MALE (C T) ASSOCIATES SCHENECTADY NY
NATIONAL DAM INSPECTION PROGRAM. TILLSON LAKE DAM (NY00083), LO--ETC(U)
AUG 81 K J MALE, W M SMITH
DACW51-81-C-0014

UNCLASSIFIED
This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.

Examination of available documents and visual inspection of the dam did not reveal conditions which constitute an immediate hazard to human life or property. However, the dam has some serious deficiencies which require further investigation and remedial work.
Hydrologic and hydraulic analysis indicates that maximum spillway discharge capacity without flashboards is only about 39% of the PMF peak outflow. The 1/2 PMF would overtop the earth embankment and would probably cause failure. Therefore, in accordance with Corps of Engineers' screening criteria for review of spillway adequacy, spillway capacity is considered "seriously inadequate" and the dam is assessed as "unsafe, non-emergency".

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean that there appears to be a serious deficiency in spillway capacity and if a severe storm were to occur, overtopping and failure of the dam could take place, significantly increasing the hazard to loss of life downstream of the dam.

Therefore, it is recommended that within 3 months after receipt of this report by the Owner, any appropriate remedial work should be completed. The detailed analysis and the design and construction observation of any remedial work should be done by a qualified, registered professional engineer.

In the meantime, the flashboards should immediately be removed from the spillway and kept removed pending the results of the detailed hydrologic and hydraulic analysis. Also, the Owner should immediately institute a program to visually inspect the dam and its appurtenances at least once a month. Within 3 months after receipt of this report the Owner should complete an emergency action plan outlining action to be taken to minimize the downstream effects of an emergency, together with an effective warning system.

Structural stability analysis of the spillway section indicates that it has unsatisfactory stability for all cases except normal spring and fall conditions (with flashboards removed) and that the right training wall is critically unstable for normal conditions. Therefore, it is recommended that a detailed structural stability analysis of the spillway section for all loading conditions be started within 3 months after receipt of this report by the Owner. This analysis should include investigation of foundation conditions, embankment loading conditions, and structural details. The large crack in the right training wall should be taken into account. Any necessary remedial work should be completed within 18 months after receipt of this report by the Owner. The investigation and the design and construction observation of any remedial work should be done by a qualified, registered professional engineer.
This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

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

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway 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.
TILLSON LAKE DAM, NY 00083

PHASE I INSPECTION REPORT

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Identification No.: NY 00083
Name of Dam: Tillson Lake Dam
State Located: New York
County: Ulster
Municipality: Town of Gardiner
Watershed: Lower Hudson River Basin
Stream: Palmaghatt Kill
Date of Inspection: April 8, 1981

ASSESSMENT

Examination of available documents and visual inspection of the dam did not reveal conditions which constitute an immediate hazard to human life or property. However, the dam has some serious deficiencies which require further investigation and remedial work.

Hydrologic and hydraulic analysis indicates that maximum spillway discharge capacity without flashboards is only about 39% of the PMF peak outflow. The 1/2 PMF would overtop the earth embankment and would probably cause failure. Therefore, in accordance with Corps of Engineers' screening criteria for review of spillway adequacy, spillway capacity is considered "seriously inadequate" and the dam is assessed as "unsafe, non-emergency".

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean that there appears to be a serious deficiency in spillway capacity and if a severe storm were to occur, overtopping and failure of the dam could take place, significantly increasing the hazard to loss of life downstream of the dam.

Therefore, it is recommended that within 3 months after receipt of this report by the Owner, a detailed hydrologic and hydraulic analysis be started to better assess spillway capacity. This should include a more accurate determination of the site specific characteristics of the watershed. Within 18 months
after receipt of this report by the Owner, any appropriate remedial work should be completed. The detailed analysis and the design and construction observation of any remedial work should be done by a qualified, registered professional engineer.

In the meantime, the flashboards should immediately be removed from the spillway and kept removed pending the results of the detailed hydrologic and hydraulic analysis. Also, the Owner should immediately institute a program to visually inspect the dam and its appurtenances at least once a month. Within 3 months after receipt of this report the Owner should complete an emergency action plan outlining action to be taken to minimize the downstream effects of an emergency, together with an effective warning system.

Structural stability analysis of the spillway section indicates that it has unsatisfactory stability for all cases except normal spring and fall conditions (with flashboards removed) and that the right training wall is critically unstable for normal conditions. Therefore, it is recommended that a detailed structural stability analysis of the spillway section for all loading conditions be started within 3 months after receipt of this report by the Owner. This analysis should include investigation of foundation conditions, embankment loading conditions, and structural details. The large crack in the right training wall should be taken into account. Any necessary remedial work should be completed within 18 months after receipt of this report by the Owner. The investigation and the design and construction observation of any remedial work should be done by a qualified, registered professional engineer.

Because of other deficiencies, the following additional investigations should be started within 3 months after receipt of this report by the Owner. The investigations should be performed by a qualified, registered professional engineer.

1) Investigate the character of the spoil material on the downstream slope to determine whether it should be removed and, if so, provide the procedure for removal.

2) Determine whether major repairs should be made to the core wall, which has multiple cracks.

3) Investigate the origin of the seeps through the floor of the spillway discharge channel.

Any remedial work deemed necessary as a result of these investigations should be completed within 18 months after receipt of this report by the Owner. A qualified, registered professional engineer should design and observe the construction of any necessary remedial work.

The following remedial work should be completed by the Owner within 12 months after his receipt of this report. Where engineer-
ing assistance is indicated, the Owner should engage a qualified, registered professional engineer. Assistance by such an engineer may also be useful for some of the other work.

1) Remove trees and brush and their root systems from all surfaces of the dam and for 20 feet downstream of the toe in accordance with procedures established by an engineer. Continue to keep these same areas clear by cutting brush and trees and mowing grass at least annually.

2) Repair the eroded zones of the embankment adjacent to the spillway and along the upstream slope in accordance with a design by an engineer.

3) Monitor the seep adjacent to the outlet conduit and have the data evaluated in accordance with procedures established by an engineer.

