, PLAN 1, RTIO 2

0.	8.	33.	69.	101.	108.	115.	132.	173.	236.
286.	302.	306.	301.	287.	269.	250.	235.	221.	209.
197.	185.	175.	165.	156.	150.	144.	139.	133.	128.
123.	118.	114.	109.	105.	101.	91.	74.	60.	49.
40.	33.	26.	22.	18.	14.	12.	9.	8.	6.

STOR

0.	2.	7.	14.	22.	29.	37.	54.	92.	137.
165.	176.	178.	175.	167.	156.	146.	136.	126.	117.
109.	101.	93.	86.	80.	74.	67.	62.	56.	51.
45.	40.	36.	31.	27.	22.	18.	15.	12.	10.
8.	7.	5.	4.	4.	3.	2.	2.	2.	1.

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 306. 258. 132. 6344.
 SFS INCHES 3.53 7.22 7.23
 AC-FT 128. 262. 262.

STATION 2, PLAN 1, RTIO 3

0.	12.	50.	100.	112.	124.	137.	165.	249.	367.
450.	480.	486.	473.	448.	415.	382.	352.	327.	304.
283.	264.	245.	231.	218.	205.	194.	183.	172.	162.
154.	148.	143.	137.	132.	127.	122.	117.	113.	108.
104.	100.	96.	70.	57.	46.	38.	31.	25.	20.

STOR

0.	2.	10.	21.	33.	46.	60.	87.	145.	211.
253.	268.	270.	265.	252.	235.	217.	204.	190.	177.
165.	153.	143.	133.	124.	115.	107.	99.	92.	85.
78.	72.	66.	60.	55.	49.	44.	39.	34.	30.
25.	21.	17.	14.	12.	9.	8.	6.	5.	4.

PEAK 5-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 486. 397. 183. 9467.
 SFS INCHES 5.43 10.78 10.79
 AC-FT 197. 391. 391.

STATION 2, PLAN 1, RTIO 4

0.	16.	66.	107.	124.	141.	160.	212.	340.	518.
633.	684.	687.	666.	621.	570.	521.	476.	438.	403.
371.	343.	319.	297.	276.	257.	240.	226.	213.	201.
190.	179.	169.	159.	152.	146.	141.	135.	130.	125.
120.	116.	111.	107.	103.	98.	90.	85.	83.	73.

STOR

0.	3.	13.	29.	46.	55.	83.	120.	197.	285.
339.	358.	359.	350.	332.	309.	286.	266.	247.	230.
216.	197.	185.	172.	161.	150.	137.	130.	121.	112.

INCHES
AC-FT

7.52
273.

14.29
514.

14.31
519.

	STATION	7.52	14.29	14.31	14.31
0.	114.	136.	159.	193.	262.
849.	83.	807.	732.	662.	600.
459.	904.	358.	309.	288.	264.
221.	309.	174.	164.	156.	150.
133.	196.	114.	109.	105.	90.
	123.				101.

STOR

	STATION	7.52	14.29	14.31	14.31
0.	36.	59.	83.	106.	153.
423.	17.	407.	377.	349.	299.
257.	444.	207.	179.	167.	145.
126.	222.	193.	86.	79.	67.
56.	108.	40.	31.	26.	18.
	45.				15.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	905.	710.	325.	312.	15607.
INCHES		9.71	17.77	17.79	
AC-FT		352.	644.	645.	645.

PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

OPERATION	STATION	PLAN	RATIOS APPLIED TO FLOWS				
			.20	.40	.60	.80	1.00
HYDROGRAPH AT	1	1	687.	1374.	2060.	2747.	3434.
	2	2	0.	0.	0.	0.	0.
ROUTED TO	1	1	159.	306.	486.	687.	905.
	2	2	0.	0.	0.	0.	0.

ADDITIONAL REPORTS

SANBORN AND TORBERT
CONSULTING ENGINEERS
30 CHURCH STREET
NEW YORK

APR 14, 1927.

Mr. Thomas L. Watkins
Acting State Engineer
Department of Public Works
Albany, N. Y.

Dear Sir:

Referring to the application and plans for dams for increasing the capacity of Cooper Lake for Kingston, N. Y., and your letter of March 28, 1927, we wish to make the following comments regarding the design.

There are two dams, (1) the existing dam with spillway 23' high, and (2) the new west dike.

(1) Existing Dam. This structure consists of a masonry section about 13' long and 33' high, with earth embankment provided with core walls at either side of the masonry spillway section. (Sheet 2+). It is proposed to raise the water of the lake a little less than 11'. The proposed design of this dam contemplates raising the core wall which is to be carried across the existing masonry spillway section and placing earth embankment on the existing slopes and parallel with them. The earth slopes are thoroughly well stabilized. The down-stream slope stands at present somewhat steeper than 1 on 1 1/2. Soundings on the water side show the slope to be about 1 on 1 1/2. The material of the existing embankment of this dam is well compacted and impervious. Our design contemplates a slope on the back of the dam of 1 on 1 1/2, covered with rock spoil thus the dam already forms a well compacted core in the earth portion, and in the spillway portion a very broad masonry section with an apron on the down-stream side 3' thick of impervious concrete extending to the outer toe of the slope a distance of about 27' from the masonry dam, which is about 21' at the base. Our design contemplates plates covering all of this masonry at the highest section with embankment on each water side and down-stream side;

April 14, 1927.

the water level will have a depth at the base somewhat over 100 feet according to our opinion, for a depth of water of about 30'.

In view of the excellent character of the material and the fact that the existing dam and earth slopes are already well stabilized, with a heavy masonry section and broad concrete apron at the deepest portion, we feel that an entirely safe and ample section has been provided.

In view of the conditions, we feel that our design is well considered, and because of the local circumstances, we respectfully request your approval of the designs as submitted for raising the existing dam.

(2) West Dike. This is a rolled earth embankment, with a maximum of just under 12' of water at the deepest portion; for a considerable part of the length there will be less than 10 or 11' of water against the dike.

We were somewhat uncertain whether it was necessary under the law to file these plans as we understand that anything under 12' does not require approval by the State Engineer.

Our design provides for rock spoil on the back of the dam which will serve to stabilize the slope, and a heavy paving on the water side which will serve the same function. In view of the very low head of water in this case and in view of the stabilizing effect of the slopes due to the rock and paving, we feel that the slopes provided are adequate since the bottom width of the embankment as designed is 33 feet, with 11' of water; using the slopes recommended in your letter, namely 1 on 2 $\frac{1}{2}$ and 1 on 2, with a 10' top, a 2' freeboard works out a 33' bottom width, - this is presumably without the stabilizing effect of the rock fill. In other words our design gives all you ask.

With regard to your recommendation that a core wall be used in this section; this subject was discussed with your Engineer on Mr. Sanford's visit at Albany; in view of the slight depth of water we understood that the core wall could be omitted, particularly since the material for this embankment is ideal, consisting of very fine sand, just enough clay material so that the embankment packs perfectly and makes a thoroughly impervious dam.

April 14, 1927.

The design for the embankment of the Birnewater Reservoir for irrigation, now under construction, as approved by the State Engineer, has a depth of water of 20', slopes of 1 on 2 and 1 on 1 $\frac{1}{2}$, and no core in the rolled earth portion of the embankment, which is material similar to that at Cooper Lake, (print enclosed).

In view of these circumstances, particularly considering the low head of water against the embankment and considering the angle width of the base and the impervious character of the material, we respectfully request approval of the design as submitted.

Yours very truly,

W. F. Sanborn.

SANBORN AND BOGERT

JFS.X