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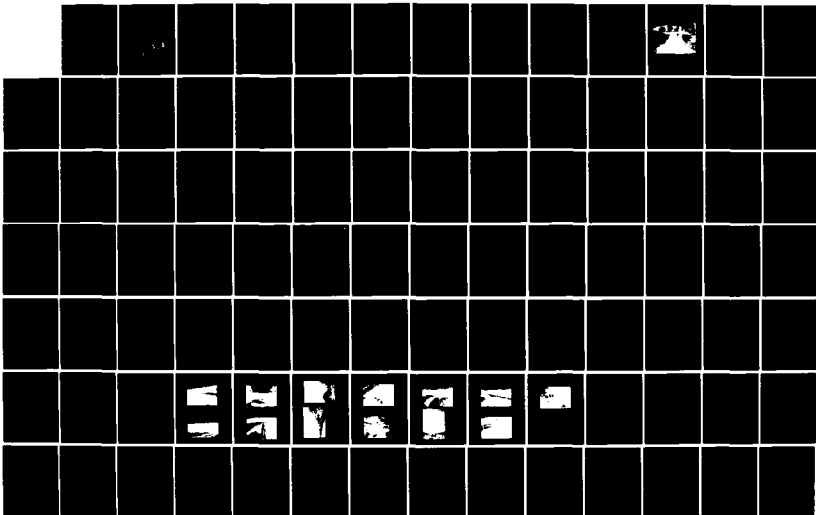
NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
WHITIN RESERVOIR DAM. (U) CORPS OF ENGINEERS WALTHAM MA
NEW ENGLAND DIV JUL 80

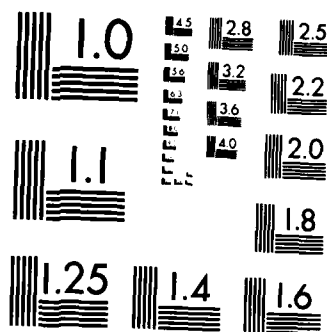
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BLACKSTONE RIVER BASIN
DOUGLAS, MASSACHUSETTS

WHITIN RESERVOIR DAM

MA. 00200

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

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WHITIN RESERVOIR DAM

MA 00200

BLACKSTONE RIVER BASIN
DOUGLAS, MASSACHUSETTS

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.: MA 00200
Name of Dam: Whitin Reservoir Dam
Town: Douglas
County and State: Worcester County, Massachusetts
Stream: Unnamed Tributary to Mumford River
Date of Inspection: 15 April and 20 May 1980

BRIEF ASSESSMENT

Whitin Reservoir Dam is an ashlar faced stone wall dam with an upstream earth embankment constructed in the mid-1800's to supply the water needs of mills located downstream on the Mumford River. The facility is still used by the mills as a supply of process water. The reservoir is also used for recreational purposes. The dam is about 473 ft. long and 33 ft. high. Its horizontal alignment is of a gentle "S" configuration and Northwest Main Street is located along the entire length of the dam crest. The facility has two spillways: a relatively new concrete main spillway which is 27.5 ft. long and an auxiliary spillway constructed of heavy stone blocks which is about 25 ft. long. The two spillways are side by side and are located on the right side of the dam. There is a 2 ft. square stone box conduit passing through the dam near its midpoint which serves as a low level outlet.

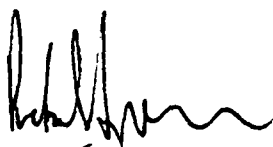
The reservoir is about 10,000 ft. long and the surface area of the reservoir at spillway crest level is about 315 acres. The drainage area above the dam is about 8.93 sq. mi. (5,716 acres), the maximum storage to top of dam is about 4,475 acre-ft. Based on storage, the size classification is intermediate. A breach of the dam would damage about seven houses, two industrial buildings, two commercial buildings, a Mobil Oil Co. pipeline and several local roadways and potentially could cause the loss of more than a few lives; therefore, the dam has been classified as having a high hazard potential. Based upon the guidelines, the recommended test flood is a full PMF. The test flood inflow was calculated to be 13,540 cfs.

The routed test flood outflow of 9,000 cfs would overtop the dam by about 4.1 ft. The spillway can pass about 850 cfs or about 9 percent of the routed test flood outflow without overtopping the dam.

The dam is judged to be in generally good physical condition. However, because of the inadequate spillway discharge capacity, it is rated as in fair condition. Seepage was noted at two locations at the toe of the downstream stone wall. A stone parapet located on the upstream edge of the crest of the dam is in need of minor repair and the right training wall of the main spillway is in need of repointing. There is some vegetation growth and silt in the approach channel to the spillways.

Within one year after receipt of this Phase I Inspection Report, the owner, the Mumford River Reservoir Association, should retain the services of a qualified registered professional engineer and implement the results of his evaluation of a detailed hydrologic-hydraulic investigation to assess further the potential for overtopping and the adequacy of the spillways and their approach channel.

The owner should also implement the following operating and maintenance measures: (1) repair voids in the upstream parapet wall at a point about 20 ft. left of the low level outlet; (2) repoint the masonry rubble portion of the right training wall of the main spillway; (3) remove weeds and siltation in the approach channel downstream of the four 36 in. dia. pipe culverts; (4) monitor seepage at the toe of the downstream face of the stone wall to the left of the outlet structure on a six month basis to ascertain any changes in clarity or quantity of flow; (5) develop a formal surveillance and downstream emergency warning plan including round-the-clock monitoring during periods of heavy precipitation; (6) clean and repaint the footbridge; (7) continue to conduct annual technical inspections of the dam and its appurtenant structures; and, (8) implement a regular periodic maintenance program.



Peter B. Dyson
Project Manager



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, sub-surface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through 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. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. 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.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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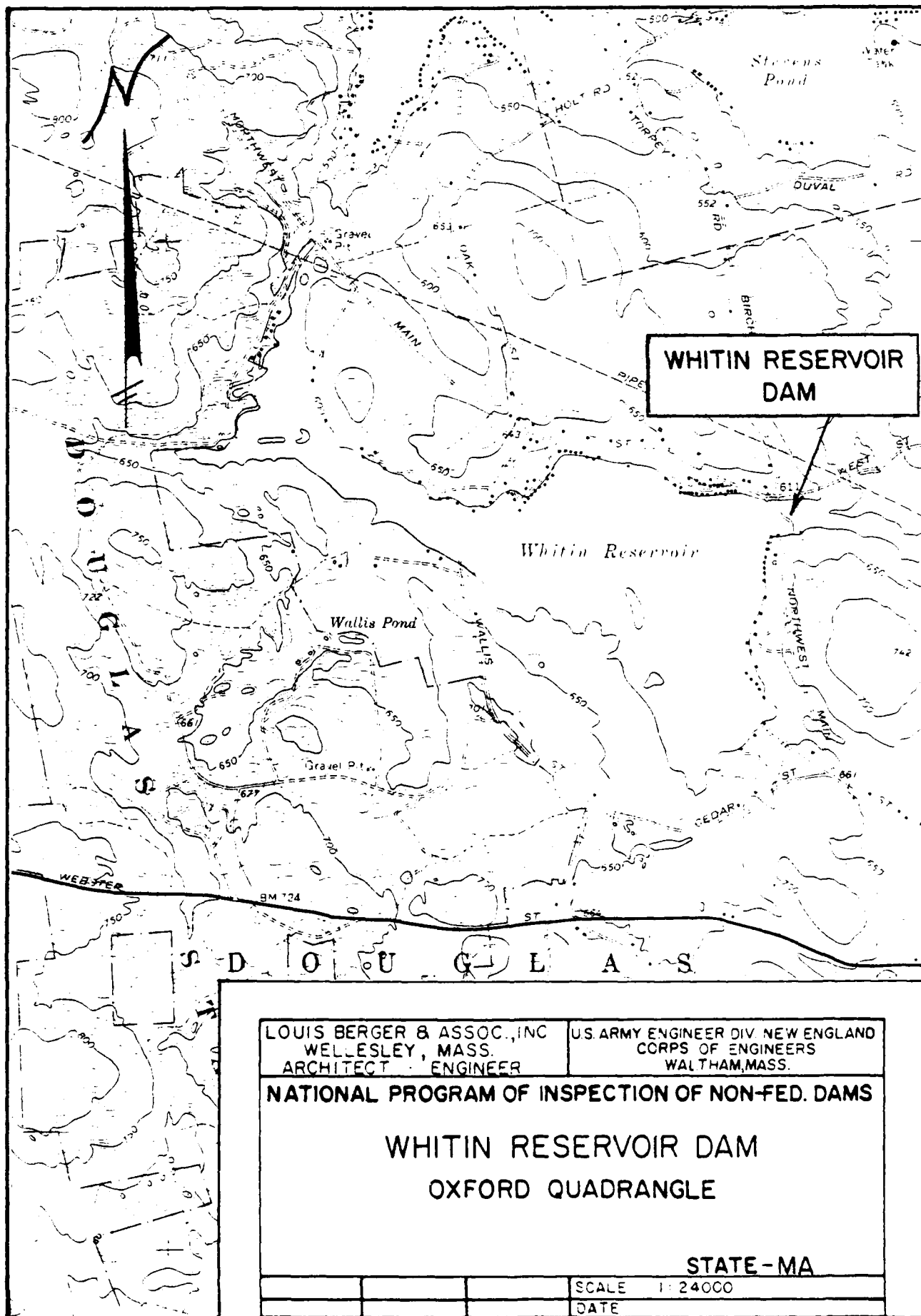
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INVENTORY OF DAMS

WHITIN RESERVOIR DAM



OVERVIEW FROM RIGHT ABUTMENT



PHASE I INSPECTION REPORT

WHITIN RESERVOIR DAM MA 00200

SECTION 1 - PROJECT INFORMATION

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Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam safety inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Louis Berger & Associates, Inc. was retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Louis Berger & Associates, Inc. under a letter of 28 March 1980 from William E. Rouse, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0043 has been awarded by the Corps of Engineers for this work.

Purpose of Inspection

-) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
-) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
-) Update, verify and complete the National Inventory of Dams.

Description of Project

Location. Whitin Reservoir Dam is located in Worcester County in the Town of Uxbridge in south-central Massachusetts. The reservoir is situated on an unnamed brook approximately two miles upstream from its confluence with the Mumford River. The dam is reached via Northwest Main Street. The dam is shown on U.S.G.S. Quad - 22-10-100, Oxford, Mass. - Conn. - R.I. with coordinates approximately at N 42° 04' 18", W 71° 5' 29".

Description of Dam and Appurtenances

-) Description of Dam. Whitin Reservoir Dam is a 33 ft. high, 473 ft. long, gravity stone wall dam with an earthfill embankment upstream of the wall. The dam is constructed across a steep-sided valley reach of an unnamed brook. The downstream face of the dam has a slight batter and the upstream face has a slope of 1 horizontal to 1 vertical. The upstream face is protected with dumped stone masonry which has been gunited at the higher elevations. The horizontal alignment of the dam is in a gentle "S" configuration and a paved roadway known as Northwest Main Street runs along the entire length of the earthfill. The crest of the dam has a variable width with a minimum of about 30 ft. Stone parapets with mortared joints are located along each edge of the crest and extend from the left abutment to the spillway facilities at the right abutment. The parapets vary slightly in height. On the average,

SECTION 6 - EVALUATION OF STRUCTURAL STABILITY

Visual Observations

Whitin Reservoir Dam is in good structural condition as revealed by the field inspection of April 15 and May 20, 1980. However, there are several items of a minor nature which were observed and which require treatment as outlined in Section 7.

Principal items requiring remedial treatment are the occasional voids in the masonry rubble parapet wall left of the outlet structure, the need for repointing masonry rubble training wall on the right side of the main spillway, and the need to remove weeds and siltation at the downstream end of the reinforced concrete spillway on the right of the spillway inlet channel.

Design and Construction Data

Original layout plan of the Whitin Reservoir Dam prepared by G. Bertrand Bibeault in August 1958 is available. However, no definitive plans of the embankment, spillway and typical cross-sections are available. Data on construction of the dam including detailed laboratory soil test results are also not available. Observations pertaining to the stability of the embankment and masonry rubble walls are available.

Post-Construction Changes

There are no formal records of any post-construction changes made to the dam or spillway or outlet structure over the course of its history. However, correspondence indicates the main spillway was reconstructed in 1977, and that the control structure at a low level outlet was completely reconstructed after the floods of 1955. The observations indicated no items which appear to be inconsistent with the original layout plan previously noted.

Seismic Stability

The dam is located in Seismic Zone #2 and in accordance with recommended Phase I procedures does not warrant seismic analysis.

vicinity of Gilboa Pond located about three quarters of a mile below East Douglas, it is estimated that an industrial building, Gilboa Street, a sewage treatment plant and about seven houses will be flooded to a depth of between 1 and 6 ft. Below the area of initial impact the flood flows should be significantly reduced as they enter Lackey Pond, Meadow Pond and Whitins Pond, all of which are impoundments of the Sumford River.

Summary, about thirteen houses, two industrial buildings, a commercial building, a school building, a sewage treatment plant, a pipe line, and eight local roadways within the area of potential flooding and there is also the potential for the loss of more than a few lives (see Sheet D-25, Appendix D). Therefore, in accordance with the Recommended Guidelines for Safety Inspection of Dams the dam has been classified as having a high hazard potential.

Discharge tables and curves for the spillway and for over the top of the dam are shown on Sheets D-4 thru D-6, Appendix D. The discharge capacity of the low level outlet was not considered. For determining surface areas and surcharge capacities, dimensioned areas were taken from contours delineated on 1:24,000 U.S.G.S. Sheets.

Routing computations were performed for both the test flood and a $\frac{1}{2}$ PMF. Results of these computations are shown on Sheets D-10 thru D-15, Appendix D, and are summarized as follows:

<u>Flood Magnitude</u>	<u>Test Flood Inflow (cfs)</u>	<u>Maximum Res. El. (ft. NGVD)</u>	<u>Max. Head Over Crest of Dam (ft.)</u>	<u>Routed Test Flood Outflow (cfs)</u>
TF	6,770	601.4	1.9	3,500
(Test Flood) 13,340		603.2	3.7	9,000

From the above table, it can be seen that the project will not pass the routed test flood outflow without overtopping the crest of the dam by about 4.1 ft. The project can handle about 9 percent of the routed test flood outflow without overtopping the

Dam Failure Analysis

Each owing to structural failure of the dam by piping or sloughing is a possibility. For this analysis a breach was assumed to occur with the water surface level at top of dam. The "rule of thumb" method in the March 1978 Guidance Report was used for the breach analysis. With a breach width of 30 percent of the embankment length, since the mid-height length is unknown, or about 125 ft., an outflow of about 1000 cfs, which includes 850 cfs from the spillway, would be realized (see Sheets D-20 thru D-24, Appendix D). Because of the relatively small spillway discharge, downstream valley storage filled by the pre-failure flow was not subtracted from available storage for attenuation of the dam-failure flow when routing the dam-failure flood.

In the reach below the dam, the breach flood flows would travel down a two mile long unnamed brook to the Mumford River. In this reach, it is estimated that three local highways which cross the brook would be flooded and seriously damaged. A 6 in. dia. lined products pipeline with about a 3 ft. cover crosses the brook approximately 100 ft. below the dam and would be seriously damaged. Also, three houses in the vicinity of the Mumford River would sustain severe flooding. It is estimated that the breach discharge would flood these houses by as much as 3 to 5 ft., and that the spillway discharge prior to the breach would not flood these homes. When the breach flow reaches the Mumford River it is estimated that the discharge will be about 1000 cfs in the brook and that the stage will be about 13 ft. higher than the stage at the spillway discharge. In the 1.8 mile reach between the confluence of the unnamed brook and the Mumford River and the village of East Douglas, it is estimated that the stage in the Mumford River will rise about 11.5 ft. and flood two local highways and 3 houses will be flooded by 1 to 3 ft. of water. In East Douglas it is estimated that the breach discharge will be about 21,900 cfs. The Mumford River is never confined as it passes through the village and it is probable that two local highways, one mill building, one commercial building and one other building will be flooded to an additional depth of between 5 and 9 ft. Flooding will take place in

SECTION 5 - EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

General. Whitin Reservoir Dam is an ashlar faced stone wall dam with an upstream earthfill which supports a paved roadway across the entire length of its crest. The dam impounds a normal storage of about 2,800 acre-ft. with provision for an additional 1,675 acre-ft. of capacity in its surcharge space to top of dam. It is basically a low surcharge - low spillage facility used to impound water for recreational purposes. Flows through the spillway are controlled by a constriction in the spillway approach channel. This constriction consists of a roadway embankment that crosses the approach channel which has a 15 ft. long bridge opening and four 36 in. dia. concrete pipes for conveying water from the reservoir to the spillway. With the reservoir water surface level at top of dam the spillway discharges about 850 cfs. If the approach channel were unconfined, the spillway would be capable of passing about 1,480 cfs with the water surface level at top of dam.

The general topographic characteristics of the 8.93 sq. mi. (5,716 acres) drainage area is best described as rolling terrain, which rises from elevation 595.5 ft. at spillway crest level to elevation 900. The area is nearly all forested with a considerable amount of the area located in the Douglas State Forest. The only populated area is located in the lower reaches of the basin around the rims of Whitin Reservoir and Crystal Lake.

2 Design Data

No hydrologic computations or hydraulic data has been recovered for the dam.

3 Experience Data

No records are available in regard to past operation of the reservoir, nor of surcharge encroachments and flows through the spillway. The maximum past outflows are known. It was reported that after the floods of 1955, the four 36 in. dia. pipes mentioned above were installed to increase the discharge capacity of the spillway approach channel.

4 Test Flood Analysis

The hydrologic characteristics of Whitin Reservoir Dam and drainage area were evaluated in accordance with criteria given in Recommended Guidelines for Safety Inspection of Dams. As indicated in Section 1.2, paragraphs c and d, Whitin Reservoir Dam is classified as intermediate in size and has a high hazard potential. The recommended test flood for hydraulic evaluation of such a dam is a full PMF.

Precipitation data was obtained from Hydrometeorological Report No. 33, which for this area of Massachusetts is about 23.5 in. of 6 hour maximum rainfall over a 10 square mile area. This value was then reduced by 20 percent to allow for basin size, shape and fit factors and further reduced by 0.4 in. for infiltration losses. The 6 hour rainfall was distributed into one hour incremental periods as suggested in NCE Publication EC 1110-2-1411.

A triangular incremental unitgraph was assumed for the inflow hydrograph using a computed lag time of 5.6 hours to derive a time-to-peak for the triangular hydrograph of 5.0 hours (see computations on Sheets D-7 and D-8, Appendix D), indicating a peak inflow of about 13,540 cfs or a CSM of about 1,320 cfs.