4) Dewater and clean the outlet conduit and have it inspected by an engineer.

5) Restore the outlet conduit sluice gate to operation and exercise it regularly.

6) Contingent on the results of the detailed stability analysis by an engineer, repair the zones of eroded and deteriorated concrete of the spillway, discharge channel, and training walls in accordance with a design by an engineer.

7) Develop and implement effective routine operation and maintenance procedures for the dam and its appurtenances.

8) Institute a program of comprehensive technical inspection of the dam and its appurtenances by an engineer on a periodic basis of at least once every two years.

Kenneth J. Male
President
C. T. Male Associates, P.C.
NY PE 25004

Col. W. H. Smith, Jr.
New York District Engineer
Corps of Engineers

31 Aug 81
Overview Photo - Tillson Lake Dam. Note trees on slope and irregular crest - 4/8/81
PROJECT INFORMATION

1.1 GENERAL

a. Authority

The National Dam Inspection Act, 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 inspection throughout the United States. The New York District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within New York State. C. T. Male Associates, P.C., has been retained by the New York District to inspect and report on selected dams in the State of New York. Authorization and notice to proceed was issued to C. T. Male Associates, P.C., under a letter from Michael A. Jezior, LTC, Corps of Engineers. Contract No. DACW51-81-C-0014 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

The purpose of the inspection program is to perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public, and thus permit correction in a timely manner by non-Federal interests.

1.2 DESCRIPTION OF PROJECT

a. Location

The dam is located on the Palmaghatt Kill about 10 miles southwest of the Village of New Paltz. The dam at its maximum section is at Latitude 41 degrees - 40.3 minutes North, Longitude 74 degrees - 14.8 minutes West.

Access to the dam is from County Route 7 to the east, then via Tillson Lake road to either South Mountain Road or Lake Road, and then via a private gravel road that runs south of the lake between South Mountain Road and the Tillson Lake Recreation Park and pavilion on Lake Road (see Vicinity Map, and Drainage Area Map Appendix C-5).
The official and popular name of the dam is Tillson Lake Dam and the official and popular name of the reservoir is Tillson Lake.

b. **Description of Dam and Appurtenances**

Tillson Lake Dam is an earth embankment with a central concrete core wall. The dam has an ogee-like spillway about 30 feet from the left abutment. The irregular brush, tree, and debris-covered embankment is about 308 feet long (including the spillway) by about 39 feet high. The upstream and downstream slopes are irregular with the upstream slope above the beach estimated at 1.5H:1V and with portions of the downstream slope as steep as 1.25H:1V. The upstream slope is covered with rock riprap to about 4 feet below the top of the dam. The dam has an irregular crest width averaging about 15 feet.

The dam has a reinforced concrete core wall about 18 inches wide at portions of the top which are exposed. The wall increases in section as it extends down to the original ground surface. The core wall is partially exposed on both sides of the spillway and the top of the core wall, at EL 376, has been considered to be the top of the dam.

The ogee-like spillway is a concrete gravity overflow section about 3.5 feet wide at the top with a crest length of about 55 feet. The spillway overflow section varies uniformly in downstream height from left to right, being 4 feet high on the left and about 20 feet high on the right. The spillway discharge channel is formed by training walls on each side of the spillway extending downstream about 80 feet. The channel bottom consists of concrete pavement over bedrock (and possibly over some hardpan) and it slopes downward left to right, as well as downstream (see Photo A-6A).

The spillway crest has 4 sections of 3-foot-high wooden flashboards, each section being 13.75 feet long. The sections are supported at their ends by 3 railroad rails embedded in the spillway crest (see Photo A-6B). The two end sections are each additionally supported by three 1.5-inch pipes and the middle sections by two 1.5-inch pipes. At the time of inspection one section of flashboards was removed. Also, just downstream of the weir crest there are 3 additional railroad rails embedded in the spillway overflow section which are apparently not used.

The dam has a concrete outlet conduit about 3 feet square on the inside and about 170 feet long. In the reservoir there is a concrete control tower with a floor stand control mechanism for a 30-inch-diameter sluice gate at the end of the conduit at the base of the tower. The handwheel for the control mechanism is missing and the gate is inoperable. The conduit discharges into the streambed at the downstream toe and presently is about half silted shut at its downstream end.
c. **Size Classification**

In accordance with Recommended Guidelines (Reference 1), Tillson Lake Dam is classified as "small" in size because its height is 39 feet (within the 25 to 40-foot range) and the maximum storage capacity at the top of the dam is 394 acre-feet (within the 50 to 1,000-acre-foot range).

d. **Hazard Classification**

In accordance with Recommended Guidelines (Reference 1), Tillson Lake Dam is classified as having a "high" hazard potential. This is because it is judged that failure of the dam would significantly increase flows downstream which could cause loss of more than a few human lives and appreciable property damage. Downstream development that could be damaged or destroyed by a dam failure includes: a home to the left of the stream about 300 feet downstream and the associated driveway bridge over the stream (both are visible in Photo A-9B), and several homes even closer and lower to the stream about 900 feet downstream near South Mountain Road (vertical drop from the dam to the homes near South Mountain Road is about 40 feet).

e. **Ownership**

It is suspected that the dam was constructed in the 1920's or early 1930's for Hassey A. Tillson. Presently the dam and reservoir are owned by:

U & U Realty, Inc.
100 Seaview Drive
Secaucus, New Jersey 07094

Attention: Joseph Uanue, President
(201) 348-4900

f. **Operator**

Day-to-day operation of the dam is the responsibility of:

Tillson Lake Recreation Park, Inc.
Gardiner, NY 12525

Attention: Henry S. Cuney, President
(914) 564-2718

and

George Surinach, Vice-President
(Mr. Cuney's Son)
35 Utterb; Rd.
Malverne, NY 11565
(516) 887-7859
Tillson Lake Recreation Park, Inc. is the leasee of the property upon which the dam and the associated recreational facilities are located.