SECTION 4 - OPERATIONAL AND MAINTENANCE PROCEDURES

1 Operation Procedures

a. General. The dam is owned and operated by the Mumford River Reservoir Association. It is operated in conjunction with several other bodies of water to supply cooling water and a small amount of process water for mills located downstream of the dam. Whitin Reservoir is also used as a recreational facility by property owners located along the shoreline. In the fall the reservoir is said to be drawn down to allow shoreline property owners to make repairs to boat docks and other recreational facilities.

b. Description of any Warning System in Effect. No warning system is in effect at Whitin Reservoir Dam.

2 Maintenance Procedures

a. General. There is no documented regular periodic maintenance program in effect at Whitin Reservoir Dam. There are, however, several items which require periodic maintenance, such as: the removal of debris from the crests of the spillways; the repair of the spillway training walls and the parapets on the crest of the dam; keeping the approach channel clear of vegetation growth; surveillance of the downstream wall regarding seeps; and, maintenance of the outlet facility.

b. Operating Facilities. The only operating facility for the dam is a hand operated sluice gate which regulates the flows through the low level outlet. Maintenance of this facility is said to be performed as required.

3 Evaluation

Overall maintenance of the dam is generally good. Specific maintenance items are evaluated as follows: The main spillway was recently reconstructed and is in good condition with the exception of the need for repointing of the right training wall; the main spillway has a small amount of debris on its crest; the approach channel has some vegetation growing in it; and the upstream parapet has an area that should be repaired. A regular periodic maintenance program should be implemented. The owner should also establish a formal downstream warning system for the dam in the event of an emergency.

downstream stone wall, but the seepage appeared to be clear and free from silt. The low level outlet was in an operational condition and the control structure appeared to be in good condition. The upstream parapet wall and the right training wall of the main spillway need a minor amount of repointing and the spillway approach channel should be cleared of vegetation and silt. There is no regular periodic maintenance program.

mortared stone and concrete training wall on the right which also serves as the left training wall of the auxiliary spillway. A short mortared stone training wall is located to the left of the main spillway. A narrow steel footbridge spans the main spillway as can be seen in Photo No. 12. This photo shows the right end of the main spillway in the foreground and the left end of the auxiliary spillway in the background. Generally, the main spillway is in good condition. However, the right training wall is in need of repointing and the footbridge is in need of cleaning and repainting.

The auxiliary spillway is located just to the right and adjacent to the right training wall of the main spillway. The spillway is about 25 ft. long and is constructed of heavy stone blocks which blend into natural ground on the right side of the spillway. The sill of the auxiliary spillway is about 1.2 ft. higher than the top of the channel iron in the main spillway. The auxiliary spillway is in good condition.

Photo No. 11 shows the roadway passing over the approach to the spillways. The waterway openings through the roadway consist of a 15 ft. long bridge opening and four 36 in. dia. pipe culverts. The pipes are located to the right of the bridge. The roadway acts as a constriction in the approach channel. There is some weed growth in the water immediately downstream of the four pipe culverts and there is also minor silting at the downstream end of these culverts.

The channel downstream of the spillways is formed by massive bedrock, which appears to be in good condition as shown on Photo No. 13. A small amount of debris is in the channel as well as on the crest of the main spillway.

The low level outlet structure is situated at about midspan of the dam and consists of a 2 ft. square stone box conduit with a control structure located on the upstream end. The control structure can be seen in Photo Nos. 1 and 9 and the outlet end of the conduit can be seen in Photo Nos. 6 and 10. Photo No. 10 was taken on 15 April when the control gate was fully closed, and Photo No. 6 was taken on 20 May when the control gate was partially open. The control for the conduit is a sluice gate which is hand operated from the deck of the outlet control structure. The control mechanism is reported to be in good condition and the entire structure is said to have been reconstructed after the floods of 1955.

d. Reservoir Area. The shorelines upstream of the dam on both the right and left abutments appear stable with no evidence of landslides or sloughing. The shores of the reservoir are moderately to steeply sloped and numerous houses dot the rim.

e. Downstream Channel. As noted above, the spillways discharge into a massive bedrock channel which later joins the regulating outlet discharge channel to form the unnamed brook which traverses down a rather steep incline until it nears the Mumford River at a point about two miles below the dam. Though no houses are located along the brook until it is in close proximity to the Mumford River, it passes under three local roadways and over a pipeline. Beyond the confluence of the brook and the Mumford River, this river flows through a series of manmade impoundments as it winds its way through the villages of East Douglas, Whitinsville, Linwood, North Uxbridge and Uxbridge before reaching the Blackstone River about 12.7 miles below Whitin Reservoir Dam.

3.2 Evaluation

The visual inspection adequately revealed key characteristics of the dam as they may relate to its stability and integrity. The dam and appurtenant works were judged to be in good physical condition. Two seeps were found at the toe of the

SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General. The visual inspection of Whitin Reservoir Dam took place on 15 April and 20 May 1980. On 15 April the water level was about 0.7 ft. above the channel iron sill in the main spillway and the crest of the auxiliary spillway was dry. The discharge over the spillway was estimated to be about 47 cfs. Seepage was noted at two locations at the downstream toe of the dam. The upstream parapet is in need of minor repair and the right training wall of the main spillway is in need of minor repair. There was no evidence of any major problems and in general the physical condition of the dam was judged to be good.

b. Dam. Whitin Reservoir Dam is an uncemented ashlar faced stone wall dam with an upstream earthfill. The crest length of the dam is about 473 ft. and the maximum height is about 33 ft. The top width of the dam varies, having a minimum width of about 30 ft. and a maximum width of about 75 ft. The horizontal alignment of the dam has a slight "S" shaped configuration (see Photo No. 3), and a paved roadway is located along the crest of the dam. Stone parapets are located on either side of the roadway at each edge of the crest. The parapets vary slightly in height. The upstream parapet rises about 1.5 ft. above the crest and the downstream parapet rises about 1.1 ft. above the crest. The downstream parapet has a chain link fence mounted on it (see Photo No. 4). The downstream face of the dam consists of an uncemented stone wall which has a slight batter (see Photos No. 5 and 6). Photo No. 2 is a view of the upstream face of the dam taken (by others) prior to the date of the inspection, at a time when the reservoir was drawn down. Below the parapet, the upstream slope is about $1\frac{1}{2}$ horizontal to 1 vertical and the slope is protected with dumped stone which has been gunited at the higher elevations.

Two areas of seepage were noted at the toe of the downstream stone wall and are shown on Photo Nos. 7 and 8. Photo No. 7 shows seepage emanating from a point about 30 ft. left of the low level outlet. The seepage at this location was estimated to be about 2 gpm. Photo No. 8 shows the other area of seepage which is at a point about 2 ft. left of the low level outlet. The rate of flow at this location was estimated to be less than 2 gpm. The owner's representatives stated that these areas of seepage had existed for many years, essentially unchanged. The stone wall itself appeared to be in good condition and its alignment was good.

The parapet walls are in generally good condition with the exception of a small deteriorated area in the upstream parapet about 20 ft. left of the low level outlet. The paved roadway between the parapets is in fair condition with sporadic and longitudinal cracking; however, this should be of no significance with regard to the safety of the dam. Where visible, the stone protection on the upstream slope appeared to be in good condition.

c. Appurtenant Structures. The spillways for the facility are located on the right side of the dam adjacent to the right abutment. The facilities consist of a main spillway located on the left and an auxiliary spillway located on the right, an approach channel and a discharge channel. The main spillway has a crest length of 27.5 ft. and is a concrete structure which is probably founded on bedrock. It has a 6 in. high channel iron mounted on its concrete crest and stanchions are located in the spillway for the support of stoplogs. The main spillway has a short

SECTION 2 - ENGINEERING DATA

2.1 Design Data

No data on the design of the dam or appurtenances has been recovered. One plan dated 1958 showing a sketch of the dam in plan view was recovered and is included in Appendix B. In the course of the inspection, measurements were taken and a sketch plan and profile layout of Whitin Reservoir Dam and spillway has been prepared. This plan is also included in Appendix B.

2.2 Construction Data

No records or correspondence have been found regarding construction data.

2.3 Operation Data

No engineering operational data were disclosed.

2.4 Evaluation of Data

a. Availability. There was no engineering data available. The basis of the evaluation presented in this report is principally the visual observations of the inspection team.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Validity. Not applicable.

(4) Gates - None

(5) U/S Channel - Obstructed by roadway across channel with 15' long bridge and 4-36 in. dia. pipes

(6) D/S Channel - Natural channel in bedrock

(7) General -

Spillway (Auxiliary)

(1) Type - Granite block gravity section

(2) Length of weir - 28 ft.

(3) Crest elevation - 596.2

(4) Gates - None

(5) U/S Channel - Same as above

(6) D/S Channel - Same as above

j. Regulating Outlets

(1) Invert - 566.5

(2) Size - 2 ft. x 2 ft. square

(3) Description - Stone Box conduit

(4) Control mechanism - Hand operated sluice gate

e. Storage (acre-ft.)

- (1) Normal pool - 2,800
- (2) Flood control pool - Not applicable
- (3) Spillway crest pool - 2,800
- (4) Top of dam - 4,475
- (5) Test flood pool - 5,900

f. Reservoir Surface (acres)

- (1) Normal pool - 315
- (2) Flood-control pool - Not applicable
- (3) Spillway crest - 315
- (4) Top of dam - 382
- (5) Test flood pool - 419

g. Dam

- (1) Type - Stone wall with upstream earth embankment
- (2) Length - 473 ft.
- (3) Height - 33 ft.
- (4) Top width - Varies, 30 ft. minimum
- (5) Side slopes - Downstream: Slight Batter
Upstream: $1\frac{1}{2}$ horizontal to 1 vertical
- (6) Zoning - Unknown
- (7) Impervious core - Unknown
- (8) Cutoff - Unknown
- (9) Grout curtain - Unknown

h. Diversion and Regulating Tunnel - Not applicable

i. Spillway (Main)

- (1) Type - Concrete gravity section surmounted with 6 in. high channel iron sill
- (2) Length of weir - 27.5 ft.
- (3) Crest elevation - 595.0

concrete pipes under the roadway. Thus the total capacity of the spillway is only about 850 cfs when the reservoir water surface level is at top of dam, elevation 599.5.

(4) Ungated Spillway Capacity at Test Flood Elevation. Because of the spillway approach control described in (3) above, the ungated spillway capacity is about 3,800 cfs when the reservoir water surface level is at test flood elevation 603.2.

(5) Gated Spillway Capacity at Normal Pool Elevation. Not applicable

(6) Gated Spillway Capacity at Test Flood Elevation. Not applicable

(7) Total Spillway Capacity at Test Flood Elevation. The total spillway discharge at the test flood elevation is the same as (4) above, 3,800 cfs at test flood elevation 603.2.

(8) Total Project Discharge at Top of Dam. With the low level outlet open the total project discharge at top of dam is about 970 cfs at elevation 599.5.

(9) Total Project Discharge at Test Flood Elevation. The total project discharge at test flood is 9,000 cfs at elevation 603.2.

c. Elevation (ft. N.G.V.D.)

(1) Streambed at toe of dam - 566.5

(2) Bottom of cutoff - Unknown

(3) Maximum tailwater - Unknown

(4) Normal pool - 595.0

(5) Full flood control pool - Not applicable

(6) Spillway crest - 595.0

(7) Design surcharge (Original Design) - Unknown

(8) Top of dam - 599.5

(9) Test flood surcharge - 603.2

d. Reservoir (Length in feet)

(1) Normal pool - 10,000

(2) Flood control pool - Not applicable

(3) Spillway crest pool - 10,000

(4) Top of dam - 10,200

(5) Test flood pool - 10,300

e. Ownership. Whitin Reservoir Dam is owned by Mumford River Reservoir Association, c/o Mr. Joseph Rosol, ATF Davidson, Main St., Whitinsville, Massachusetts 01588. Telephone: (617) 234-7451.

f. Operator. Mr. Joseph Rosol, ATF Davidson, Main Street, Whitinsville, Massachusetts 01588. Telephone: (617) 234-7451

g. Purpose of Dam. The dam impounds a reservoir used for recreational purposes. Also, the dam still serves its original purpose of supplying the water needs of mills located downstream on the Mumford River.

h. Design and Construction History. It is not known by whom the dam was designed or constructed. It is believed the dam was built in 1854 to meet the water demands of mills located downstream on the Mumford River. Correspondence in the owner's files indicates that the main spillway was completely reconstructed in 1977. The files also indicate that the masonry and steel structure for the low level outlet facility was reconstructed after the floods of 1955. At that time the four 36 in. dia. pipe culverts were also installed in the embankment to increase the discharge capabilities of the spillway approach channel.

i. Normal Operating Procedures. No written operating procedures for the dam were disclosed. According to the owner's representatives, the low level outlet sluice gate is operated from time to time and the reservoir is drawn down in the fall in anticipation of spring runoff and for the benefit of property owners located along the rim of the reservoir.

1.3 Pertinent Data

a. Drainage Area. The drainage area contributing to Whitin Reservoir is situated at the headwaters of an unnamed stream leading to the Mumford River. The drainage area encompasses a total of about 8.93 sq. mi. (5,716 acres), of which 315 acres are occupied by the reservoir. The longest circuitous stream course leading to the dam is about 4.7 miles long with an elevation difference of about 295 ft., or at a slope of about 63 ft. per mile. The drainage area has a length of about 3.6 miles and an average width of 2.3 miles. The basin consists of forested areas with a few open fields in the lower reach. The only populated areas are along the rim of the reservoir.

b. Discharge at Damsite

(1) Outlet Works Conduit. Low level discharge from Whitin Reservoir is provided for by means of a 2 ft. square stone box conduit which is located at about midspan of the dam and passes through its base. The outlet of the conduit has an invert elevation of 566.5 ft. The conduit would be capable of discharging about 120 cfs when the sluice gate was wide open and the reservoir water surface level was at the top of the dam.

(2) Maximum Known Flood at Damsite. No records are available of flood inflows into Whitin Reservoir, nor of spillway releases and surcharge heads during such inflows.

(3) Ungated Spillway Capacity at Top of Dam. About 50 ft. upstream from the spillway crest a roadway crosses the spillway approach channel. Inflows to the spillway are controlled by a 15 ft. long bridge opening and four 36 in. dia.

top of the upstream parapet is about 1.5 ft. higher than the crest of the embankment. The top of the downstream parapet is about 1.1 ft. high and is surmounted by a chain link fence. A sketch plan can be found in Appendix B.

(2) Spillway. The spillway facilities for Whitin Reservoir Dam are located in the embankment near the right abutment. The facilities consist of a main spillway, an auxiliary spillway, an approach channel and a discharge channel. The main spillway is a 27.5 ft. long concrete structure which is probably founded on bedrock. A 6 in. high channel iron is mounted on its concrete crest. The top of dam is 4.5 ft. above the top of the channel iron. The spillway has a short rubble masonry and concrete training wall on the right and a short rubble masonry training wall on the left. The spillway is spanned by a narrow steel bridge. The auxiliary spillway is located just to the right and adjacent to the right training wall of the main spillway. This spillway is about 25 ft. long and is constructed of heavy stone blocks which blend in with the natural ground on the right side of the spillway. The sill of the auxiliary spillway is about 1.2 ft. higher than the top of the channel iron in the main spillway. The approach channel which serves both spillways is about 80 ft. long and is constricted at its upstream end by a bridge and culvert under the roadway along the dam. The waterway opening through the roadway embankment consists of a 15 ft. long bridge and four 36 in. dia. concrete pipes. The elevation on the roadway pavement in this vicinity is slightly lower than the remainder along the earth embankment of the dam. The channel below the spillways traverses down a relatively steep slope and its floor is made up of bedrock and massive boulders.

(3) Low Level Outlet. The low level outlet for the dam is situated at about mid-span, where a masonry and steel control structure is located about 15 ft. upstream of the parapet. The low level conduit is a 2 ft. square stone box that outlets at the toe of the downstream ashlar faced wall. The control for the facility is a hand operated sluice gate which is operated from the deck of the outlet structure. There is a staff gage located on the outlet structure which is not in use and the deck of the structure is enclosed by a low chain link fence.

c. Size Classification. Whitin Reservoir Dam has a hydraulic height of about 33 ft. above downstream river level, and impounds a normal storage of about 2,800 acre-ft. to spillway crest level and a maximum of about 4,475 acre-ft. to top of dam. In accordance with the capacity criteria given in Recommended Guidelines for Safety Inspection of Dams, the project falls into the intermediate category on the basis of height and capacity and is therefore classified accordingly.

d. Hazard Classification. A breach failure of Whitin Reservoir Dam would release water down a two mile long unnamed brook into the Mumford River and thence along the Mumford River Valley. Three local roadways, three houses and a Mobil Oil Co. refined products pipelines (6 in. dia.) located along the unnamed brook would be subject to flood waters from the breach. It is estimated that the stage in the brook would rise about 13 ft. above the stage due to the spillway discharge. From the confluence of the unnamed brook and the Mumford River to a point about 1 mile below the Village of East Douglas, which is located about four miles below the dam, it is estimated that about ten houses, two industrial buildings, one commercial building, one other building, a sewerage treatment plant and several local roadways would also be flooded as the stage in the Mumford River would rise by as much as 15 ft. The range of flooding would vary between 1 and 9 ft. It is estimated that the prefailure spillway discharge would not cause any significant flooding damage in the reaches described above. In this area of initial impact it is estimated that there is also the potential for the loss of more than a few lives. In accordance with the Recommended Guidelines for Safety Inspection of Dams, Whitin Reservoir Dam has therefore been classified as having a high hazard potential.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. On the basis of the Phase I visual examination, Whitin Reservoir Dam is judged to be in good physical condition, but because of the inadequate spillway discharge capacity it is rated as in fair condition. The deficiencies reveal that a further investigation should be carried out and that some remedial work is needed. The major concern revealed by the Phase I investigation is that the spillways will only pass about 8 percent of the routed test flood outflow.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Urgency. The recommendations and remedial measures enumerated below should be implemented by the owner within one year after receipt of this Phase I Inspection Report.

7.2 Recommendations

It is recommended that the owner, the Mumford River Reservoir Association, should retain the services of a registered professional engineer experienced in the design of dams to make a thorough study of the hydrology of the drainage basin and evaluate further the potential for overtopping and the adequacy of the spillways and their approach channel. If proved necessary, appropriate remedial works should be designed and constructed.

7.3 Remedial Measures

a. Operation and Maintenance Measures

(1) Repair voids in the upstream parapet at a point about 20 ft. left of the low level outlet structure.

(2) Repoint the masonry rubble portion of the right training wall of the main spillway.

(3) Remove weeds and siltation in the approach channel downstream of the four 36 in. dia. pipe culverts.

(4) Monitor seepage at the toe of the downstream face of the stone wall to the left of the low level outlet structure on a six month basis to ascertain any changes in clarity or quantity of flow.

(5) Develop an "Emergency Action Plan" that will include an effective pre-planned downstream warning system, locations of emergency equipment, materials and manpower, authorities to contact and potential areas that require evacuation. The plan will also include round-the-clock monitoring of the project during periods of heavy precipitation.

(6) Clean and repaint the footbridge.

(7) Continue to conduct annual technical inspections of the dam and its appurtenant structures.

(8) Implement a regular periodic maintenance program.

7.4 Alternatives

There are no feasible alternatives to the above recommendations.

Appendix A
Inspection Checklist

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT WHITIN RESERVOIR DAM DATE 15 April and 20 May 1980
20 May: 9:00 AM
OWNER Mumford River Reservoir Association TIME 15 April: 9:30 AM
20 May: Clear, Warm
WEATHER 15 April: Clear, Mild
W.S. ELEV. 595.7 U.S. NA DN.S.

INSPECTION PARTY

A/E REPRESENTATIVES

1. Peter B. Dyson
2. Pasquale E. Corsetti
3. Roger F. Berry
4. Carl J. Hoffman
5. William Z. Zoino

OWNER'S REPRESENTATIVES

1. Joseph Rosol
2. Carl Feraco
3. Delwyn K. Barnes
4.
5.

PROJECT FEATURE

INSPECTED BY

REMARKS

- | | | |
|---------------------------------|-----------------------------|------------|
| 1. <u>Hydrologic</u> | <u>Roger F. Berry</u> | <u>LBA</u> |
| 2. <u>Hydraulics/Structures</u> | <u>Carl J. Hoffman</u> | <u>LBA</u> |
| 3. <u>Soils and Geology</u> | <u>William S. Zoino</u> | <u>GZA</u> |
| 4. <u>General Features</u> | <u>Peter B. Dyson</u> | <u>LBA</u> |
| 5. <u>General Features</u> | <u>Pasquale E. Corsetti</u> | <u>LBA</u> |
| 6. <u></u> | <u></u> | <u></u> |
| 7. <u></u> | <u></u> | <u></u> |
| 8. <u></u> | <u></u> | <u></u> |
| 9. <u></u> | <u></u> | <u></u> |
| 10. <u></u> | <u></u> | <u></u> |

LBA - Louis Berger & Associates, Inc.
GZA - Goldberg-Zoino & Associates, Inc.

PERIODIC INSPECTION CHECKLIST

PROJECT WHITIN RESERVOIR DAM DATE 20 May 1980

PROJECT FEATURE Stonewall Dam NAME

DISCIPLINE Soils/Geology NAME William S. Zoino

AREA EVALUATED CONDITIONS

DAM EMBANKMENT

Crest Elevation	599.5
Current Pool Elevation	595.7
Maximum Impoundment to Date	Unknown
Surface Cracks	Numerous minor cracks in paved roadway surface.
Pavement Condition	Fair
Movement or Settlement of Crest	None, but somewhat irregular across crest
Lateral Movement	None
Vertical Alginment	Good
Horizontal Alignment	Curved, but visually appears good.
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	Missing stones in U/S parapet 20 ft. left of low level outlet
Trespassing on Slopes	None
Sloughing or Erosion of Slopes or Abutments	None
Rock Slope Protection - Riprap Failures	None
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	2 seepage spots at base of D/S wall: one 20 ft. left of low level outlet issuing about 2 gpm; one 2 ft. left of low level outlet
Piping or Boils	None
Foundation Drainage Features	None evident
Toe Drains	None evident
Instrumentation System	None evident

PERIODIC INSPECTION CHECKLIST

PROJECT WHITIN RESERVOIR DAM DATE 15 April 1980

PROJECT FEATURE Outlet Control Tower NAME

DISCIPLINE Hydraulics/Structures NAME Carl J. Hoffman

AREA EVALUATED	CONDITIONS
<u>OUTLET WORKS - CONTROL TOWER</u>	

a. Concrete and Structural	Structural Steel Tower
----------------------------	------------------------

General Condition	Good
Condition of Joints	N/A
Spalling	N/A
Visible Reinforcing	N/A
Rusting or Staining of Concrete	N/A
Any Seepage or Efflorescence	N/A
Joint Alignment	N/A
Unusual Seepage or Leaks in Gate Chamber	Unknown
Cracks	N/A
Rusting or Corrosion of Steel	Minor

b. Mechanical and Electrical	None
------------------------------	------

Air Vents	N/A
Float Wells	N/A
Crane Hoist	N/A
Elevator	N/A
Hydraulic System	N/A
Service Gates	N/A
Emergency Gates	N/A
Lighting Protection System	N/A
Emergency Power System	N/A
Wiring and Lighting System in Gate Chamber	N/A

PERIODIC INSPECTION CHECKLIST

PROJECT WHITIN RESERVOIR DAM DATE 15 April 1980

PROJECT FEATURE Outlet Conduit NAME

DISCIPLINE Hydraulics/Structures NAME Carl J. Hoffman

AREA EVALUATED	CONDITIONS
----------------	------------

OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL

General Condition of Concrete	N/A - See note below.
Rust or Staining	N/A
Spalling	N/A
Erosion or Cavitation	N/A
Visible Reinforcing	N/A
Any Seepage or Efflorescence	Not observed
Condition at Joints	Not observed
Drain Holes	Unknown
Channel	
Loose Rock or Trees Overhanging Channel	Yes
Condition of Discharge Channel	Good

Note: Outlet conduit is a stone box culvert which is not visible.

PERIODIC INSPECTION CHECKLIST

PROJECT WHITIN RESERVOIR DAM DATE 15 April 1980

PROJECT FEATURE Spillway NAME

DISCIPLINE Hydraulics/Structures NAME Carl J. Hoffman

AREA EVALUATED	CONDITIONS
----------------	------------

OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS

a. Approach Channel

General Condition	Fair
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Vegetation growing

b. Weir and Training Walls

General Condition of Concrete	Good
Rust or Staining	None
Spalling	None
Any Visible Reinforcing	None
Any Seepage or Efflorescence	No
Drain Holes	N/A

c. Discharge Channel

General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Yes
Floor of Channel	Ledge
Other Obstructions	None

PERIODIC INSPECTION CHECKLIST

PROJECT WHITIN RESERVOIR DAM DATE 15 April 1980

PROJECT FEATURE Spillway Bridge NAME _____

DISCIPLINE Structures NAME Carl J. Hoffman

AREA EVALUATED	CONDITIONS
----------------	------------

OUTLET WORKS - SERVICE BRIDGE

a. Superstructure

Bearings	Good
Anchor Bolts	Good
Bridge Seat	Good
Longitudinal Members	Good
Underside of Deck	Good
Secondary Bracing	N/A
Deck	Good
Drainage System	N/A
Railings	Good
Expansion Joints	N/A
Paint	Fair

b. Abutment & Piers

General Condition of Concrete	Good
Alignment of Abutment	Good
Approach to Bridge	Good
Condition of Seat and Backwall	N/A

PERIODIC INSPECTION CHECKLIST

PROJECT: WHITIN RESERVOIR DAM

DATE: 15 April 1980

AREA EVALUATED

CONDITIONS

DIKE EMBANKMENT

N/A

OUTLET WORKS - INTAKE CHANNEL
AND INTAKE STRUCTURE

N/A

OUTLET WORKS - TRANSITION & CONDUIT

N/A

Appendix B
Engineering Data

TOWN OR CITY **Douglas**

LOCATION **3 m. west of E. Douglas - Wallis Pond Reservoir**

DECREE NO.

PLAN NO. **13-01**

DAM NO. **13-01**

DESCRIPTION OF DAM

Type **Hy Emb - 1/2:1 down & 1/2:1 riprap upstream dry wall**

Length **500**

Height **32**

Thickness top **36**

" bottom **60**

Downstream Slope **1/2:1 dry wall**

Upstream " **1/2:1 Riprap**

Length of Spillway **El. crest = 96.0**

Size of Gates **4x4**

Location of Gates **180 from No. End Dam**

Flashboards used **Yes**

Width Flashboards or Gates **El. 100**

Dam designed by **4**

" constructed by

Year constructed

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream **Mumford River**

" " any other Streams

Length of Watershed

Width "

Is Watershed Cultivated

Percent in Forests

Steepness of Slope

Kind of Soil

No. of Acres in Watershed **8.80 sq. M**

" " " Reservoir **C. R. Cap = 180,000,000 gal. 250**

Length of Reservoir

Width "

Max Flow Cu. Ft. per Sec.

Head or Flashboards-Low Water

" " " High "

GENERAL REMARKS

Owned by the Mumford River Reservoir Assoc.

Write Whitin Machine Works Whitinsville.

Inspected: Sept. 15, 1924 - L.O. Marden

Aug 1, 1928

June 11, 1931

Oct. 5, 1933

March 30, 1937 - K.M.F. Willard - Burrap.

May 17, 1939 - L.H.S. & M.F.H.

Oct. 25, 1938 - L.H.S.

GENERAL REMARKS

March 17, 1939 - J.B. Tytula - J.C. Powers

Inspected: July 13, 1943 - L.O.M

Sept. 9, 1944

12-11-45 - K.M.F.

5-15-47 - L.O.M.

11-18-46 " R.K. Barnes

JAN 1953 CH. SPOFFORD & PELICERT BARNES

11-21-51 - L.H.S.

Douglas

DAM NO. 13-07

Willis Pond Reservoir

STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Mumford River Reservoir Asscn write
by Whitin Machine Works PLACE Whitinsville USE storage

ED BY L.O. Marden DATE May 15, 1947

DAM High earthen hy emb. stone supporting CONDITION good
walls, stone spillway

WAY

ASHBOARDS IN PLACE yes RECENT REPAIRS none

CONDITION good

REPAIRS NEEDED none

WINKMENT

RECENT REPAIRS none

CONDITION good

REPAIRS NEEDED none

S

RECENT REPAIRS none

CONDITION good

REPAIRS NEEDED none

S

HOW SERIOUS none visible

DATE May 15, 1947

L.O. Marden
COUNTY ENGINEER

Douglas

DAM NO. 13-07

IN Douglas

STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

BY Mumford River, Res. Assoc. PLACE Whitinsville USE storage

TESTED BY LOM-D.K.Barnes DATE Nov. 18, 1946

OF DAM CONDITION

LOWAY

DASHBOARDS IN PLACE RECENT REPAIRS

CONDITION OK

REPAIRS NEEDED

ANKMENT

RECENT REPAIRS

CONDITION OK

REPAIRS NEEDED

ES

RECENT REPAIRS

CONDITION OK

REPAIRS NEEDED

ES

HOW SERIOUS none visible.

DATE Nov. 18, 1946

COUNTY ENGINEER

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by R.M.F. Date 12-11-45 Dam No. 13-07

Owner Douglas Location Willis Pond

Operator John M. M. Use Storage

Material and Type

Designed by Constructed by

SPILLWAY

Top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Flashboards carried Kind Flashboards

Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Foundation under Spillway

Condition On pond 6' ± below flow line

EMBANKMENT

Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Top of Corewall Riprap

Material in Embankment Foundation

Condition On

GATES

Kind El. Flowline

Condition On

HEEL On Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure

Recent Repairs and Date

Topography of Country below Dam

Structure of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

B-15

WORCESTER COUNTY ENGINEERING DEPT.

WORCESTER, MASS.

DATE

9-12-44

SUBJECT:

Dam No. 13-07 - Douglas - Willis Pond Res.

This high earthen embankment Highway dam
with up and downstream dry breast walls in good
condition.

AS USED

AS MILEAGE

END TRIP

BEGIN TRIP

TRIP MILES

S. O. Marden

SIGNATURE

B-14

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by R. H. Spofford Date Dec 15 / 40 Dam No. 13-07

Town Douglas Location Willis Pond

Owner Wm. Wash Co Use Impounding

Material and Type

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried None Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition Good

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition

GATES 1 Location Embankment

Size Kind El. Flowline

Condition Good - open about 5" and taking entire flow -
at about 5' below crest of spillway

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure None

Recent Repairs and Date None

Topography of Country below Dam

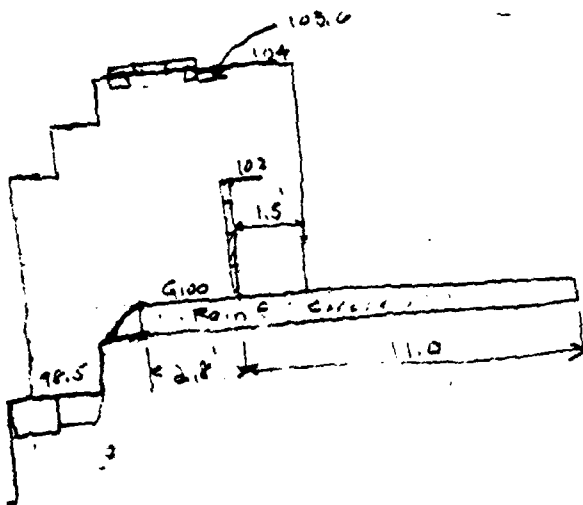
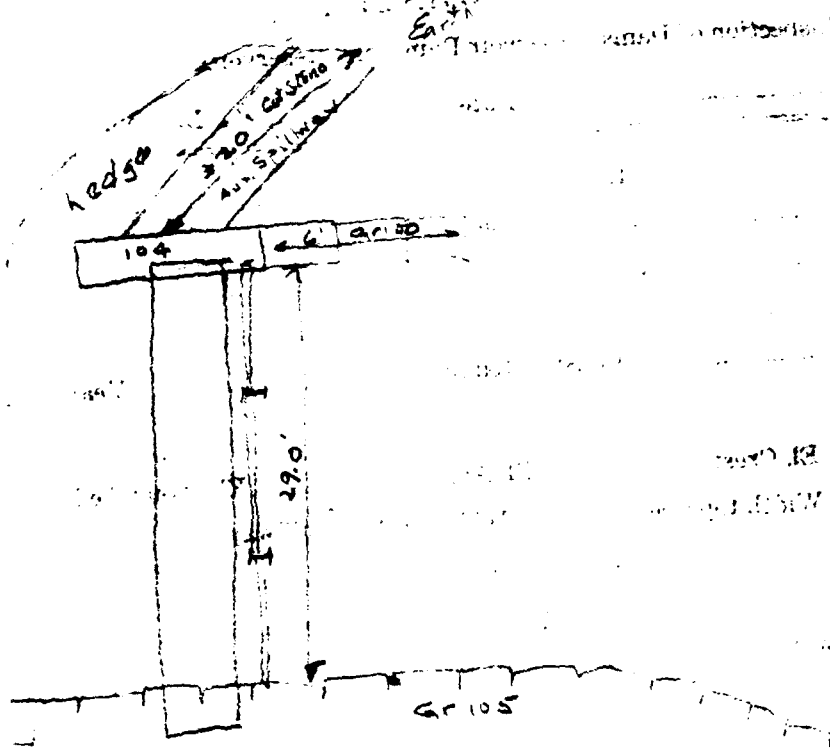
Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

PLAN OF EMBANKMENT AT GATE 73



Drawoff from lead sewer
operated gate in center of
embankment.
2' x 2' stone box
Invert = Gr 73

COUNTY OF WORCESTER MASSACHUSETTS
COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by LHS + MTH Date 5/17/39 Dam No. 13-07

Town Douglas Location Willis Pond
Owner _____ Use _____

Material and Type _____

Dam Designed by _____ Constructed by _____ Year _____

SPILLWAY

El. top Abutment _____ El. Crest _____ El. Apron _____ El. Streambed _____

Width top Abutment _____ Width top Crest _____ Width bottom Spillway _____

Width Flashboards carried _____ Kind Flashboards _____

El. Flowline Cleanout Pipe _____ Size and Kind Cleanout Pipe _____

Kind of Foundation under Spillway _____

Condition Good

EMBANKMENT

El. Top _____ El. Natural Ground _____ Width Top _____

Width of Bottom _____ Upstream Slope _____ Downstream Slope _____

Kind of Corewall _____ Riprap _____

Material in Embankment _____ Foundation _____

Condition Good

GATES _____ Location _____

Size _____ Kind _____ El. Flowline _____

Condition Good

WHEEL _____ Kind _____ Size _____ Rated H. P. _____

Location _____ Ave. Head _____

Evidence of Leaks in Structure None

Recent Repairs and Date _____

Topography of Country below Dam _____

Nature of Buildings and Roads below Dam _____

Number Acres in Pond _____ Drainage Area in Square Miles _____

Discharge in Second Feet per Square Mile _____

Estimated Storage Million Cubic Feet _____

WORCESTER COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs

Inspected by L. C. P. H. H. T. Date 3/11/39 Dam No. 12-27

Owner Douglas Location Willis Pond

Owner Whitin Machine Works Use Reservoir

SPILLWAY

El. top abutment _____ El. Crest _____ El. Apron _____ El. St. Bed _____

Width top Abut. _____ Width top Crest _____ Width bottom Sp. way _____

Width flashboards _____ Kind Flashboards _____

1. Flowline Cleanout Pipe _____ Size and Kind Pipe _____

Kind of Foundation under Spillway _____

Condition Water level below crest

EMBANKMENT

El. Top _____ El. Natural Ground _____ Width Top _____

Width of Borrom _____ Upstream Slope _____ Downstream Slope _____

Kind of Corewall _____ Riprap _____

Material in Embankment _____ Foundation _____

Condition _____

GATES _____ Location _____

Size _____ Kind _____ El. Flowline _____

Condition _____

Evidence of Leaks in Structure _____

Recent Repairs and Date _____

Number Acres in Pond _____ Drainage Area in Sq. Miles _____

Discharge in Second Feet per Square Mile _____

Estimated Storage Million Cubic Feet _____

WORCESTER COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs

Inspected by L. H. Spofford Date Oct. 23, 1938 Dam No. 13-07

Town Douglas Location Willis Pond Reservoir

Owner Whitin Machine Works Use Impounding

Cone apron 28' x 2' stone side walls.

SPILLWAY Also aux. spillway 24" higher than main spillway 20' long-stone

El. top Abutment _____ El. Crest _____ El. Apron _____ El. St. Bed _____ apron

Width top Abut. _____ Width top Crest _____ Width bottom Sp. way _____

Width flashboards ^{Provision for} 24" of boards Kind Flashboards in I beam guides

El. Flowline Cleanout Pipe _____ Size and Kind Pipe _____

Kind of Foundation under Spillway _____

Condition Excellent - no flashboards on this date - no evidence of any
trouble from September flood.