93 g. Purpose of Dam

The dam was originally constructed to impound water for recreational purposes. The impoundment is presently used for the same purpose by the Operator who runs a swimming beach and pavilion at the western end of the lake. The dam is at the eastern end of the lake.

h. Design and Construction History

It is suspected that the dam was constructed in the 1920's or early 1930's for Hassey A. Tillson. The original designer and construction contractor are unknown. No direct data concerning the original design or construction could be found.

On September 21, 1938 the dam was overtopped and a large section to the right of the spillway failed causing violent flooding and damage downstream. The spillway was completely flashboarded shut prior to and during the flood with 4-foot-high flashboards. In 1939 the dam was reconstructed for the original owner. The reconstruction consisted of repairing the breach in the core wall and embankment. In addition, the core wall and the dam to the right of the spillway were raised about 2 feet, new fill was placed over the entire downstream slope, and new flashboards 2.5 feet high were installed.

In August 1955 the portion of the dam to the left of the spillway, which had never been raised as intended during the 1939 work, was overtopped. A portion of the toe of the dam was washed away, and the spillway discharge channel was damaged. In 1956 major repairs were undertaken for the owner, Dominick Porco. The repair work consisted of raising the core wall and dam on the left side of the spillway to match the right side, rebuilding portions of the spillway training walls and discharge channel bottom, filling in washed out areas, and possibly adding riprap to the upstream slope. The sluice gate, then inoperable, was also supposedly repaired at that time.

Refer to Section 2 of this report, as well as to the Engineering Data Checklist in Appendix F2, for a complete discussion of the design and construction history. Drawings and other engineering data are included in Appendices F3 and G.

i. Normal Operating Procedures

The Operator visits the dam site at least twice a week during the summer and randomly at other times. The 3-foot-high
Flashboards are up May through September and are normally removed by the Operator's son for the period of October through April. Last winter, however, only one of the four sections of flashboards was removed.

The outlet conduit sluice gate, normally closed, is inoperable. The control tower over the gate can only be reached by boat and the operating handwheel is missing. The sluice gate was last operated 15 or 20 years ago. The lake used to be drained for cleaning about every 10 years, but this was last done in the 1960's according to the Operator's son.

### 1.3 Pertinent Data

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Drainage Area (square miles)</td>
<td>4.78</td>
</tr>
<tr>
<td>b. Discharge at Dam Site (cfs)</td>
<td></td>
</tr>
<tr>
<td>Spillway (W.S. at top of dam)</td>
<td></td>
</tr>
<tr>
<td>- with flashboards</td>
<td>950</td>
</tr>
<tr>
<td>- without flashboards</td>
<td>2,690</td>
</tr>
<tr>
<td>Outlet Conduit (normally closed and presently inoperable - estimated potential with W.S. at spillway crest w/o flashboards)</td>
<td>130</td>
</tr>
<tr>
<td>Maximum Known Flood (estimated at 2 ft. over flashboard crest in August 1955)</td>
<td>500</td>
</tr>
<tr>
<td>c. Elevation (feet - NGVD)</td>
<td></td>
</tr>
<tr>
<td>Top of Dam (top of core wall)</td>
<td>376</td>
</tr>
<tr>
<td>Design High Water (for 1,250 cfs)</td>
<td>373.5 ±</td>
</tr>
<tr>
<td>Spillway Crest - with flashboards</td>
<td>370</td>
</tr>
<tr>
<td>- without flashboards</td>
<td>341   ±</td>
</tr>
<tr>
<td>Entrance Invert of Outlet Conduit</td>
<td></td>
</tr>
<tr>
<td>d. Reservoir Length (feet) - at spillway crest</td>
<td>1,700 ±</td>
</tr>
<tr>
<td>e. Reservoir Surface Area (acres)</td>
<td></td>
</tr>
<tr>
<td>Top of Dam</td>
<td>28.5 ±</td>
</tr>
<tr>
<td>Spillway Crest - with flashboards</td>
<td>25.6 ±</td>
</tr>
<tr>
<td>- without flashboards</td>
<td>22.7</td>
</tr>
<tr>
<td>f. Reservoir Storage (acre-feet)</td>
<td></td>
</tr>
<tr>
<td>Top of Dam</td>
<td>394</td>
</tr>
<tr>
<td>Spillway Crest - with flashboards</td>
<td>312</td>
</tr>
<tr>
<td>- without flashboards</td>
<td>230</td>
</tr>
</tbody>
</table>
**g. Dam**

Type - Earth embankment.
Length - 308 feet including spillway.
Height - 39 feet.
Top Width - Irregular, averages about 15 feet.
Side Slopes - Upstream - 1.5H:1V above beach, 8H:1V on beach, below water presumed original 2.5H:1V.
   - Downstream - Original 2H:1V. Present steepest slope of spoil over original surface is 1.25H:1V.
Zoning - Homogeneous with central concrete core wall and miscellaneous spoil on downstream slope.
Impervious Core - Central concrete core wall (cracked and therefore not an impervious barrier) reported to be 28 inches thick at its base and 12 to 15 inches thick at its top (measures 18 inches thick on portions of top exposed).
Cutoff - Concrete core wall extends to bedrock or to hardpan.
Grout Curtain - None known.

**h. Spillway**

Type - Concrete ogee-like with 3-foot flashboards.
Length of Weir - 55 feet.
Upstream Channel - Reservoir immediately upstream of weir crest. Bottom of reservoir is silted up level with weir crest at each end of spillway.
Downstream Channel - About an 80-foot-long concrete paved channel with concrete training walls. Channel slopes down steeply toward right side as well as toward downstream.

**i. Outlet Conduit (reservoir drain)**

Size - Reported 3 feet square by about 170 feet long (measures 3.8 feet wide at outlet).
Description - Concrete box culvert from control tower in reservoir, through dam to downstream toe. The downstream end of the conduit is about half silted shut.
Control - Reported 30-inch-diameter sluice gate at upstream end at base of control tower with floor stand on top of control tower. Control tower only accessible by boat, handwheel is missing, and sluice gate is inoperable.
SECTION 2  
ENGINEERING DATA  

2.1 DESIGN DATA  

a. Geology  

There is no geologic information available in the data for this dam. The following information was obtained from current geologic maps and publications (References 28 and 29), as well as from the site visit.