Earth about 30 ft. high - good drystone wall on downstream side

EMBANKMENT Highway on top - heavy riprap on upstream side

El. Top _____ El. Natural Ground _____ Width Top _____

Width of Bottom _____ Upstream Slope _____ Downstream Slope _____

Kind of Corewall _____ Riprap _____

Material in Embankment _____ Foundation _____

Condition Excellent - no damage whatever

GATES 1 large flood gate controlling entire flow on this date.
 Location _____

Size _____ Kind _____ El. Flowline _____

Condition Located in stone pier in center of embankment - pond side -
operated by means of large lead screw - well oiled and in good
operating condition.

Evidence of Leaks in Structure none

Recent Repairs and Date none

Number Acres in Pond _____ Drainage Area in Sq. Miles _____

Discharge in Second Feet per Square Mile _____

Estimated Storage Million Cubic Feet _____

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by KmF. Willard Burnap Date 3-30-37 Dam No. 13-07

Town Douglas Location Willis Pond Reservoir

Owner _____ Use _____

Material and Type _____

Dam Designed by _____ Constructed by _____ Year _____

SPILLWAY—Length _____ Feet. Depth _____ Feet

El. top Abutment _____ El. Crest _____ El. Apron _____ El. Streambed _____

Width top Abutment _____ Width top Crest _____ Width bottom Spillway _____

Width Flashboards carried _____ Kind Flashboards _____

El. Flowline Cleanout Pipe _____ Size and Kind Cleanout Pipe _____

Kind of Foundation under Spillway _____

Condition OK, floor of spillway has been paved with concrete.

EMBANKMENT—Length overall _____ Feet

El. Top _____ El. Natural Ground _____ Width Top _____

Width of Bottom _____ Upstream Slope _____ Downstream Slope _____

Kind of Corewall _____ Riprap _____

Material in Embankment _____ Foundation _____

Condition OK

GATES _____ Location _____

Size _____ Kind _____ El. Flowline _____

Condition OK

WHEEL _____ Kind _____ Size _____ Rated H. P. _____

Location _____ Ave. Head _____

Evidence of Leaks in Structure _____

Recent Repairs and Date _____

Topography of Country below Dam _____

Nature of Buildings and Roads below Dam _____

Number of Acres in Pond _____ Drainage Area in Square Miles _____

Discharge in Second Feet per Square Mile _____

Estimated Storage Million Cubic Feet _____

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.O. Marden Date Oct. 5, 1933 Dam No. 13-07

Town Douglas Location Douglas Reservoir

Owner Whitin Machine Works Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY—Length Feet. Depth Feet

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition OK

EMBANKMENT—Length overall Feet

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition OK

GATES Location

Size Kind El. Flowline

Condition OK

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure None visible

Recent Repairs and Date None

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number of Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L. O. Marden - Burnap Date 6-11-31 Dam No. 13-07

Town Douglas Location Douglas Res.

Owner _____ Use _____

Material and Type High water acct 6 days rain-water was 6" over top
wood frame of gate.

Dam Designed by _____ Constructed by _____ Year _____

SPILLWAY—Length _____ Feet. Depth _____ Feet

El. top Abutment _____ El. Crest _____ El. Apron _____ El. Streambed _____

Width top Abutment _____ Width top Crest _____ Width bottom Spillway _____

Width Flashboards carried _____ Kind Flashboards _____

El. Flowline Cleanout Pipe _____ Size and Kind Cleanout Pipe _____

Kind of Foundation under Spillway _____

Condition cleaned out-O.K.

EMBANKMENT—Length overall _____ Feet

El. Top _____ El. Natural Ground _____ Width Top _____

Width of Bottom _____ Upstream Slope _____ Downstream Slope _____

Kind of Corewall _____ Riprap _____

Material in Embankment _____ Foundation _____

Condition O.K.

GATES _____ Location _____

Size _____ Kind _____ El. Flowline _____

Condition O.K.

WHEEL _____ Kind _____ Size _____ Rated H. P. _____

Location _____ Ave. Head _____

Evidence of Leaks in Structure small seepage one spot downstream wall.

Recent Repairs and Date _____

Topography of Country below Dam _____

Nature of Buildings and Roads below Dam _____

Number of Acres in Pond _____ Drainage Area in Square Miles _____

Discharge in Second Feet per Square Mile _____

Estimated Storage Million Cubic Feet _____

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.O.M. Date 8.1.28 Dam No. 13-07

Town Douglas Location 1 mi. W East Douglas.
 Owner Mumford River Res. Ass. Use
 Material and Type Highway Emb.

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed
 Width top Abutment Width top Crest Width bottom Spillway
 Width Flashboards carried Kind Flashboards 24" flashboard carried
pond high;
 El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe
 Kind of Foundation under Spillway
 Condition Flashboard Frame etc. painted recemented would suggest
taking off one row of flash boards. cut off brush in walls.

EMBANKMENT

El. Top El. Natural Ground Width Top
 Width of Bottom Upstream Slope Downstream Slope
 Kind of Corewall Riprap
 Material in Embankment Foundation
 Condition good. would suggest cutting off brush at downstream side emb.
so that ex mination can be made for leaks.

GATES Location
 Size Kind El. Flowline
 Condition good.

WHEEL Kind Size Rated H. P.
 Location Ave. Head
 Evidence of Leaks in Structure None that can be determined.

Recent Repairs and Date
 Topography of Country below Dam

Nature of Buildings and Roads below Dam Number Acres in Pond Drainage Area in Square Miles Discharge in Second Feet per Square Mile Estimated Storage Million Cubic Feet

Decree No.

Dam No. 13-07

**COUNTY OF WORCESTER, MASSACHUSETTS
OFFICE OF COUNTY ENGINEER**

Neg. Nos.

INSPECTION OF DAMS, RESERVOIR DAMS AND RESERVOIRS

Town Douglas Date Sept. 15, 1924 Dam No.

Location 3 ml. W. E. Douglas Name of Pond or Stream Mumford River

Inspected by L.O. Marden Willis Pond Reservoir

Owner Use Storage

MATERIAL & TYPE Earth about 1½:1 D.S. dry stone wall Hy. Emb.

Elevations in feet: above (+) or below (-) full pond or reservoir level.

FOR DAM Bed of stream below 32 from top wall top of spillway 96

FOR RESERVOIR

top of dam 102 top of flashboards 4'-0" using 10" flashboards ground surface below 28

level of overflow pipe length in feet 500'

width top in feet 36' width bottom in feet 60+- size pipe to mill

inches length spillway in feet 29+30' head in feet additional 10' span

Size of wheel none H. P. developed

Size of gates 4x4 opening location of gates 180' from N. end

Foundation and details of construction Both sides mortared granite wall

earth fill used as highway condition of embankment good

Constructed by date

Designed by location

Recent repairs and date

Evidence of leakage none

Condition good

Topography of country below wooded

Nature of buildings and roads below dam none possible 3 or 4 farm houses

No. Acres in watershed No. Acres in pond

Plans secured Percent watershed in cultivation

Percent in forests Note: Cross out word not applicable

road on top 1:1 slope downstream
1½:1 slope riprap upstream

TOWN Douglas

DAM NO. 13-07

LOCATION Wills Pond Res

STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT

WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY _____ PLACE _____ USE Flood control

INSPECTED BY H Spofford DATE 11/21/51

TYPE OF DAM _____ CONDITION _____

SPILLWAY

FLASHBOARDS IN PLACE None RECENT REPAIRS None

CONDITION Good

REPAIRS NEEDED None

Gate $\frac{2}{3}$ open and entire
flow going thru at this time

EMBANKMENT

RECENT REPAIRS None

CONDITION Good

REPAIRS NEEDED None

GATES

RECENT REPAIRS _____

CONDITION Good

REPAIRS NEEDED _____

LEAKS

HOW SERIOUS _____

DATE _____

COUNTY ENGINEER

TOWN Douglas
LOCATION Wells River

DAM NO. 13-07

STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY Whitehead Co PLACE USE Drainage
INSPECTED BY Lt Spafford & Mr Barnes 11/8/53
TYPE OF DAM Earth Dam - Stone Breast Wall CONDITION

SPILLWAY

FLASHBOARDS IN PLACE None RECENT REPAIRS None
CONDITION Good
REPAIRS NEEDED None

EMBANKMENT

RECENT REPAIRS None
CONDITION Good - Recent repairs at draw off gate - concrete laid on apron
REPAIRS NEEDED

GATES

RECENT REPAIRS None
CONDITION Good (Leak sound)
REPAIRS NEEDED None

LEAKS

old leak pretty much stopped by application of concrete to top rap on panel side
HOW SERIOUS

DATE

COUNTY ENGINEER

TOWN Douglas

DAM NO. 13-07

LOCATION Walls Pond or Whitten Reservoir

STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY Mumford River Res. Assn. PLACE Whittamere USE Impounding

INSPECTED BY H. Spafford DATE 11/8/54

TYPE OF DAM _____ CONDITION _____

SPILLWAY

FLASHBOARDS IN PLACE ± 2 ft RECENT REPAIRS _____

CONDITION Good - some boards washed out - these boards ought to

REPAIRS NEEDED be all taken off this fall - pond is now going around

end of stone spillway & cutting new channel down thru the woods

EMBANKMENT

RECENT REPAIRS _____

CONDITION Good

REPAIRS NEEDED _____

GATES Lead Screw Type

RECENT REPAIRS _____

CONDITION Good - about half open on 7-22-54

REPAIRS NEEDED _____

LEAKS

HOW SERIOUS _____

DATE _____

COUNTY ENGINEER _____

TOWN Douglas
LOCATION Willis Reservoir

DAM NO. 13-07
STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY _____ PLACE _____ USE _____
INSPECTED BY L.H. Spafford DATE 8/24/55
TYPE OF DAM _____ CONDITION _____

SPILLWAY

FLASHBOARDS IN PLACE ±12" RECENT REPAIRS _____
CONDITION Good - water now going over storm spillway
REPAIRS NEEDED everything O.K.

EMBANKMENT

RECENT REPAIRS _____
CONDITION Good - not stopped by flood
REPAIRS NEEDED _____

GATES

RECENT REPAIRS _____
CONDITION Good - about half open this date
REPAIRS NEEDED _____

LEAKS

HOW SERIOUS _____

DATE _____

COUNTY ENGINEER

TOWN Douglas DAM NO. 13-07

LOCATION Whitin - or Willis or STREAM Trib Mummer River
Mumford Res

Lake Good Map
called "Wallis Res" WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

D A M I N S P E C T I O N R E P O R T

Owned by Mumford River Res Co Place Whitinsville Use _____

Inspected by P. B. Walker - D. Barner Date Oct. 6, 1961

Type of Dam _____ Condition _____
W. side Rd at spillway - New Bridge after '55 flood

SPILLWAY 4 - 36" r.c. pipe.

Flashboards in Place yes - downstream Recent Repairs _____

Condition _____

Repairs Needed To replace or
remove structure and construct self failing
Flash bdr - 2 Feet high -

EMBANKMENT

Recent Repairs _____

Condition _____

Repairs Needed _____

GATES

Recent Repairs None

Condition Have Maintained Structure

Repairs Needed None - Have done greasing around the gate
Structure.

LEAKS

How Serious _____

DATE: Oct. 6, 1961 F. O. Marden County Engineer

TOWN Douglas DAM NO. 13-07
LOCATION Willis Pond Res STREAM _____
"Whitins Res"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

D A M I N S P E C T I O N R E P O R T

Owned by Mumford Res. Co. owner Place Douglas Use _____
Inspected by L.O.M. Don Barnes ^{Whitins Works - one of owner} Date April 5, 1962
Type of Dam _____ Condition _____

SPILLWAY

Flashboards in Place 19" x 20" Bds Recent Repairs _____
Condition New Catwalk - structural Steel - 12" C - 25
Repairs Needed Failing type Pins

EMBANKMENT

Recent Repairs Hy Emb
Condition Good
Repairs Needed OK

GATES

Recent Repairs 1961 - + 1962
Condition Good - New Cycloar Fence
Repairs Needed None

LEAKS

How Serious Some seepage No. side spill

DATE: 4-4-1962 L.O.M. Don Barnes County Engineer

TOWN Douglas DAM NO. 13-07
LOCATION On Northwest Main St STREAM Branch - Mumford River

Wallis Reservoir
WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

D A M I N S P E C T I O N R E P O R T

Owned by Mumford River Reservoir Assn. Place Douglas Use Storage reservoir
Inspected by WOL Date June 6, 1963
Type of Dam Highway Embankment Condition Good

SPILLWAY

Flashboards in Place 2' of pin boards Recent Repairs _____
Condition Good
Repairs Needed _____

EMBANKMENT

Recent Repairs _____
Condition Good
Repairs Needed _____

GATES

Recent Repairs _____
Condition Good
Repairs Needed _____

LEAKS

How Serious There is a small leak at the gate

DATE: _____ County Engineer

Dam 13-07

7/22

10 6, 1963 WOL.

ay - This 30' (4) long, stepped granite stone spillway, is located 25' below the small bridge on Northwest Main St. This spillway ^{foundation} is on ledge. 4 @ 36" pipes have been added to the bridge at the roadway. This spillway has 24" of pin boards.

A new additional ^{spillway,} on ledge and natural ground has been ^{added} on the southerly end of the original spillway. This new overflow spillway is 20' long. The crest elevation is the same as the old spillway. This spillway has 2 boards @ 24" in height. The pins and pin boards have been recently renewed. The walkway and abutment walls are good.

ement - The highway embankment is good. The riprap on the upstream slope has been recently gunited with cement. The pins is full to the top of the pin boards. This dam is about 25' high.

- The gate looks ok. Some of the timbers are beginning to rot and should be replaced. There is a small leak at the 2' x 2' stone on gate outlet.

WN Douglas DAM NO. 13-07
CATION In North West Main St STREAM Branch - Mumford River

"Wallis Pond"
WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

D A M I N S P E C T I O N R E P O R T

ned by Mumford River Associates Place Whitinsville Use Storage reservoir
spected by FEP-WOL - Del Bernes Date Sept 2, 1968
pe of Dam Highway embankment Condition Good

WILLWAY

ashboards in Place _____ Recent Repairs _____
ondition Good
pairs Needed _____

BANKMENT

cent Repairs _____
ondition Good
pairs Needed The slope exists with some minor erosion

TES

cent Repairs _____
ondition Good Repaired work at this point in road
pairs Needed Being done by the owners

The earth is now good

AKS

w Serious No leaks are visible

TE: _____ County Engineer

WN Douglass DAM NO. 13-07

LOCATION Northwest Main St. STREAM Branch - Mumford River

"Wallis Reservoir"
WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

D A M I N S P E C T I O N R E P O R T

Mumford River Reservoir Assn.

Owned by Whiting Machine Works Place Whitingville Use Storage Reservoir

Inspected by W.O. - D. Barnes Date Aug. 19, 1965

Type of Dam Highway embankment Condition Good

BILLWAY

ashboards in Place _____ Recent Repairs _____

Condition Good

Repairs Needed _____

BANKMENT

Recent Repairs _____

Condition Good

Repairs Needed _____

DES

Recent Repairs _____

Condition Repairs were recent - done to the gate structure

Repairs Needed - new steel grating was installed

AKS

How Serious No leaks

Signature: _____ County Engineer

James Brown

B-27

1000 17th St.

Spring 1911

at by Whitin Machine Works - Whitin line.

at by "Del" Barnes - Mar 1912.

at by were not removed. The water was first 21" above the
level. Before the spring the water was 31" above the level of the spring.

ION REPORT & DATA FOR DAMS

Mumford River Res. Assn. 90 Whitin Machine Works
 Address: Main St., Whitinsville
 Name of Dam: Storage Reservoir

Location & Access: South of Birch St. - West St. Intersection
 on Northwest Main St.
 Location: Oxford 210 Lat. 42°04'45" Long. 71°45'30"
 Area: Sq. Mi.; Ponds: ac.; Res. @ dam:
 Number of D.A.s:

Dam No. 13-07

Town: Douglas

Stream: Mumford River

Pond: Mumford Reservoir

Date:

By:

CONDITION RATING

Structural:

Hydraulic:

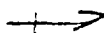
General:

PRIORITY:

Red
 Age
 Type

Description of Dam and Discharge Control: Earth Dam - Stone Wall
 Sides on N.W. Main St. Reservoir Face Gunite. Control by
 Gate

(Not to Scale):



ARDS
 Spillway

s and Recommendations:

1/2/71

By A.R.T.
 P.R.

Comment

The flash boards has been lower 1, making it safer. There is one portion on southerly of the spillway between the spillway and Douglas Road which have bulged and at present there seems to be no apparent leakage, but it might be advantageous to have this investigated and either install s or put fill behind this area to give the dam more body.

A third dam is located to the easterly side of Castle Hill Road and is a mite dam. Both this and the Power House Dam probably have some type of at least puddled clay, but there are no plans to my knowledge to show the construction. This latter dam we call the Whitin Estate Pond Dam. It is a dam which was on a former Whitin estate and backs up a small body of approximately 8' in depth. This dam has a gate structure which, to my knowledge, is never been used. It has an overflow and after the '55 flood had a scroflow installed wider than the original and 3" higher than the normal to function only in case of flood. This dam has no value to the plant in an aesthetic value. Since the company turned over the larger body of stream known as Riley's Pond, it is of no value to the plant operation.

A fourth dam known as Lackey Dam is owned by " and wood log dam with granite block side- operated with rack and pinion carries two permanent " s was rebuilt in " re in su " end up

any. It is an old end and a dual gate spillway is 66' and spillway. The gate od. The log timber to a major repair the dam was re-blanket of clay. irons and flash-settling -

over the to cut de pports an the log ci f level at e triple st clude any d f water appr

ue for the plant operation except the fact the gate can be f you need wa in a hurry. (I should have mentioned that since the Mille Water Company built the dam at the point where the Meadow Pond and River join, that the body of water behind the Power House Dam is cut down considerably and is about 12' deep at the dam.) Each gate is approximately in the waste gate structure in Lackey Dam.

ure end is about is planning to re- ver. I don't know if their probably not. This dam backs up

WHITIN RESERVOIR
The next dam that the company is involved in is on the head waters of the River known as the Mumford River Reservoir. This dam is a granite block granite block walls for guard rails on top, as the dam is crossed by the hwy. This dam also has a bridge under the highway between the lake side dam and the spillway. The spillway is approximately 36' in width, carry- f removable flash boards. This flash board structure was just rebuilt in t also has an unrestricted spillway without flash boards which is approxi- he same width and height. Both spillways overflow the water onto a ledge which runs all the way to the discharge stream below the dam. The has a gate structure in the center with a 2' square gate operated on a screw with a large nut. This structure, formerly of wood, was all re- with steel after the '55 flood. The bridge seemed to be a bottleneck he '55 flood so three large concrete culverts were installed through way southerly of the bridge. This dam is owned by the Mumford River r Company of which the company's share is 10/16. The dam and some land e dam and along the discharge brook and some land adjacent to the Reservoir

EXCERPT OF LETTER
From DELWYN BARNES
TO JOSEPH ROSOL

end of the Reservoir are owned, I believe, by ATF/Davidson. Any dimension than what I have given you, with the exception of the depth of water at full pond, I would have to obtain for you. The Mumford River as a causeway which cuts the Reservoir roughly in half. This causeway study, was proven to belong to the town and at that time the raised the culvert which joins the two bodies together and installed road rails on the culvert. The town maintains the roadways on the dam causeway. The dam has been fenced on the down stream face with a fence and the gate structure and overflow structure have also been

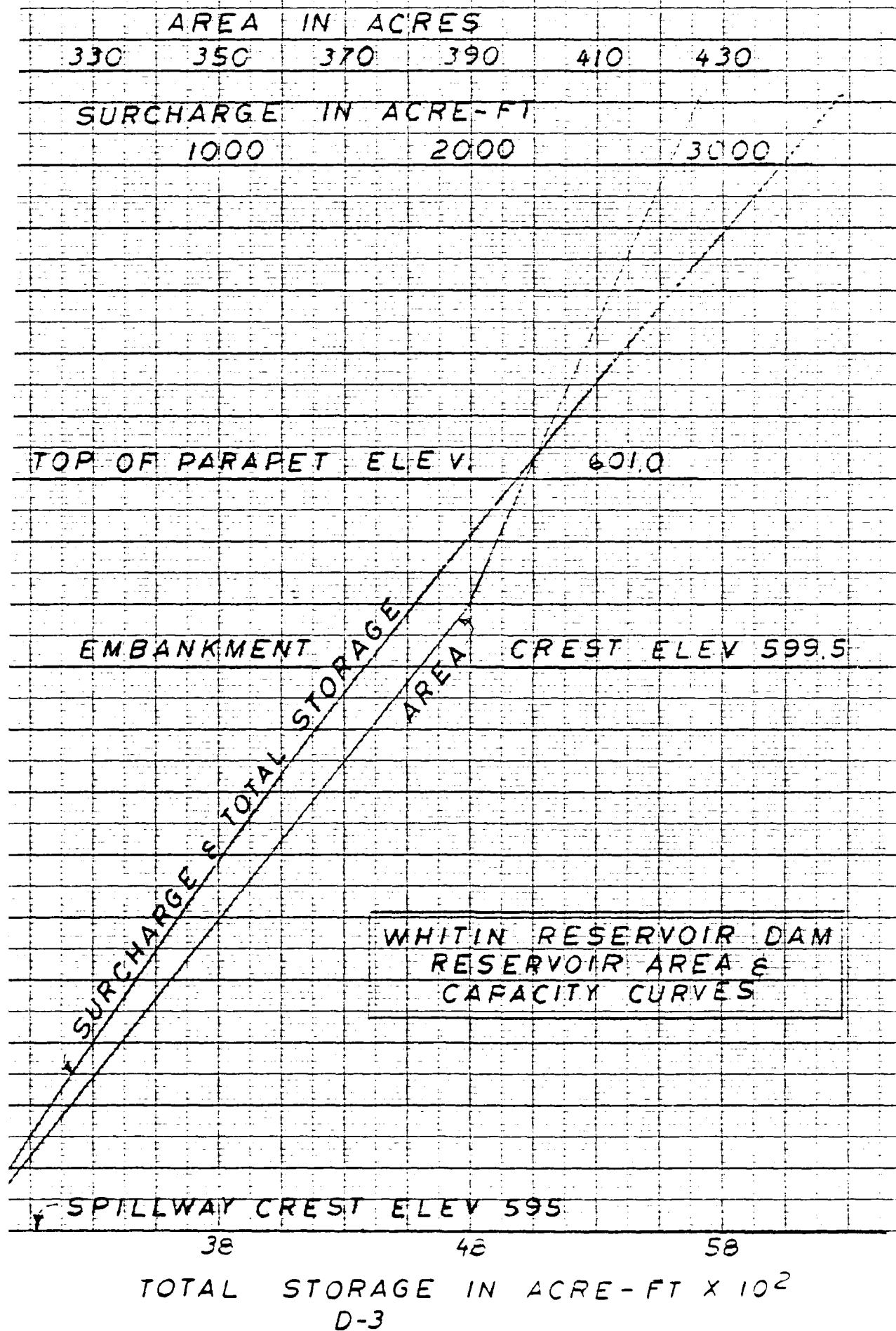
last and final dam is the Manchaug Reservoir Corporation Dam which is made up of two mills - ATF/Davidson owning 5/6. The Manchaug Reservoir is one block dam as Mumford, and has a gate structure with a 2' square same type of operation with a vertical screw and nut. The spillway is at the top of the dam and has removable flash boards. The spillway is 10' high and is practically 10' high and carries flash boards 40" high. This dam originally had granite block guard rails, but after the '55 flood the Massachusetts Department of Public Works, Division of Waterways, made a study of the dam which is just down stream from the Manchaug Dam and was damaged by the flood. They decided to spend considerable money on the Manchaug Reservoir so that it would act as a flood control dam and would thus protect the Mumford Dam instead of spending a large amount of money on the Stevens Pond Dam which near as beneficial results. To do this they raised the dam's height and reinforced the dam by adding a long slop embankment to the back side. The town highway also crosses this dam. At the same time, the State raised the spillway and the bridge over the spillway and carried the spillway to the back toe of the dam and covered this spillway to this point where it enters into the stream. This is the same stream which the gate structure discharges. The gate structure and the spillway structure have also been changed and fenced in by the Reservoir Company. The front face of the dam the original granite block wall is rip rap. The highway crossing the dam is owned by the town and has concrete and cable guard rails - also owned by the town.

Low Ring Shop Dam, the Power House Dam and the Whittin Estate Pond Dam are located in the Town of Northbridge. Lackey Dam and Manchaug Dam are in the Town of Sutton and the Mumford River Reservoir Dam is located in Douglas. Portions of Lackey Pond are in Sutton and Northbridge and portions of Manchaug Pond are in Sutton and Douglas. Portions of the Mumford River Dam are up by the Power House Dam are in Northbridge and Sutton. The other portions are in Northbridge.

Dams have been well maintained yearly, keeping all brush and grass away from the dam, doing all necessary pointing and masonry, repairing structures, etc. The annual inspection used to be done by the Worcester County.

It is now handled by the State of Massachusetts. We have always depended on the maintenance of all these dams. They were viewed in 1974 by Mr. Les McLean of the Travellers' Insurance Company. He was again in 1977. The dams are now supervised and regulated by the New England Water Company who inspects and maintains the structures on an annual basis with visits to the dams as necessary, depending on weather conditions. Sometimes during critical periods these inspections are oftener than once.

Manchaug Dam was built in 1836 and revamped in 1960 and the Mumford River Dam was built in 1854. The Lackey Dam, I imagine, was built around the time of



DATE 6-6-60 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. _____ OF _____
 PROJECT INSULATION OF TANK
 TANK NO. 235 TANK TYPE STORAGE

Normal Storage: $H = 525 - 300 = 225$

$$Vol = \frac{1}{3} HA = \frac{1}{3} (235) (315) = 2400 \text{ A-F}$$

FROM OLD INVENTORY SHEET Vol = 2200 A-F

$$\text{Say Normal Storage} = 2200 \text{ A-F}$$

LEV.	AREA ACRES	Avg AREA	ΔH FT	Δ VOL	Total Volume	Storage Volume
595	315				2200	
596	331.6	323.3	1	323	3123	323
597	348.2	339.9	1	340	3462	662
598	364.8	356.5	1	357	3820	1019
599	381.4	373.1	1	373	4192	1392
600	398	389.7	1	390	4582	1782
601	406	400	1	402	4984	2184
602	414	410	1	410	5395	2595
603	422	418	1	418	5813	3013
604	430	426	1	426	6239	3439
605	438	434	1	434	6673	3873

DATE 3-15-80 LOUIS BERGER & ASSOCIATES INC.
 BY INSPECTOR DATE 3-15-80
 CT NEW YORK H & H

SHEET NO. 1 OF 1
 PROJECT 1-75

FILL AREA: MAX 22.5 1' 24 000

AREA #1	READ #2	20.76	READ #3	123.26	AVE = 30.515
"	#1	58.33	"	90.76	
		30.53		30.70	

AREA #2	READ #2	69.74	READ #3	49.45	AVE = 29.707
"	#1	40.00	"	69.74	
		29.74		29.71	

DRAIN AREA = 62.24 (1435) = 3.93 ACRES = 3716 A.

Retention Area Elev 595

READ #2	29.00	READ #3	32.43		
"	#1	25.57	"	#2	29.00
		3.43			3.43

Retention Area = 3.43 (91.33) = 3.5 ACRES

Area Elev 600

READ #2	36.65	READ #3	40.96		
"	#1	32.35	"	#2	36.65
		4.33			4.31

Area Elev ⁶⁰⁰ = 4.33 (91.32) = 3.98 ACRES

Area Elev 610

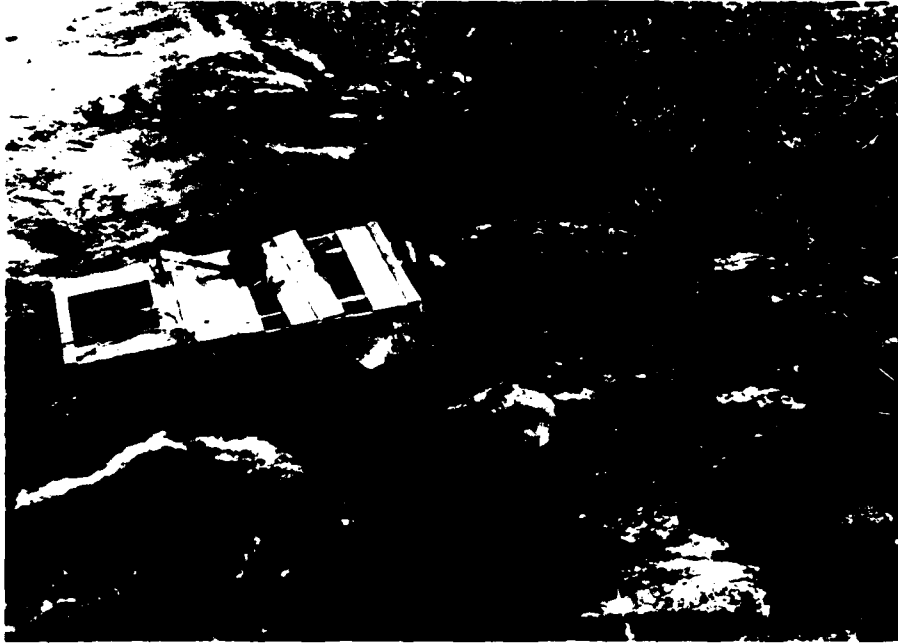
READ #2	46.57	READ #3	51.76		
"	#1	41.38	"	#2	46.57
		5.19			5.19

Area @ Elev 610 = 5.19 (91.32) = 4.77 ACRES

Appendix D

Hydrologic and Hydraulic Computations

WHITIN RESERVOIR DAM



13. Downstream spillway discharge channel

WHITIN RESERVOIR DAM



11. Roadway bridge over spillway approach channel



12. Footbridge over spillway crest

WHITIN RESERVOIR DAM



9. Gate structure on upstream face of dam



10. Low level outlet
at base of downstream
face of dam.

WHITIN RESERVOIR DAM



7. Seepage at base of downstream rubble masonry wall about 20 ft. left of the low level outlet



8. Seepage at base of downstream rubble masonry wall about 2 ft. left of the low level outlet

WHITIN RESERVOIR DAM



5. Downstream rubble masonry face



6. Downstream rubble masonry face

WHITIN RESERVOIR DAM



3. View along crest of dam



4. Crest of dam and downstream face

WHITIN RESERVOIR DAM



1. Upstream face of dam



2. Stone riprap on upstream slope of dam
(photo taken by others)

LOUIS BERGER & ASSOC., INC.
WELLESLEY, MASS.
ARCHITECT-ENGINEER

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

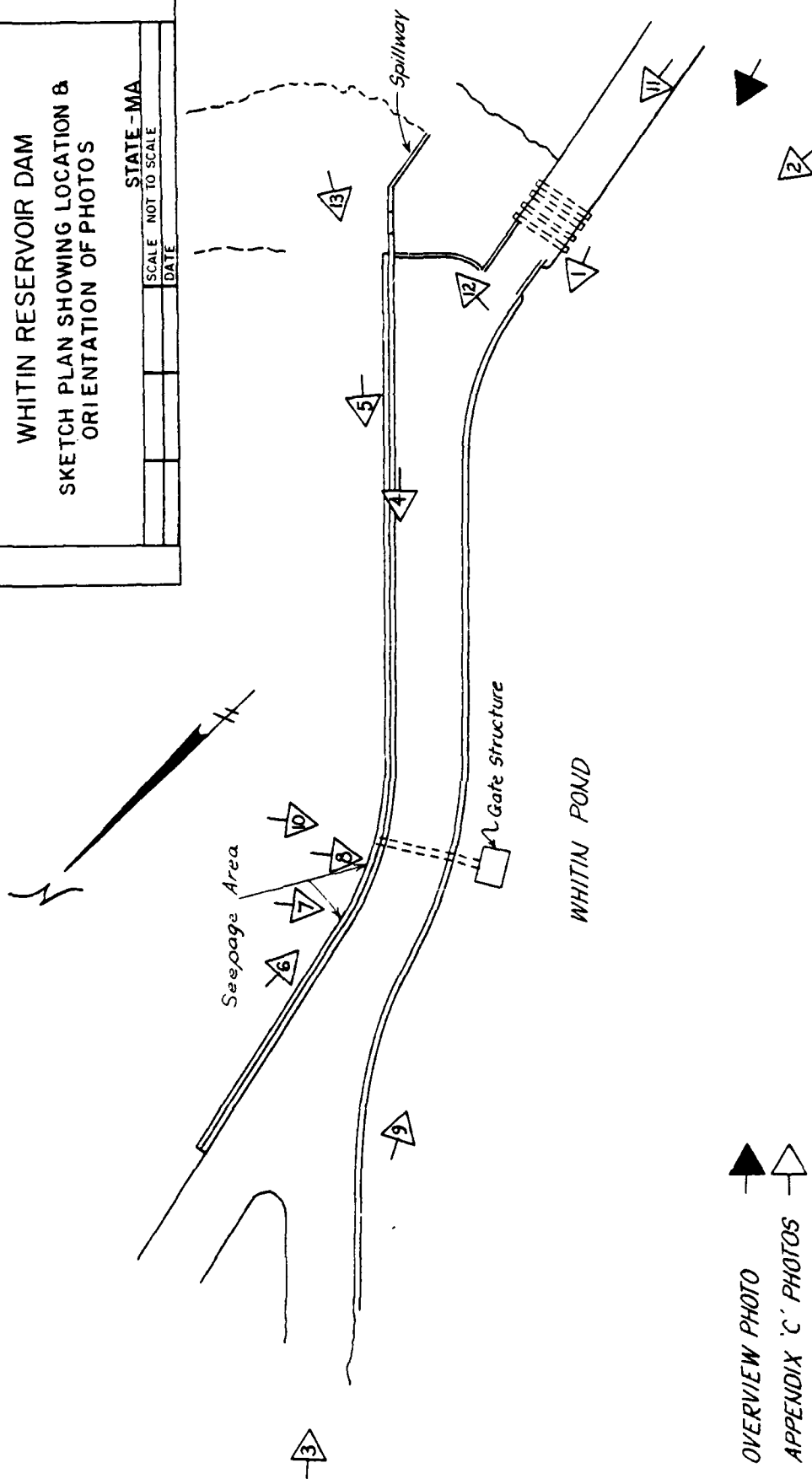
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

WHITIN RESERVOIR DAM

SKETCH PLAN SHOWING LOCATION &
ORIENTATION OF PHOTOS

STATE - MA

SCALE NOT TO SCALE
DATE



OVERVIEW PHOTO
APPENDIX 'C' PHOTOS

Appendix C

Photographs

Mr. Joseph H. Rosol

h.

the Power House Dam. These dams have gone through several critical floods, particularly the flood of 1955 when we had 13.69 inches of rain basically over a three-day period with 10 inches coming in one day.

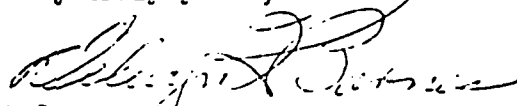
These structures that are not enclosed in the plant area, are all posted for trespassing, and we have very good cooperation with the police forces in the three towns and have very few problems with vandalism.

The Mumford and Manchaug Dams (as well as the Carpenter Reservoir Dam which was a power dam and sold to the Whitinsville Water Company) were built to store water to make sure that the different companies owning shares would have a constant supply of water to operate throughout the year. The amount of water to be drawn was all restricted. This practice is still followed, except that now that the mills are not as many and are not wholly dependent on water power and since there are more campers around the reservoirs, we try to favor the campers during camping season.

The land under the reservoirs was acquired for flowage rights and are not directly owned, but the dams and other areas mentioned are owned direct.

If there is any further information you might wish to have, I'll be glad to try to obtain it for you.

Very truly yours,



Delwyn H. Barnes
Vice President

DKB:upp

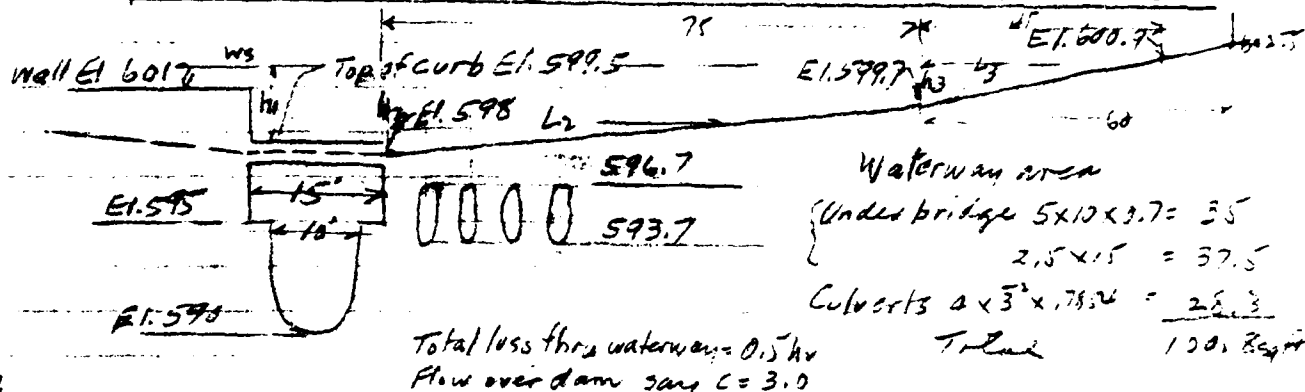
BY C54 DATE _____
 CHKD. BY _____ DATE _____
 SUBJECT WHITIN RESERVOIR DAM - SPILLWAY DISCHARGE CURVE

LOUIS BERGER & ASSOCIATES INC.