Tillson Lake Dam is located in the Hudson-Mohawk lowlands of the Valley and Ridge physiographic province in southeast New York State. Bedrock in the vicinity of the dam is shale, argillite, and siltstone of the middle Ordovician period (approximately 460 million years old). The dam is located on the eastern flank of generally flat-lying basin rocks that underlie the Catskill Mountains.

The bedrock at the dam is a slate or argillite with closely-spaced (approximately 1/2 inch) foliations. The strike and dip measured about 20 feet downstream from the dam on the right side of the discharge channel is N 30° E, 28° N. Since the dam is oriented northeast-southwest, the horizontal thrust of the dam tends to close the north-dipping foliation planes. (Note: in the application for repairs, dated May 12, 1939 (see Appendix F3-3), the bedrock was called slate and indicated to have a dip of 50°W. It is not known where this measurement was taken.)

There is no surficial geology map available for this site.

b. Subsurface Investigations  

There are no subsurface investigations available for this dam site.

A drawing by Solomon LeFevre dated March 22, 1939 (see Appendix G-1) shows the dam to be founded on slate from Sta 0+00 to Sta 2+70 and on hardpan from Sta 2+70 to the right abutment. The same drawing shows that the spillway was founded chiefly on bedrock but that hardpan was left unexcavated under the central portion (looking in transverse section) of the spillway.

The visual inspection showed bedrock exposed about 10 feet to the right of the low-level outlet conduit, about at Sta 1+30. Also, till (hardpan) is evident on top of bedrock to the left of the spillway. A scarp in till is evident in a zone just downstream of the right side of the dam. This zone seems to be a former borrow area.
c. Dam and Appurtenances

It is suspected that the dam was designed and constructed in the 1920's or early 1930's for Hassey A. Tillson. The original designer is unknown. No direct data concerning the original design could be found.

There are no direct data available on the composition of the dam. In a letter by Mr. Fred Briehl dated September 27, 1938 (see Appendix F3-1) describing the failure of the dam, he referred to the fill in the dam as "dirt" and as "rock and dirt." In a drawing by Solomon LeFevre dated March 22, 1939 (see Appendix G-1) he refers to the old and the proposed fill as "earth fill."

Immediately downstream from the dam, on the right side, there are the remains of an old borrow pit, which may be the source of the fill for the embankment.

The top surfaces of the crest and downstream slope are very irregular. According to the Owner's representative, the lake has been drained in the past and the bottom cleaned. He indicated that the spoil may have been dumped on the crest and downstream shell.

2.2 CONSTRUCTION HISTORY

a. Initial Construction

The original contractor for the dam is unknown and no records concerning the actual construction of the dam and appurtenances are known to exist. A brief review of the construction history can be found in Appendix F2, Checklist for General Engineering Data and Interview with Dam Owner.

b. Modifications and Repairs

On September 21, 1938 the dam was overtopped and breached. The spillway was completely flashboarded shut prior to and during the flood with 4-foot-high flashboards. As a result of this condition water from the storm rose in the reservoir, and aided somewhat by high winds, proceeded to spill over the dam. The flow of water over the dam washed out the fill section on the downstream side of the core wall to the right of the spillway. The core wall, then unsupported on the downstream side, burst. A portion of the core wall about 90 feet wide at the top and 30 feet deep failed. A letter by Fred Briehl, dated September 27, 1981 (see Appendix F3-1) describes the dam failure and the resulting damage.

In 1939 the dam was reconstructed for the original owner, H. A. Tillson. An application for the dam's reconstruction, dated May 12, 1939, appears as Appendices F3-3 to F3-6.
The core wall was repaired with new reinforced concrete which was doweled to the old remaining concrete with 3/4-inch steel rods. The core wall and embankment were both raised about 2 feet on the right side of the spillway. The earth fill washed away by the breach was replaced and additional fill was added to the entire downstream slope of the dam to the right of the spillway. New 2.5-foot-high flashboards were also installed on the spillway, resulting in 3.5 feet of freeboard on the right side but only 1.5 feet on the left. The core wall to the left of the spillway was never raised during the 1939 reconstruction.

The engineer for the 1939 reconstruction was Solomon LeFevre, New Paltz, New York. Correspondence concerning the 1939 work can be found in Appendices F3-7 to F3-8. A drawing concerning the reconstruction of the dam appears as Appendix G-1. The construction contractor for the 1939 work is not known.

In August 1955 another storm and subsequent flood caused a portion of the dam and core wall to the left of the spillway, which had never been raised during the 1939 reconstruction, to be overtopped and the embankment was eroded. There appears to have been about 2-foot-high flashboards on the spillway just prior to and during the flood. The lower ends of the spillway channel training walls were overtopped by water flowing in the channel. This flooding eroded the ground area behind the left training wall and caused a portion of the earth dam at the toe, to the right of the spillway, to be washed away. A section of the right spillway training wall and part of the channel bottom were also undermined and washed away. A report on damage to the dam due to the storm can be found on Appendix F3-9.

In 1956 the dam was repaired and reconstructed for the owner, Dominick Porco. A listing of the proposed 1956 reconstruction, as well as an application for the dam's reconstruction in 1956, appear as Appendices F3-10 to F3-14.

The core wall and dam to the left of the spillway were raised about 2 feet to match the rest of the dam. The left training wall of the spillway was raised about 1.5 feet and extended downstream. Some concrete work to promote better flow may have been done in the trough along the right side of the spillway discharge channel. The downstream end of the right training wall and the downstream end of the concrete bottom of the spillway discharge channel were replaced. The washed out fill areas were also repaired. At this time additional riprap may have been placed on the upstream slope and the sluice gate was supposedly repaired.