INSPECTION OF DAMS - MASS

SHEET NO. 1 OF 2
 PROJECT W-198

SPILLWAY DISCHARGE - CONTROL AT BRIDGE AND CULVERTS

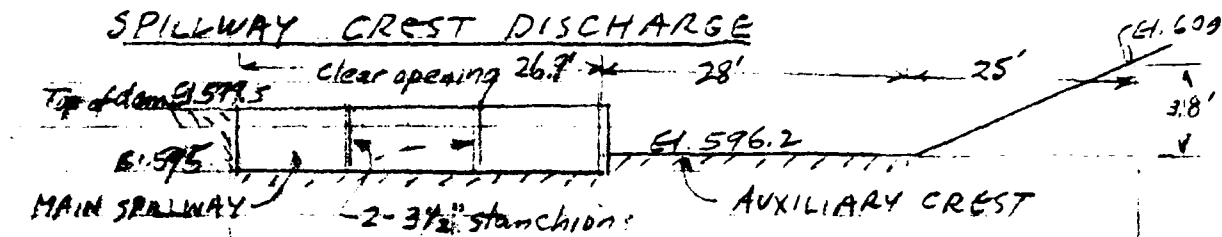


Trials

Q ₁	h ₁	h _v	1.5h _v	water Surf.	h ₂	q ₁	ΔQ, L=15	h ₂	q ₂	q ₃	q ₃	$\frac{q_2+q_3}{2}$	L ₂	ΔQ ₂	$\frac{q_2}{2}$	L ₃	ΔQ ₃	SQ
Downstr. W.S. El. 598.0 Total Q = 685 cfs																		
600	5.95	0.55	0.83	598.83	0.33	0.57	9	0.83	2.27	0	0	1.13	36.6	41	0	0	0	650
615	6.10	0.58	0.87	598.87	0.37	0.68	10	0.87	2.43	0	0	1.22	38.4	47	0	0	0	672.0
Downstr. W.S. El. 599 Total Q = 1180 cfs																		
700	6.74	0.75	1.12	600.12	1.62	6.19	93	2.12	9.26	0.42	0.82	5.04	75	378	0.41	15.8	6	1177.4
Downstream W.S. El. 599.5 Total Q = 1470 cfs																		
700	6.94	0.75	1.12	600.62	2.12	9.26	139	2.62	12.70	0.92	2.65	7.69	75	576	1.33	34.5	46	1461.0
Downstream W.S. El. 600 Q = 1832 cfs																		
700	6.94	0.75	1.12	600.12	2.62	9.26	191	3.12	16.53	1.42	5.08	10.30	75	810	2.50	52.3	133	1834.0
Downstream W.S. El. 601 Q = 2008																		
700	6.94	0.75	1.12	600.12	3.62	20.66	310	4.12	25.19	2.42	11.29	18.14	75	1364	5.65	60	339	2713
675	6.70	0.70	1.04	602.04	3.54	19.98	300	4.04	24.36	2.34	10.74	17.54	75	1316	5.37	60	322	2613.4
Downstream W.S. El. 602 Q = 3517																		
650	6.45	0.65	0.97	602.97	4.47	28.35	425	4.97	33.24	3.27	17.74	25.49	75	1912	9.37	60	562	3544.0
Downstream W.S. El. 603 Q = 4561																		
600	5.95	0.55	0.83	603.83	5.33	36.72	554	5.83	42.23	4.13	25.18	33.71	75	2528	14.87	60	893	4575.0

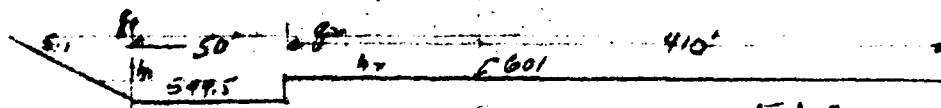
BY ON DATE _____ LOUIS BERGER & ASSOCIATES INC. SHEET NO. 2 OF 2
 CHKD. BY _____ DATE _____ INSPECTION OF DAMS - MASS. PROJECT W-108
 SUBJECT WHITIN RESERVOIR DAM - SPILLWAY DISCHARGE CURVE

SPILLWAY CREST DISCHARGE

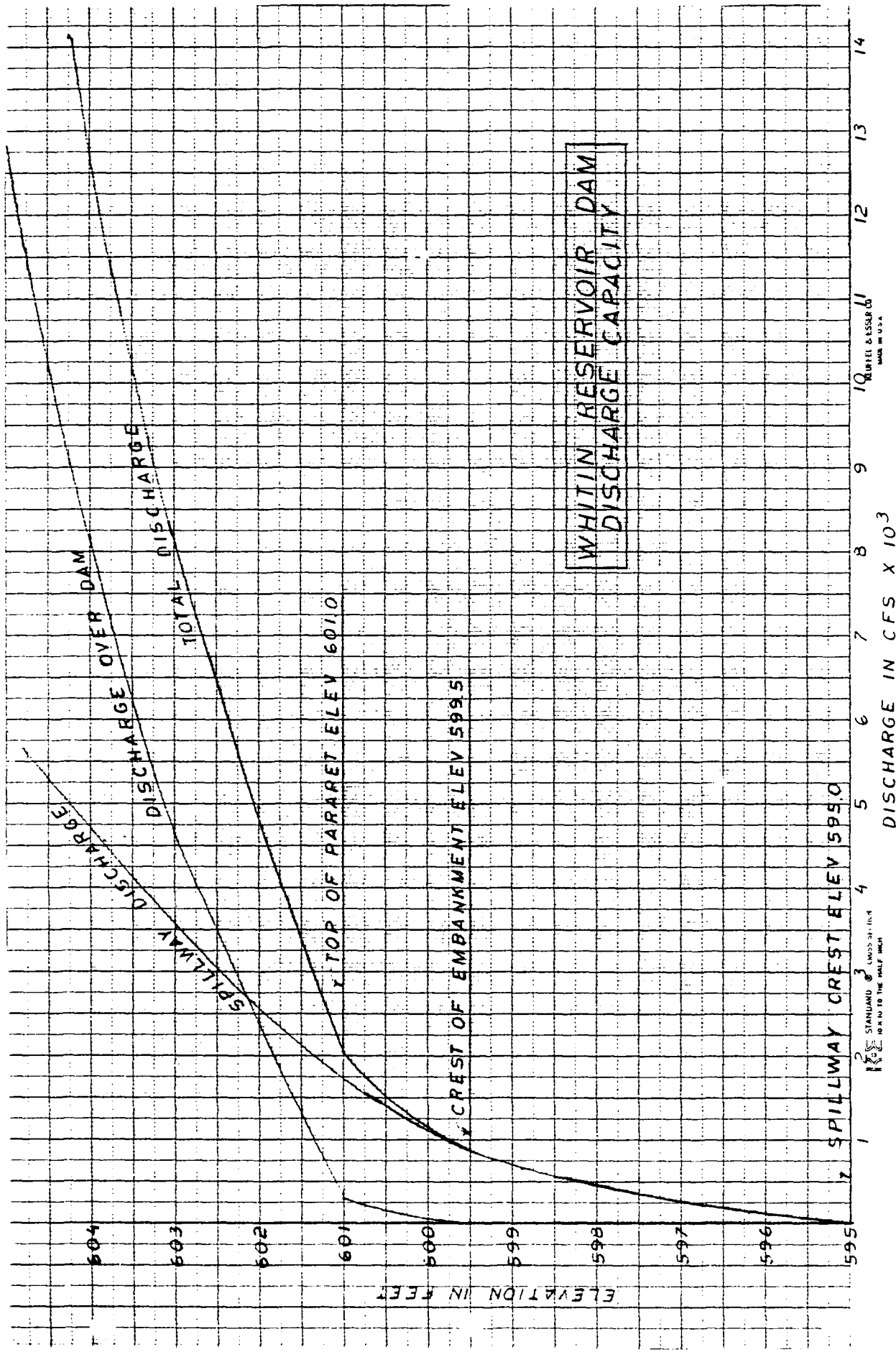


MAIN SPILLWAY L=26.7				AUXILIARY CREST L=28'				Ave. q	L	ΔQ	ΣQ
ELEV.	H	C	ΔQ	H	C	ΔQ	ΔQ				
595	-	-	0	-	-	0	0			0	0
596.2	1.2	3.0	106	0		0	0	0		0	106 596.22
597	2.0	3.0	228	0.8	2.9	2.08	58	1.04	5.3	6	292 597.22
598	3.0	3.03	424	1.8	2.95	7.12	199	3.56	11.8	42	665
599	4.0	3.06	659	2.8	3.0	14.06	394	7.03	19.4	129	1180
599.5	4.5	3.08	772	3.3	3.0	17.98	503	8.99	24.7	195	1470
600	5.0	3.1	932	3.8	3.0	22.22	622	11.11	25.0	278	1832
601	6.0	3.1	1226	4.8	3.0	31.55	883	15.78	31.6	499	2608
602	7.0	3.1	1544	5.8	3.0	41.90	1173	20.95	38.2	806	3517
603	8.0	3.1	1887	6.8	3.0	53.12	1487	26.56	44.7	1187	4561

DISCHARGE OVER DAM



ELEV	h_1	Q_{10} q_1	h_2	Q_{20} q_2	ΔQ $L=410$	Q $L=50$	$\frac{q_1}{2}$	L	Q ∇	ΣQ
599.5	0	0				0	0	0	0	0
600	0.5	1.06	0			53	0.53	2.5	1	54
601	1.5	5.51	0	0	0	276	2.76	7.5	21	297
602	2.5	16.86	1.0	3.06	1230	593	5.93	12.5	74	2384
603	3.5	19.64	2.0	8.48	3477	982	9.82	17.5	172	4631
604	4.5	28.64	3.0	15.59	6392	1432	14.32	22.5	322	8146
605	5.5	38.7	4.0	24	9840	1935	19.35	27.5	532	12310



BY RFB DATE 4-1-50 LOUIS BERGER & ASSOCIATES INC.
CHKD. BY DATE INSPECTION OF DAM
SUBJECT WHITTEN RESERVOIR DAM

SHEET NO. 1 OF 5
PROJECT 15-28

$$\text{DRAINAGE AREA (TOTAL)} = 3.43 \text{ MI}^2$$

By INSPECTION RESERVOIR ARE < 25% D.A.

$$\text{LENGTH LONGEST WATER COURSE, } L = 24,300 \text{ FT} = 4.7 \text{ MI}$$

$$\text{ELEV DIFFERENCE} = 890 - 595 = 295 \text{ FT}$$

$$\therefore \text{SLOPE} = \frac{295}{4.7} = 62.77 \text{ FT/MI} \sqrt{S} = 7.92$$

$$\text{Now } \left(\frac{L L_c}{\sqrt{S}} \right)^{.33} = \left[\frac{4.7 \times 4.7}{7.92(2)} \right]^{.33} = 1.12$$

$$\text{LAG} = K \left(\frac{L L_c}{\sqrt{S}} \right)^{.33} = 1.12 K$$

ASSUME $K = 5.0 \text{ HRS}$ REFER TO 'CURVE B' MOUNTAIN SLOPE
REGION, MIXED TERRAIN, 2 IN REL

$$\text{LAG} = 1.12(5) = 5.6 \text{ HRS}$$

$$T_p = 0.41D + .82 \text{ LAG, WHERE } D = 1.0 \text{ HRS}$$

$$T_p = 0.41(1) + .82(5.6)$$

$$T_p = 0.41 + 4.59 = 5.0 \text{ HRS}$$

CHECK VELOCITY

$$T_c = \frac{T_p - 0.52}{0.6}$$

$$T_c = \frac{5.0 - 0.5}{0.6} = 7.5 \text{ HRS}$$

$$V = \frac{24,900}{(7.5)(3600)} = 0.91 \text{ FT/SEC} \quad \text{OK}$$

BY REE DATE 4-1-50 LOUIS BERGER & ASSOCIATES INC. SHEET NO. 1 OF 2
 CHKD. BY _____ DATE _____ INSPECTION OF DAMS PROJECT NO. 2
 SUBJECT NORTH BERTH DAM, HYDROLOGY

$$T_2 = 1.67 T_0 = 1.67 (5.0) = 8.35 \text{ hrs}$$

$$T_a = T_p + T_2 = 5.0 + 3.35 = 8.35 \text{ hrs}$$

$$q_p = \frac{484 A Q}{T_0} \quad , \quad A = \text{DRAINAGE AREA}$$

$$Q = \text{RUNOFF IN INCHES}$$

$$q_p = \frac{484 (8.43) (1)}{5.0} = 864 \text{ CFS}$$

PMF = 23.5 (.8) = 18.8' FOR DOUGLAS, MARY
 = 18.4" CONSIDERING EFFECT OF FLOW OVERLAND FLOW.

FLOOD HYDROGRAPH FOR PMF

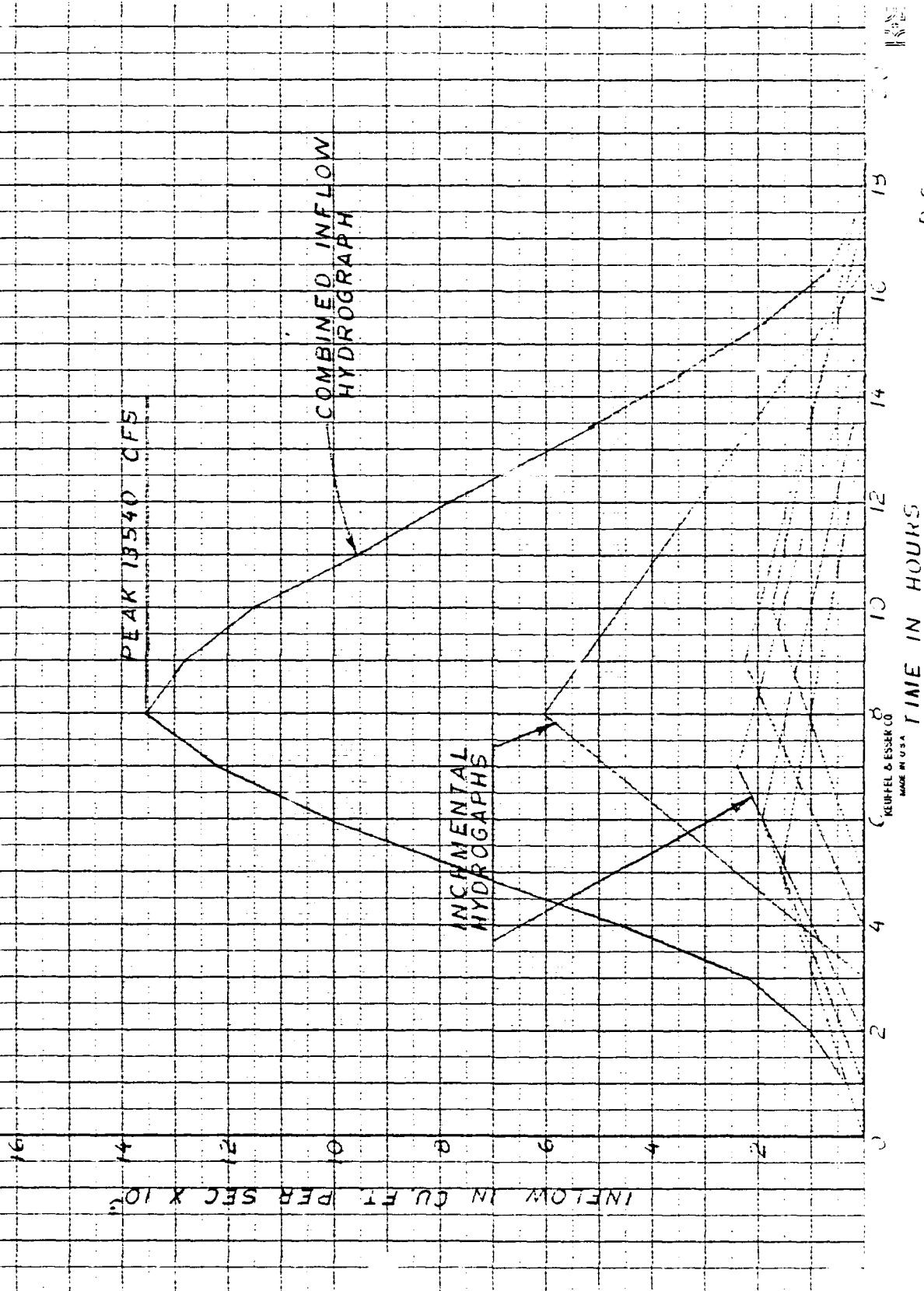
$$q_p = 864$$

TIME (HOURS)	RAINFALL		Qp CFS	TIME		
	* %	INCHES		BEGIN	PEAK	END
0.0						
1.0	10	1.84	1590	0	5.0	13.4
2.0	12	2.21	1909	1.0	6.0	14.4
3.0	15	2.76	2385	2.0	7.0	15.4
4.0	33	6.99	6039	3.0	8.0	16.4
5.0	14	2.58	5229	4.0	9.0	17.4
6.0	11	2.02	1745	5.0	10.0	18.4

* DISTRIBUTION OF MAXIMUM 6 HOUR PMF
 IN PERCENT OF 6 HOUR AVERAGE PMF

ENR 10-2-41

WILLIAMS RESERVOIR DAM INF HYDROGRAPH



D-9

MADE IN U.S.A.

KEUFEL & ESSER CO.

REF DATE 9-18-80 LOUIS BERGER & ASSOCIATES INC. SHEET NO. 1 OF 6
D. BY DATE INSPECTION OF DAMS PROJECT W-198
SUBJECT WHITIN RESERVOIR DAM, RESERVOIR ROUTING

DRAINAGE AREA = 8.93 SQ MI = 5,716 ACRES

SIZE CLASSIFICATION - INTERMEDIATE

MAXIMUM STORAGE = 4,475 ACRE-FT.
HEIGHT = 33 FT

HAZARD CLASSIFICATION = HIGH

OCE GUIDELINES, USE FULL PMF

FROM INFLOW HYDROGRAPH, PMF = 13,540 CFS

STEP 1: $Q_{P1} = 13,540$ CFS

STEP 2a: ELEV. = 604.13 FT

STEP 2b: SURCHARGE VOLUME = 3,480 ACRE-FT

$$\text{INCHS RUNOFF} = \frac{3,480 \text{ ACRE-FT}}{5716 \text{ ACRES}} \times 12 \text{ IN/FT} = 7.31 \text{ IN.}$$

STEP 2c: $Q_{P2} = 13,540 \left(1 - \frac{7.31}{19}\right)$

$$Q_{P2} = 8,230 \text{ CFS}$$

STEP 3a: FOR $Q = 8,230$ CFS

SURCHARGE HEIGHT = 603.05 FT

SURCHARGE VOL = 3030 A.F.

$$\text{INCHS OF RUNOFF} = \frac{3030}{5716} \times 12 \text{ IN} = 6.36 \text{ IN.}$$

STEP 3b

$$\text{AVE STORAGE} = \frac{6.36 + 7.31}{2} = 6.835$$

2ND ITERATION

$$\text{STEP 2c } Q_{p2} = 13,540 \left(1 - \frac{6.835}{19}\right)$$

$$Q_{p2} = 8670$$

$$\text{STEP 3a FOR } Q = 8,670 \text{ CFS}$$

$$\text{SURCHARGE HEIGHT} = 603.15$$

$$\text{SURCHARGE VOL} = 3075 \text{ A.F.}$$

$$\text{INCHS RUNOFF} = \frac{3075 \times 12}{5716} = 6.455$$

$$\frac{\text{STOR}_1 + \text{STOR}_2}{2} = \frac{6.835 + 6.455}{2} = 6.645$$

3RD ITERATION

$$\text{STEP 2c } Q_{p2} = 13,540 \left(1 - \frac{6.645}{19}\right)$$

$$Q_{p2} = 8806$$

$$\text{STEP 3a FOR } Q = 8,806$$

$$\text{SURCHARGE HEIGHT} = 603.20$$

$$\text{SURCHARGE VOLUME} = 3,100 \text{ A.F.}$$

$$\text{INCHS RUNOFF} = \frac{3100 \times 12}{5716} = 6.51 \text{ IN.}$$

$$\frac{\text{STOR 1} + \text{STOR 2}}{2} = \frac{6.645 + 6.51}{2} = 6.58$$

4th ITERATION

STEP 2c $Q_{P2} = 13,540 \left(1 - \frac{6.58}{19}\right)$

$Q_{P2} = 8,850$

STEP 3a FOR $Q = 8,850$

SURCHARGE HEIGHT = 603.25

" VOLUME = 3125

INCH RUNOFF = $\frac{3125 \times 12}{5716} = 6.56$

STEP 3b $\overline{\text{STOR}} = \frac{6.58 + 6.56}{2} = 6.57$

Ave SURCHARGE VOL = $\frac{6.57 \times 5716}{12} = 3120$

" SURCHARGE HEIGHT = 603.23

$Q_{P3} = 9,000 \text{ CFS}$

PMF OVERTOPS EMBANKMENT CREST BY $\frac{603.23}{599.5} = 3.73 \text{ FT}$

SAY $H = 3.7 \text{ FT}$
 $Q = 9,000 \text{ CFS}$

$$TRY \frac{1}{2} PMF = 13,540/2 = 6,770 \text{ CFS}$$

$$STEP 1: Q_{P1} = 6,770 \text{ CFS}$$

$$STEP 2a: ELEV. 602.60$$

$$STEP 2b: SURCHARGE VOLUME = 2,850 \text{ A.F.}$$

$$INCHS RUNOFF = \frac{2850 \text{ A.F.} \times 12 \text{ IN/FT}}{5716 \text{ ACRES}} = 5.98 \text{ INCHS}$$

$$STEP 2c \quad Q_{P2} = 6,770 \left(1 - \frac{5.98}{9.5} \right)$$

$$Q_{P2} = 2,508 \text{ CFS}$$

$$STEP 3a \quad \text{FOR } Q = 2,508$$

$$\text{SURCHARGE HEIGHT} = 601.15$$

$$\text{VOLUME} = 2,250 \text{ AF}$$

$$\text{INCHS RUNOFF} = \frac{2,250 \times 12}{5716} = 4.73 \text{ IN}$$

$$STEP 3b \quad \text{AVE STORAGE} = \frac{5.98 + 4.73}{2} = 5.355$$

2ND ITERATION

$$STEP 2c \quad Q_{P2} = 6,770 \left(1 - \frac{5.355}{9.5} \right)$$

$$Q_{P2} = 2,950$$

$$STEP 3a \quad \text{FOR } Q = 2,950$$

$$\text{SURCHARGE HEIGHT} = 601.32$$

SURCHARGE HEIGHT = 2375 AF

$$\text{INCHS RUNOFF} = \frac{2375 \times 2}{576} = 4.93 \text{ IN}$$

$$\frac{\text{STOR. 1} + \text{STOR. 2}}{2} = \frac{5.37 + 4.93}{2} = 5.15$$

3RD ITERATION

$$\text{STEP 2c } Q_{P2} = 6770 \left(1 - \frac{5.15}{9.5}\right)$$

$$Q_{P2} = 3,120$$

STEP 3c FOR $Q = 3,120$

$$\text{SURCHARGE HEIGHT} = 601.4$$

$$\text{VOLUME} = 2350 \text{ AF}$$

$$\text{INCHS RUNOFF} = \frac{2350 \times 2}{576} = 4.93 \text{ INCHS}$$

$$\frac{\text{STOR. 1} + \text{STOR. 2}}{2} = \frac{5.12 + 4.93}{2} = 5.02$$

4TH ITERATION

$$\text{STEP 2c } Q_{P2} = 6770 \left(1 - \frac{5.02}{9.5}\right)$$

$$Q_{P2} = 3,100$$

$$\text{SURCHARGE HEIGHT} = 601.2$$

$$\text{VOLUME} = 2370$$

DATE 9-3-30 LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 2 OF 2

DATE INSPECTION 9-3-30 PROJECT

$$WATER SURGE VOL = \frac{2870 \times 5}{57.6} = 4.98$$

$$\text{STEP 3d } \overline{S_{0.2}} = \frac{5.02 + 4.98}{2} = 5.00$$

$$\text{AVE SURGE ARGE VOL} = \frac{50 \times 57.6}{12} = 2.75$$

$$4.98 + 2.75 = 601.45$$

$$Q_{p3} = 3,500 \text{ cfs}$$

$$\text{PNE OVERTOPS EMBANKMENT BY } 601.45 - 59.45 = 1.00$$

$$\begin{aligned} \text{Say } H &= 1.9 \text{ ft} \\ Q &= 3,500 \end{aligned}$$

STEP 1: RESERVOIR ELEVATION 510 FT
WATER AT 510 FT
STORAGE = 4475 AC-FT

HEIGHT = 33 FT

W = 30% OF 417 = 125 FT

STEP 2: PEAK FAILURE OUTFLOW

$$Q_{PI} = 8/27 W \sqrt{g} Y_0^{2/3}$$

$$Q_{PI} = 1.68 (125) (33)^{3/2}$$

$$Q_{PI} = 34,800 CFS$$

ADD SPILLWAY FLOW: $Q_{SPILLWAY} = 850 CFS$

$$Q_{PI} \text{ TOTAL} = 34,800 + 850 = 40,650$$

$$\text{Say } Q_{PI} = 40,700 CFS$$

STA 0+00 TO 54+00

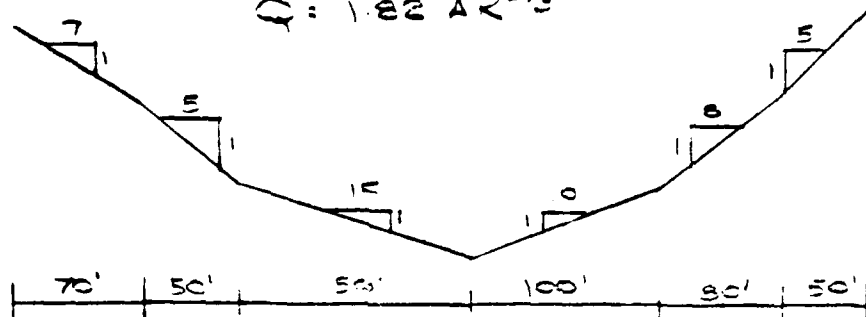
$$S = \frac{546 - 500}{5400} = 0.0122$$

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2}$$

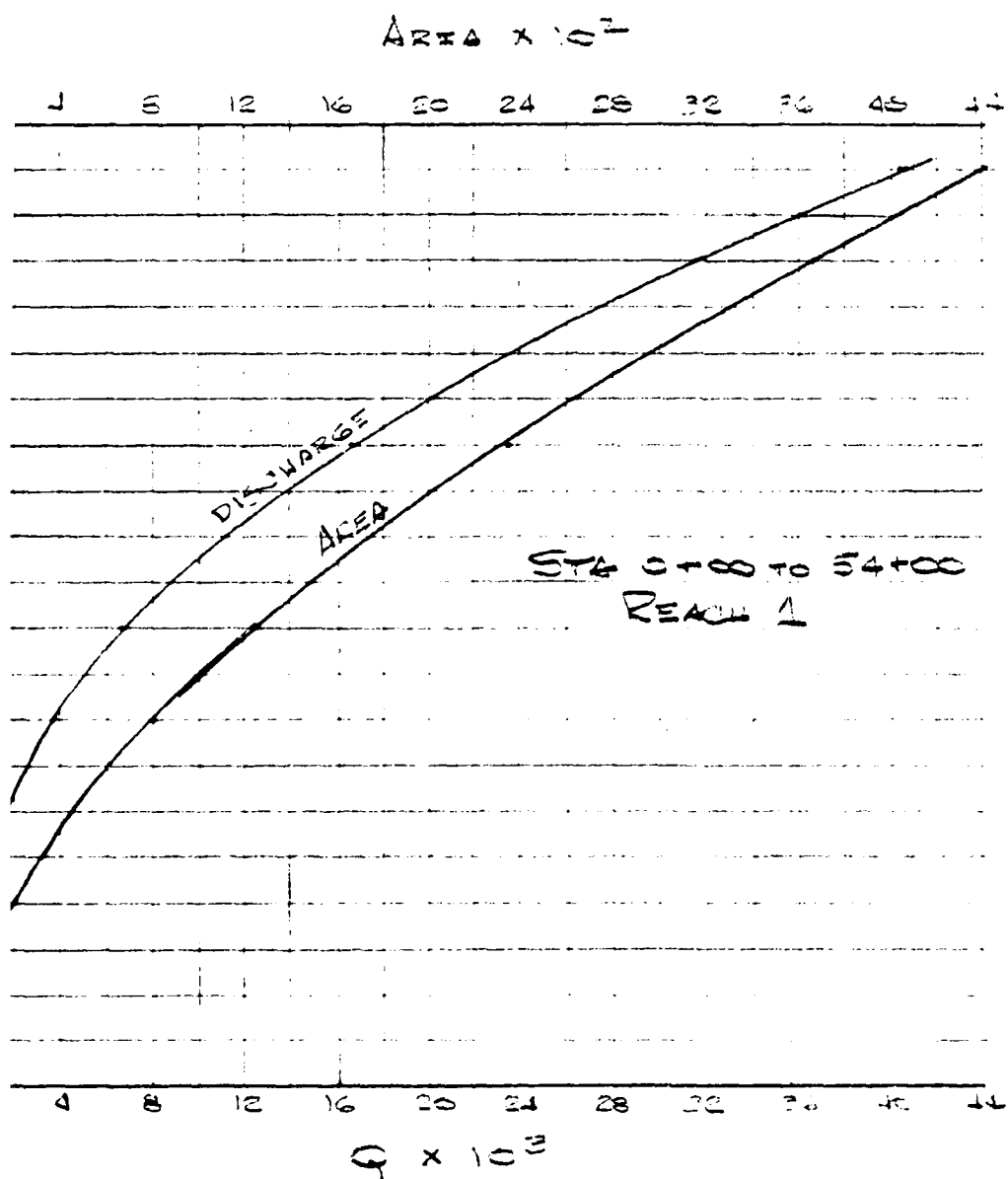
$$S^{1/2} = 0.11$$

$$Q = 1.82 AR^{2/3}$$

$$n = 0.040$$



AGE	AREA	P	R	$T^{3/2}$	Q
4	500	100.3	1.09	1.56	573
8	800	200.6	3.99	2.52	3670
10	1250	250.8	4.98	2.52	6643
14	2354	303.4	7.76	3.92	16794
18	3666	356.1	10.29	4.74	31625
22	4400	382.4	11.51	5.10	40340



NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
WHITIN RESERVOIR DAM. (U) CORPS OF ENGINEERS WALTHAM MA
NEW ENGLAND DIV JUL 80

UNCLASSIFIED

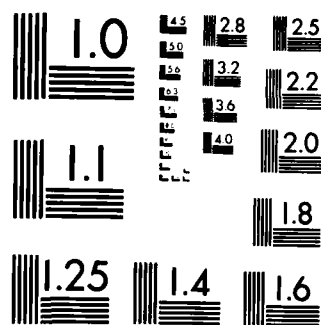
F/G 13/13

NL

END

FINANCIAL

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

BY RFE DATE 6-10-60 **LOUIS BERGER & ASSOCIATES INC.**
 CHKD. BY _____ DATE _____ INSPECTION OF DAM
 SUBJECT NATURAL SEDIMENT DAM, FALLS OF NEARLY

SHEET NO. 3 OF 9
 PROJECT N-125

For $Q = 40,700$, STAGE = 20 FT, AREA = 4400 ft^2

$$V_1 = \frac{4400 \times 5400}{43,800} = 545 \text{ ACRES-FT}$$

$$Q_{P2} (\text{TR A-}) = 40,700 \left(1 - \frac{545}{4475}\right)$$

$$= 35,740 \text{ CFS}$$

For $Q = 35,740$, STAGE = 19, AREA = 4000

$$V_2 = \frac{4000 \times 5400}{43,800} = 496 \text{ ACRES-FT}$$

$$V_{\text{AVE}} = \frac{545 - 496}{2} = 521 \text{ ACRES-FT}$$

$$Q_{P2} = 40,700 \left(1 - \frac{521}{4475}\right)$$

STA 54+00 $Q_{P2} = 36,000$, STAGE = 19 FT, $\Delta H = 14$ FT

STA 54+00 TO STA 114+00

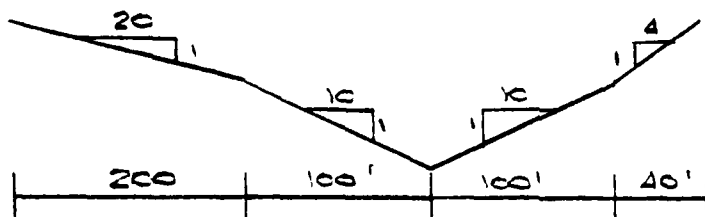
$$S = \frac{560 - 200}{6000} = .058$$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$S^{1/2} = 0.135$$

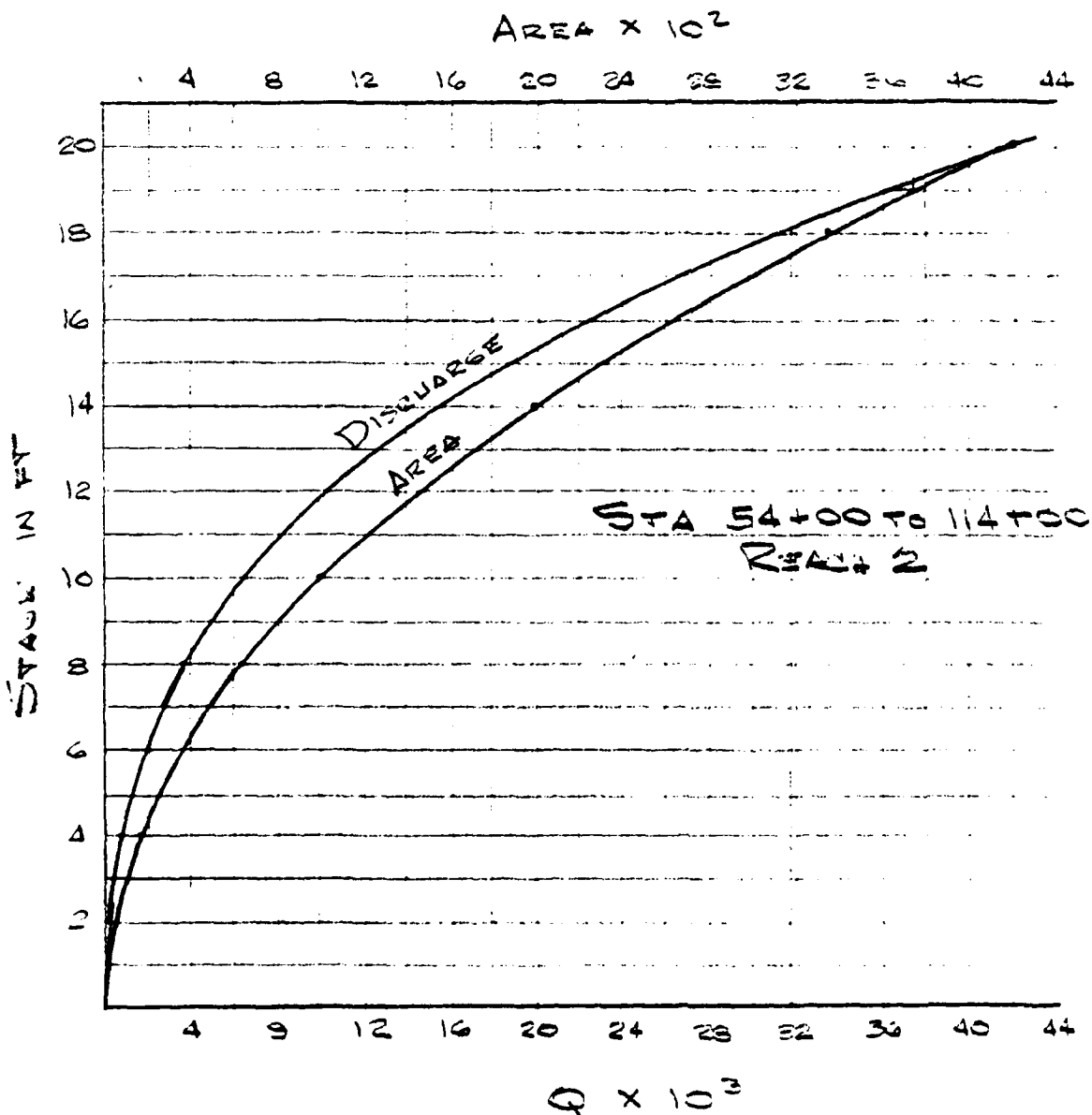
$$Q = 2.23 A R^{2/3}$$

$$n = 0.040$$



BY RFZ DATE 6-10-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 4 OF 9
 CHKD. BY _____ DATE _____ INSPECTION OF DAM PROJECT 7-128
 SUBJECT WATIN RESERVOIR DAM FAILURE ANALYSIS