The engineer for the 1956 reconstruction was T.W. ("Don") Westlake, P.E., Holmes Road, RD 1, Box 66, Newburgh, New York. Some spillway and flashboard computations, possibly done by Westlake and/or the State reviewers in 1956, appear on Appendices F3-15 to F3-
17. Drawings concerning the 1956 reconstruction can be found as Appendices G-2 and G-3. The construction contractor for the 1956 work is not known.

c. Maintenance and Pending Remedial Work

There are no known plans for any maintenance or remedial work on the dam by the Owner.

2.3 OPERATION RECORD

a. Inspections

There is no known record of inspection of the dam by the Owner.

One inspection report by the New York State Department of Environmental Conservation (NYS-DEC), dated April 23, 1973, was found (see Appendix F3-18). This inspection report indicated that concrete surfaces at the dam needed some minor repairs that could be undertaken as maintenance items. The growth of trees on the downstream slope and minor cracks in the concrete were noted. The report indicated that some periodic maintenance was being performed and that the dam was in good condition.

b. Performance Observations, Water Levels, and Discharges

There are no known records of performance observations or of routine water levels and discharges at the dam.

c. Past Floods and Previous Failures

On September 21, 1938 the dam was overtopped and breached. In August 1955 high water again overtopped and damaged the dam. The details of these failures have previously been discussed in Section 2.2b.

2.4 EVALUATION

a. Availability

As listed on Appendix F1, engineering data and records for the dam were available from the Dam Safety Section of the NYS-DEC. This data was reviewed, and copies of all the records found are included in chronological order in Appendices F3 and G. Appendix F2, Checklist for General Engineering Data and Interview with Dam Owner, also contains pertinent engineering information.

b. Adequacy

Available data consisted of drawings, letters, and a report concerning the two failures and subsequent reconstructions.
applications for reconstruction, and an inspection report. Such
data as original design drawings, construction specifications,
design calculations, record drawings, complete data on foundation
and embankment soils, and operation and performance data were not
available. The lack of such in-depth engineering data does not
permit a comprehensive review. Therefore, the available data was
not adequate by itself to permit an assessment of the dam.

c. Validity

Based on field observation and checking, some of the
data is not valid. The flashboards now used at the dam are 3 feet
high and do not resemble the 2.5-foot-high flashboards of the 1956
reconstruction design (see Appendix G-3), which were designed to
trip at various water elevations. The present flashboards are
shown in Photo A-6B.

The outlet conduit is reported as being 3 feet square
(see Appendix F3-1), but actually measures 3.8 feet wide at its
downstream end.

The dike shown on the 1956 reconstruction drawing to
the left of the spillway (see Appendix G-2) is not apparent in
the field.

The 1939 and 1956 reconstruction drawings (see Appendix
G) show that the core wall was to be raised 2.5 feet, for a total
height of 6.5 feet over the spillway crest. Measurements show that
only about 2 feet was added, for a total height of 6 feet over the
spillway crest.

The 1939 reconstruction drawing (see Appendix G-1) indi-
cates that the downstream slope should be 2H:1V and the upstream
slope 2.5H:1V. Measurements show that the downstream slope is very
irregular and is about 1.25H:1V at its steepest portion. The up-
stream slope below the water level could not be estimated, but the
beach is about 8H:1V and the slope above the beach is about 1.5H:1V.
SECTION 3

VISUAL INSPECTION

3.1 FINDINGS

a. General

Tillson Lake Dam was inspected on April 8, 1981. The inspection party (see Appendix B-1) was accompanied by Mr. George Surinach, Vice-President of Tillson Lake Recreation Park, Inc., lessee of the dam and lake, who represented the Owner. Mr. Surinach is the son of Mr. Henry Cuney, who is the normal Operator of the dam and is President of the Recreation Park. The weather was sunny and warm at the time of the inspection. The water surface was at about EL 370.2 or about 2 inches over the spillway crest. The Visual Inspection Checklist is included as Appendix B, while selected photos taken during the inspection are included in Appendix A and as the Overview Photo at the beginning of this report. Appendix A-1 is a photo index map.

b. Dam

There is no evidence of sloughs or slides of the embankment.

Cracked Core Wall - The core wall is cracked at its junction with the right spillway training wall, as shown in Photo A-3B. It is also cracked at Sta 1+07, 1+18, 1+35, 1+50, and 1+60. The core wall was covered with soil beyond Sta 1+75.

These cracks probably render the core wall ineffective as a barrier to seepage through the embankment. That is, observation wells on each side of the wall and installed at the same depth would probably show practically the same water level on both sides of the wall. For this reason, this dam should be considered essentially an earth dam without a core wall for the purposes of judging its susceptibility to piping, until further information is available.

The core wall does serve the function of halting further erosion if the upstream slope is eroded away. It also would considerably retard any breach that might begin to form during an overtopping. The concrete core wall is also a positive barrier to any animals burrowing in the embankment. One woodchuck hole was observed at about midheight on the downstream slope among boulders at about Sta 1+70.

Trees and Shrubs - The crest, the entire downstream slope, and the upstream slope along the normal water line are all fully
forested with trees and shrubs, as shown in the Overview Photo and Photo A-2A. This vegetation prevents any effective observation of seeps that may occur through the embankment.

Spoil on Crest and Downstream Slope - The drawing for repair of the dam in 1939 (see Appendix G-1) shows a downstream slope of 2H:1V. The measured downstream slope at its steepest portion is 1.25H:1V (see Photo A-3A). Also, the crest is at a higher elevation along much of its length, by about 2 feet, than is shown in the 1939 and 1956 reconstruction drawings. At about Sta 1+70 to 2+20 on the downstream slope there is a pile of discarded boulders, also shown in Photo A-3A.

It is probable that this steeper-than-designed downstream slope and higher crest were built up from spoil removed from the bottom of the lake. This spoil material, if it became saturated by leakage through the core wall, high rainfall, or minor overtopping, would be unstable. In addition, if the spoil is less pervious than the embankment, it could act as a cap on the downstream slope, preventing proper drainage and reducing stability.

Surface Erosion - Extensive erosion of the upstream slope has occurred both to the left and to the right of the spillway (see Photos A-2A and A-7A). This erosion has not proceeded further into the dam due to the core wall.