STAGE	AREA	F	R	R ²	Z
4	160	80.4	2.00	1.57	567
8	640	160.8	3.98	2.51	3582
10	1000	201.0	4.98	2.92	6511
14	1792	297.6	6.69	3.35	15,770
18	3368	394.2	8.54	4.18	31,394
20	4200	442.6	9.49	4.48	41,239



BY RFB DATE 6-10-80 **LOUIS BERGER & ASSOCIATES INC.**

SHEET NO. 5 OF 9

CHKD. BY _____ DATE _____ INSPECTION OF DAM

PROJECT W-108

SUBJECT WHITIN RESERVOIR DAM, FAILURE ANALYSIS

For $Q = 36,000$, $S_{-100} = 19.0$, $AREA = 3750 \text{ ft}^2$

$$V_1 = \frac{3750 \times 6000}{43,560} = 516 \text{ ACRES-FT}$$

$$Q_{P2} (\text{TRIAL}) = 36,000 \left(1 - \frac{516}{4475}\right)$$

$$= 31,850 \text{ CFS}$$

For $Q = 31,850$, $S_{\text{TAKE}} 18.5 \text{ FT}$, $AREA = 3400 \text{ ft}^2$

$$V_1 = \frac{3400 \times 6000}{43,560} = 468 \text{ ACRES-FT}$$

$$V_{\text{AVE}} = \frac{516 + 468}{2} = 492 \text{ ACRES-FT}$$

$$Q_{P2} = 36,000 \left(1 - \frac{492}{4475}\right) = 32,042$$

STA 114 $Q = 32,000$, $H = 18.1$, $\Delta H = 13.5 \text{ FT}$

STA 114+00 to 206+00

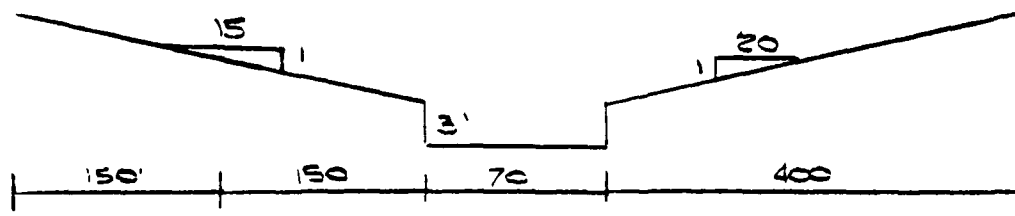
$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2}$$

$$S = \frac{340 - 370}{13,600} = .00147$$

$$S^{1/2} = .038$$

$$Q = 1.25 AR^{2/3}$$

$$n = .045$$



BY RFB DATE 6-10-80 LOUIS BERGER & ASSOCIATES INC.

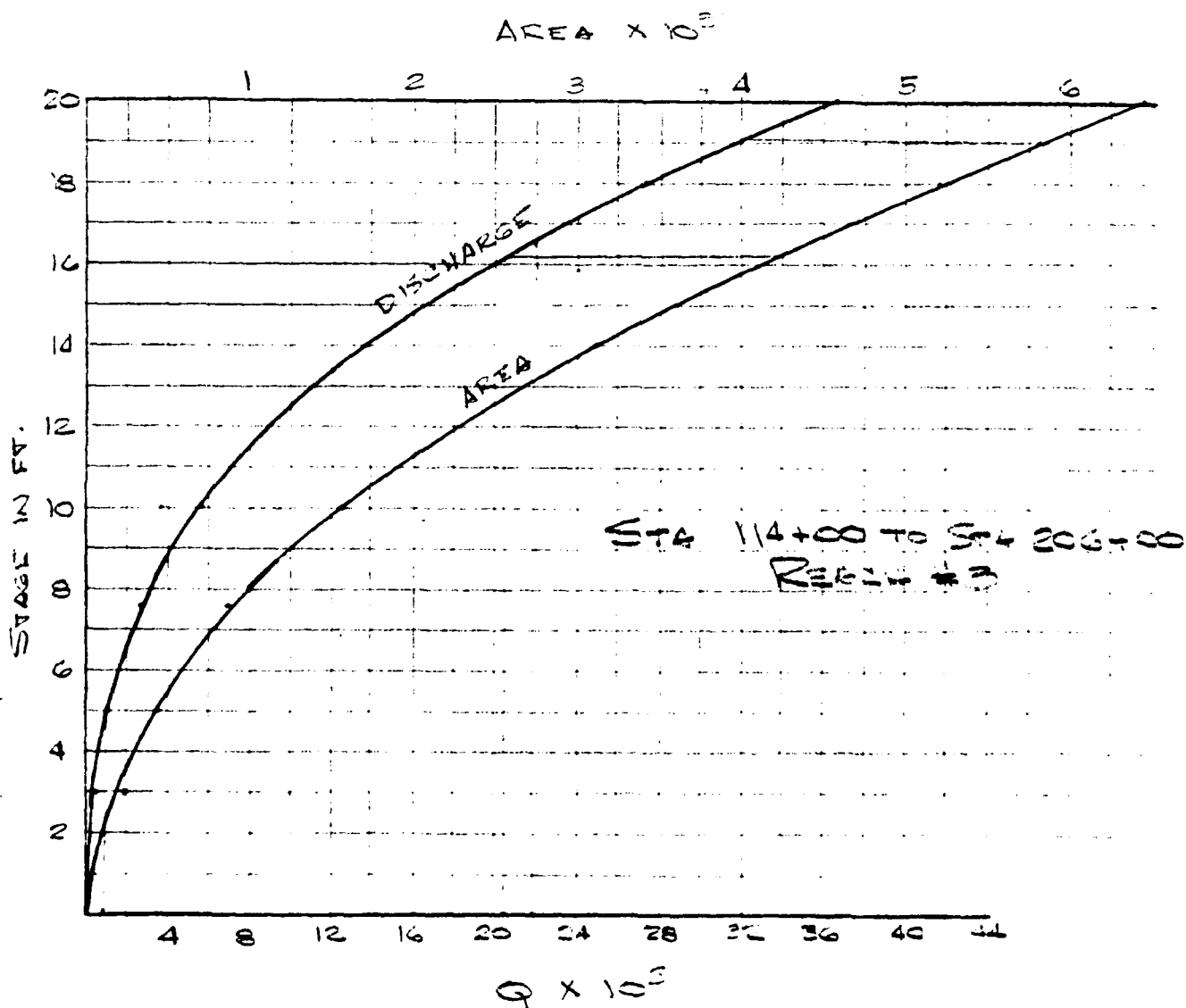
SHEET NO. 6 OF 9

CHKD. BY _____ DATE _____ INSPECTION OF DAM

PROJECT N-100

SUBJECT WHITE RESERVOIR DAM FAILURE ANALYSIS

STAGE	AREA	P	R ^{3/2}	Q
3	210	76	1.96	514
5	420	146	2.02	1060
7.5	679	232.3	2.42	2659
10	1358	321.4	2.87	5529
14	3098	461.6	3.86	13786
18	5148	601.9	4.81	27354
20	6458	672	4.82	36457



BY RFB DATE 6-10-80 **LOUIS BERGER & ASSOCIATES INC.**

SHEET NO. 7 OF 9

CHKD. BY _____ DATE _____ INSPECTION OF DAMS

PROJECT W-108

SUBJECT WHITIN RESERVOIR DAM, FAILURE AUG-1970

For $Q = 32,000$, STAGE = 19 FT, AREA = 5800 I

$$V_1 = \frac{(9200 + 3000)(5800)}{43,560} = 1624 \text{ ACRES-FT}$$

$$Q_{P2} (\text{TRIAL}) = 32,000 \left(1 - \frac{1624}{4475} \right)$$

$$= 20,390 \text{ CFS}$$

For $Q = 20,400$, STAGE = 16.2, AREA = 4250 I

$$V_2 = \frac{(12,200)(4250)}{43,560} = 1190$$

$$V_{AVE} = \frac{1624 + 1190}{2} = 1407$$

$$Q_{P2} = 32,000 \left(1 - \frac{1407}{4475} \right) = 21,938$$

STA 206, $Q = 21,900$, STAGE 16.5 FT, $\Delta H = 11.5$ FT

BY RFB DATE 6-25-80

LOUIS BERGER & ASSOCIATES INC.

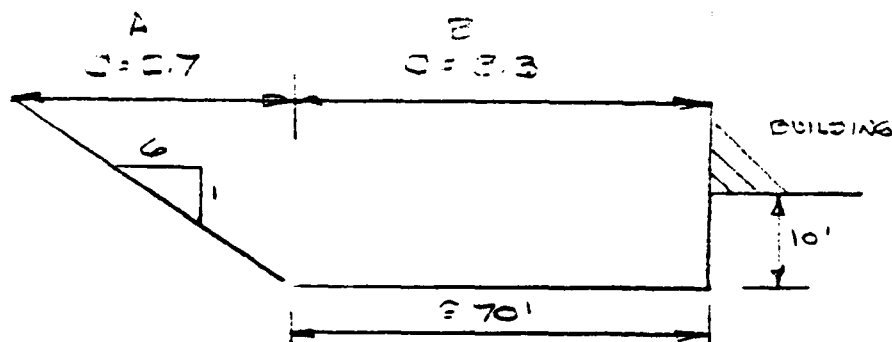
SHEET NO. 5 OF 6

CHKD. BY _____ DATE _____

INSPECTION OF DAMS

PROJECT 11-102

SUBJECT WATER RESOURCES DAM FAILURE ANALYSIS



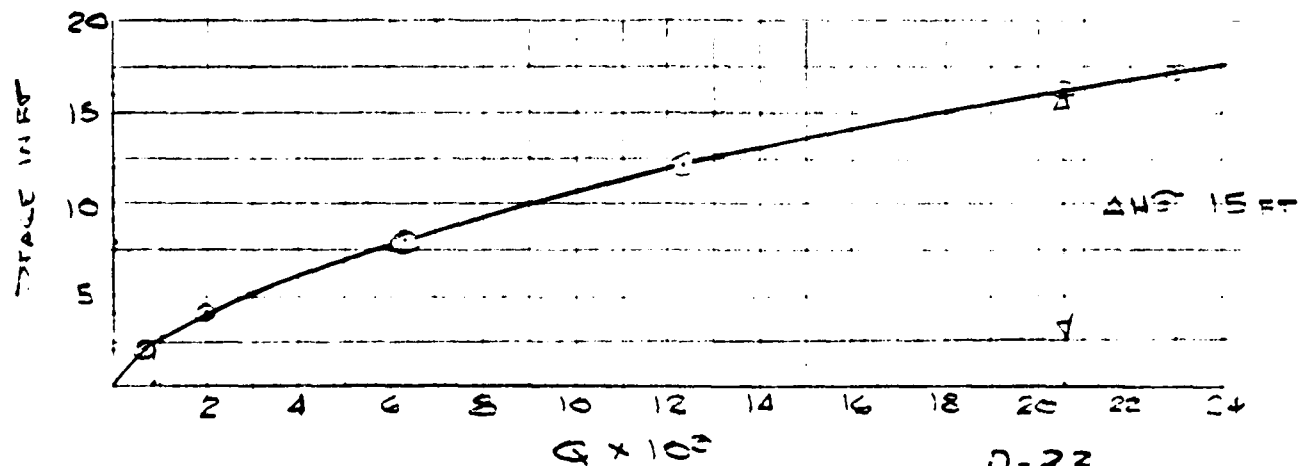
DAM AT MR CHRISTMAS TREE

APPROXIMATE STORAGE FROM STA 206 TO DAM = 90 AF

SAY DISCHARGE AT DAM = $21,700 \left(1 - \frac{90}{1175}\right)$

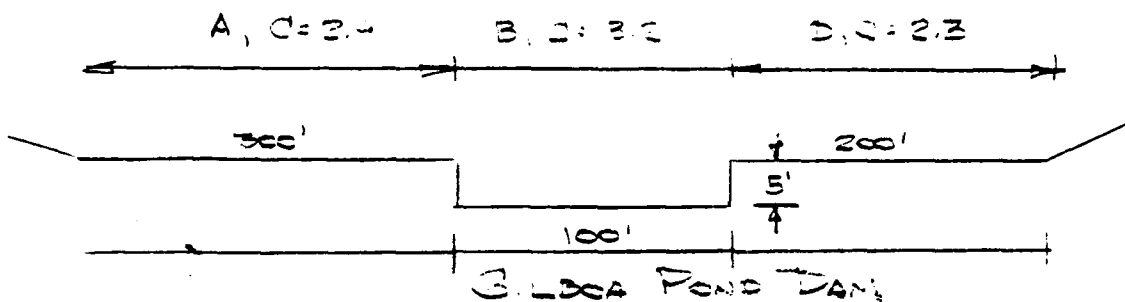
$Q = 21,500$

B, C = 3.3			A, C = 2.7			
L	L	Q	L	L	Q	ΣQ
1	70	650	1	12	30	700
2		1850	2	24	180	2000
4		5230	4	48	1080	6300
8		9600	6	72	2860	12300
12		14790	8	96	5860	20600
16		16190	8.5	102	6820	23,000



D-23

BY: RF3 DATE: 6-26-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 9 OF 9
 CHKD. BY: _____ DATE: _____ INSPECTION OF DAMS PROJECT: W-128
 SUBJECT: WUPA RESERVOIR DAM PA-305 AND-113



A, C=2:1			B, C=3:2			D, C=2:3			
H	L	Q	H	L	Q	H	L	Q	ΣQ
0	300	0	2	100	900	0	200	0	900
0		0	4		2050	0		0	2050
0		0	6		3520	0		0	3520
1		870	6		4700	1		460	6000
2		2460	7		5700	2		1300	7700
4		6960	9		8610	4		3700	14700
5		9730	10		10100	5		5110	24900

ESTIMATE OF FLOODING

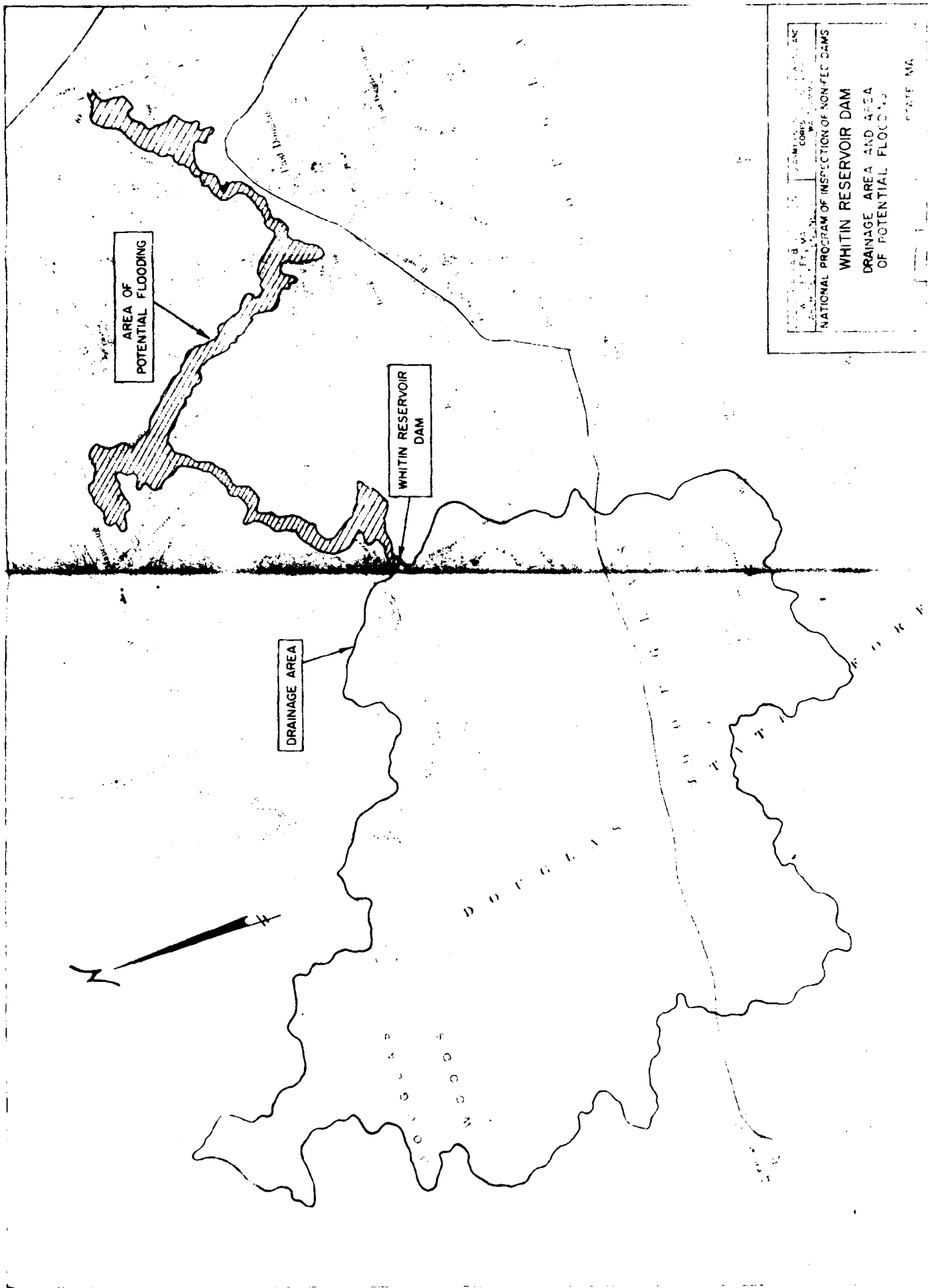
ABOUT 7 HOUSES AT EXTREME NORTHEND OF POND

JUST UPSTREAM OF BRIDGE 1 TO 3 FT

INDUSTRIAL BUILDING ON NORTH SIDE OF ROAD

5 TO 6 FT

SEWAGE TREATMENT PLANT 3 TO 4 FT



MASSACHUSETTS
COUNTY OF WORCESTER
TOWN OF WHITIN
STATE OF MASSACHUSETTS
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
WHITIN RESERVOIR DAM
DRAINAGE AREA AND AREA
OF POTENTIAL FLOODING
STATE MA

Appendix E

Information as Contained in the
National Inventory of Dams

END

FILMED

7-85

DTIC