The entire upstream slope is wave-cut at the normal lake level and a beach has formed in the riprap.

Soil has been extensively eroded from the downstream toe of the dam to the right of the right spillway training wall (see Photo A-4A). This latter erosion may have occurred during the flood in 1955 and was not repaired, or it may have been repaired and re-eroded.

Seepage - One seep was observed on the downstream side. It was exiting from a point 18 inches below and 12 inches to the right of the low-level outlet conduit (shown as an iron-stained zone on the left in Photo A-4B). This seep was clear, running at 6 to 10 gpm, and appeared to be exiting from the top of bedrock.

Some dampness was observed at the level of the toe of the pile of boulders on the downstream slope.

c. Appurtenant Structures

1) Intake Structure and Control Tower

The intake structure and control tower are one and the same concrete structure located upstream of the dam, in the reservoir, surrounded by water (see Photo A-5A). Only the upper part of the control tower was visible for inspection. The lower part of the tower and the intake structure were submerged.
From what was readily visible from shore, the control tower is in poor condition. The concrete is eroded and stained. The brackets for the slide gate control mechanism are also rusted and appear to be loose.

On top of the control tower there is a control mechanism (see Photo A-5A) for the 30-inch-diameter slide gate on the outlet conduit. The gate stem, which runs up the downstream side of the tower, and the control mechanism are rusted and in poor condition. The control mechanism is inoperable, according to the Operator's son, and its handwheel is missing. The slide gate is presently closed and has not been operated for a number of years.

2) Outlet Structure and Outlet Conduit

The outlet structure consists of just the exposed end of the square outlet conduit (see Photo A-4B). The outlet structure concrete is scaling and discolored. The outlet conduit is also silted in to about one-half its normal depth as far upstream as could be seen. The remainder of the inside of the outlet conduit was not observable.

3) Spillway and Discharge Channel

The spillway is at the left side of the dam looking downstream (see Overview Photo). The spillway consists of a concrete ogee-like weir section with flashboards and a concrete discharge channel with concrete training walls (see Photos A-5B, A-6A, and A-6B). In general, the concrete of the spillway and discharge channel is in fair to poor condition.

The upper one foot of concrete of the left training wall is crumbling (see Photos A-6B and A-7A). There is deterioration of the cold joints as well as cracking and efflorescence of the concrete. Available records indicate that the top of the left training wall was raised during the 1956 reconstruction (see Section 2.2b).

The right training wall has a crack its full height, at about the toe of the ogee section (see Photo A-8A). There is a large spall at the right training wall contact with the downstream side of the ogee crest (see Photo A-7B) and erosion of this training wall at the water line on the upstream side near the spillway (see Photo A-2A). There is erosion of the concrete along the base of the right training wall due to the flow of water (see Photo A-8A). Efflorescence, minor cracking, and the location of cold joints can be seen in Photos A-7B and A-8A.

The face of the ogee-like spillway section is eroded and the concrete is spalling and scaling (see Photo A-7B). There is also considerable erosion and spalling of the spillway-to-channel bottom transition joint (see Photo A-6B) and the erosion is as much as one foot deep in some places.
The discharge channel slab is cracking (see Photo A-8B) and there are spalls along its construction joints. The channel concrete along the base of the right training wall is also eroding due to flow which concentrates there. There are also two seeps through cracks in the concrete floor of the spillway discharge channel. One seep is flowing clear at about 1 gpm and the other is flowing clear at about 25 gpm (see Photo A-8B). There are iron stains where the seeps exit. The seepage may be entering the pavement through cracks higher up on the floor of the spillway.

d. Reservoir Area

The reservoir area is grassed or forested with hardwoods (see Photo A-9A). Slopes are gentle and there was no indication that excessive erosion or slope failures into the reservoir might occur.

e. Downstream Channel

The downstream channel (see Photo A-9B) is a continuation of the Palmaghatt Kill starting from the toe of the dam and the downstream end of the spillway discharge channel. Downstream of the dam the Palmaghatt Kill is a somewhat rocky channel that is wooded along both sides.

3.2 EVALUATION

The cracked core wall makes it necessary to assume that the core wall is absent for the purpose of evaluating potential piping.

The spoil material that was placed on the downstream side of the dam probably was merely dumped loosely. If it becomes saturated due to seepage, high rainfall, or minor overtopping, it is likely to fail since it was dumped to a slope of 1.25H:1V.

The spoil, trees, brush and the boulders on the downstream slope make it impossible to inspect the slope adequately.

Erosion that is occurring adjacent to the spillway on the upstream and downstream side should be repaired. Also, the wave-cut upstream slope should be repaired by replacing riprap and removing the trees and brush.

The outlet pipe slide gate does not work. It should be repaired and then exercised regularly.

The outlet conduit should be dewatered, cleaned, and then inspected to ascertain its condition.

The large vertical crack in the right training wall should be checked periodically for possible worsening condition.
The seeps through the spillway discharge channel floor should be investigated further when the water level is below the spillway crest to try and find their origin.

The zones of eroded and deteriorated concrete of the discharge channel, spillway crest, and training walls should be repaired.
SECTION 4
OPERATION AND MAINTENANCE PROCEDURES

4.1 OPERATION PROCEDURES

There are no written operation procedures for the dam.

Tillson Lake is used for recreational purposes. The outlet conduit sluice gate is normally shut. The dam has 3-foot-high flashboards which are in place from May through September (essentially the summer season) and are normally removed by the Operator's son for the period of October through April (fall-winter-spring).

At the time of inspection on April 8, 1981 the lake level was about 2 inches higher than the concrete weir crest with outflow estimated to be about 5 cfs. Three of the four 13.75-foot-long sections of flashboards were still in place on the weir crest since only one section had been removed prior to this last winter.

4.2 MAINTENANCE OF DAM AND OPERATING FACILITIES

There are no maintenance procedures for the dam.

The Operator visits the dam site at least twice a week during the summer and randomly at other times. The outlet conduit sluice gate, normally closed, is inoperable. It can only be reached by boat and the operating handwheel is missing. The sluice gate was reportedly last operated 15 or 20 years ago. In about 1979 a diver casually looked at the sluice gate while looking for a lost watch. The Operator's son indicated that the diver verbally reported that there was a buildup of debris in front of the gate and that it was corroded.

The lake used to be drained for cleaning about every 10 years, but this was last done in the 1960's according to the Operator's son. The flashboards are replaced or repaired as required.

4.3 EMERGENCY ACTION PLAN AND WARNING SYSTEM

There is no emergency action plan and warning system for the dam.

4.4 EVALUATION

Maintenance of the dam is unsatisfactory. The condition of the dam and its appurtenances seems to indicate that it receives little to no routine maintenance. Large trees, brush, and debris cover the upstream and downstream slopes. There is erosion damage to the upstream slope near the right training wall of the spillway. The outlet sluice gate is in a state of disrepair and the downstream
end of the outlet conduit is silted in for half its depth. Effective operation and maintenance procedures need to be developed and implemented by the Owner in order to avoid continued deterioration of the dam.

The Owner should develop an emergency action plan outlining action to be taken to minimize the downstream effects of an emergency, together with an effective warning system.
SECTION 5
HYDROLOGY AND HYDRAULICS

5.1 DRAINAGE AREA CHARACTERISTICS

Tillson Lake Dam and Tillson Lake are located on the Palmaghatt Kill in southeastern New York. About 1.5 miles downstream of the dam, the Palmaghatt Kill joins the Shawangunk Kill. The Shawangunk Kill drains to the northeast into the Wallkill River, which in turn drains to the Rondout Creek. The Rondout Creek flows east and discharges into the Hudson River at Kingston.

The total drainage area at the dam is about 4.78 square miles, of which about 0.035 square miles (22.7 acres), or less than one percent, is actual reservoir surface at the spillway crest (see Appendix C-6). Being in the Shawangunk Mountains, the topography is characterized by slopes of from 10% to 25%. Elevations in the drainage area vary from EL 370 to EL 2180.

5.2 ANALYSIS CRITERIA

The U.S. Army Corps of Engineers Hydrologic Engineering Center's Program HEC-1 DB (Reference 3) was used to develop the test flood hydrology and perform the reservoir routing.

The purpose of this analysis was to evaluate the dam and spillway with respect to their surcharge storage and spillway capacity. Accordingly, it was assumed that the water surface was at the spillway crest, with flashboards removed (normal fall-winter-spring condition), at the start of the flood routing. In addition, the outlet conduit was assumed to be closed, as it is normally. The outlet conduit gate is presently inoperable anyway.

A constant base flow of 2 cfs per square mile was chosen to represent average conditions in the drainage area and was inputted into the program for all subareas.

The index PMP (probable maximum precipitation) input to the HEC-1 DB program was 21 inches for a 24-hour duration all-season storm over a 200-square-mile basin, according to HMR 33 (Reference 4). Maximum 6-hour, 12-hour, and 24-hour precipitation for the actual size of the drainage area (same for 10 square miles or less) were inputted to the program as percentages of the index PMP in accordance with HMR 33. A storm reduction coefficient was then applied internally by the program in order to transpose or center the storm over the actual total drainage area. Thus, the corrected 24-hour PMP for the actual total drainage area became 22.2 inches. All rainfall was distributed using the Standard Project Storm arrangement embedded in the program. (Note: Only a 24-hour PMP was modeled. If a 48-hour PMP had been used, as is customary, the corrected 48-hour PMP would have been 23.9 inches,
inflow to the reservoir would have been slightly more, and spillway capacity would have been slightly more inadequate than shown by the analysis in this report.)

Appendix C-8 summarizes the subarea, loss rate, and unit hydrograph data input to the program. Only two subareas were used. Subarea 1 consists of all the drainage area around the reservoir, and Subarea 2 consists of just the reservoir surface. For the land in Subarea 1, loss rates were assumed to be 1.0 inch initially and a constant 0.1 inch per hour thereafter. Snyder unit hydrograph parameters were chosen from the 1977 Lower Hudson River Basin Flood Routing Model (Reference 20). A conservative standard lag time was computed. The program uses the inputted lag time and Snyder peaking coefficient to solve by iteration for approximate Clark coefficients, which are then used to calculate the runoff hydrograph.

For the reservoir surface making up Subarea 2, loss rates were set to zero so that rainfall would equal rainfall excess, or runoff. Assuming no delay in the rainfall/runoff response, a constant unit hydrograph for a rainfall duration equal to the HEC-1 DB calculation interval was developed per Appendix C-8 and inputted to the program.

The floods selected for analysis were full and 1/2 PMF (probable maximum flood). Floods as ratios of the PMF (e.g., 1/2 PMF) were taken as ratios of runoff, not of precipitation. Peak inflow for the PMF is about 6,870 cfs or 1,437 csm (cfs per square mile). Peak outflow is not reduced at all by reservoir routing and is the same as peak inflow. For 1/2 PMF the peak inflow is about 3,440 cfs (720 csm) and the routed peak outflow is about 3,430 cfs (718 csm).

5.3 RESERVOIR CAPACITY

Storage capacity for the reservoir, assumed to be at the spillway crest without flashboards, EL 370, was obtained from applications for the two reconstructions of the dam in 1939 and in 1956 (see Appendices F3-3 & F3-11). USGS contour mapping (see Appendix C-5) was used to obtain area measurements inside contour elevations above the spillway crest and the capacity of the reservoir for these areas was computed by the method of conic sections. A hand tabulation of the reservoir volumes inputted to the program is on Appendix C-6.

At the spillway crest without flashboards, EL 370, the reservoir has a capacity of 230 acre-feet. At the spillway crest with flashboards, EL 373, the reservoir has a capacity of 312 acre-feet. At the top of dam, EL 376, the reservoir has a capacity of 394 acre-feet. Maximum surcharge storage between the spillway crest without flashboards and the top of dam amounts to 164 acre-feet, or about 0.6 of an inch of runoff from the total 4.78-square-mile drainage area. Therefore, the reservoir has almost no capacity to attenuate peak inflow.
5.4 SPILLWAY CAPACITY

The dam has a 55-foot-long concrete ogee-like spillway. During the summer the spillway is used with 3-foot-high flashboards, but for modeling purposes the flashboards were assumed not to be in place as is normal during fall, winter, and spring. The top of the dam is about 6 feet higher than the spillway crest without flashboards.

The discharge capacity for the service spillway was computed assuming critical flow over a sharp-crested weir. Since the spillway weir is not a true ogee and has a shallow approach depth due to silt buildup, the sharp-crested weir approximation is considered adequate for this analysis. Reduction in discharge capacity due to abutment contractions was neglected. The spillway discharge computations are presented on Appendix C-7. With water 6 feet over the spillway crest without flashboards (i.e., water level at top of dam) the spillway discharges about 2,690 cfs. With the 3-foot flashboards in place and the same water level at top of dam, the spillway discharge is reduced to about 950 cfs.

The 1956 application for reconstruction of the dam (see Appendix F3-12) indicates that the spillway was designed to safely discharge 1,250 cfs at a pool level 3.5 feet above the spillway crest. Present discharge computations in this analysis are slightly more conservative and show that a pool level of about 3.6 feet above the spillway crest is required to achieve the design discharge.

Total discharge from the dam consists of just flow from the spillway. As discussed previously in Section 5.2, the capacity of the outlet conduit was neglected since it is normally closed and presently inoperable. The weir parameters for the service spillway were inputted to the HEC-1 DB program which did the spillway discharge calculations during the flood routing.

5.5 FLOODS OF RECORD

As noted in Section 2.3c, the dam was overtopped and breached by a flood on September 21, 1938, and again overtopped and damaged by a flood in August 1955. The spillway was flashboarded just prior to both flood events and available records imply that the boards did not fail during either flood. For the 1938 flood, it appears that there were 4-foot-high flashboards level with the top of the dam and water spilled over a portion of the top of the dam. The depth of flow over the top is unknown. For the 1955 flood, the maximum pool level is reported in the 1956 Engineer's Report (see Appendix F3-9) to have been about 2 feet over the flashboards (boards appear to have been about 2 feet high at that time). Using the spillway capacity data developed in Section 5.4, the corresponding flood discharge in 1955 is estimated to have been about 500 cfs (105 csm), or only about 7% of the PMF peak outflow predicted. 500 cfs is probably equal to or greater than the 1938 flood, since during that event 500 cfs would have required a depth of flow over the entire top of dam and flashboarded spillway of about 8 inches.
5.6 OVERTOPPING POTENTIAL

The results of the overtopping analysis using the HEC-1 DB program are summarized in Table 5.1. The overtopping analysis computer input and output for the PMF and 1/2 PMF are included starting on Appendix C-9.

As noted from Table 5.1, the PMF overtops the dam by about 2.2 feet maximum with duration of overtopping of about 7.2 hours. 1/2 PMF also overtops the dam but only by 0.6 of a foot maximum with duration of overtopping of about 3.3 hours. Peak inflows are 6,870 cfs for the PMF and 3,440 cfs for 1/2 PMF. PMF peak outflow is the same as inflow, while 1/2 PMF peak outflow is reduced slightly by reservoir routing to 3,430 cfs. Time to maximum stage, or the time from the start of the 24-hour storm to peak outflow, is about 20 hours for both PMF and 1/2 PMF. The peak portion of the inflow and outflow hydrographs for the PMF and 1/2 PMF are shown by the computer plots on Appendices C-15 and C-16. Total project discharge capacity at the top of dam is due only to the spillway (no flashboards, outlet conduit closed) and is about 2,690 cfs, or only about 39% of the PMF peak outflow and about 78% of the 1/2 PMF peak outflow.

Tillson Lake Dam was also modeled with the 3-foot-high flashboards in place on the spillway. For this case the total project discharge capacity at the top of dam is only about 950 cfs, or only about 14% of the PMF peak outflow. The PMF overtops the dam by about 3.0 feet and 1/2 PMF overtops the dam by about 1.6 feet. The computer input and output are included starting on Appendix C-17 and the results are summarized by footnote (e) on Table 5.1.

5.7 EVALUATION

Maximum spillway discharge capacity without flashboards is only about 39% of the PMF peak outflow. The 1/2 PMF would overtop the earth embankment and would probably cause failure. The dam has failed completely due to overtopping once in the past in 1938 causing violent flooding and damage downstream. It is judged that failure due to overtopping would significantly increase the hazard to loss of life downstream from that which would exist just prior to failure. Therefore, in accordance with Corps of Engineers' screening criteria for review of spillway adequacy, spillway capacity is considered "seriously inadequate" and the dam is assessed as "unsafe, non-emergency".
### TABLE 5.1

**TILLSON LAKE DAM**

**OVERTOPPING ANALYSIS**

**CONDITIONS**
- Total Drainage Area = 4.78 square miles
- Start Routing at Spillway Crest EL 370
- Top of Dam EL 376
- Total Project Discharge Capacity at Top of Dam = 2,690 cfs due to spillway (flashboards removed).
- Outlet conduit closed.
- Some values rounded from computed results.

<table>
<thead>
<tr>
<th>PMF</th>
<th>1/2 PMF (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INFLOW</strong></td>
<td></td>
</tr>
<tr>
<td>24-hour Rainfall (inches)</td>
<td>22.2</td>
</tr>
<tr>
<td>24-hour Rainfall Excess (inches) (c)</td>
<td>19.5</td>
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<tr>
<td>Peak Inflow (cfs)</td>
<td>6,870</td>
</tr>
<tr>
<td>Peak Inflow (csm)</td>
<td>1,437</td>
</tr>
<tr>
<td><strong>OUTFLOW</strong></td>
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</tr>
<tr>
<td>Peak Outflow (cfs)</td>
<td>6,870</td>
</tr>
<tr>
<td>Peak Outflow (csm)</td>
<td>1,437</td>
</tr>
<tr>
<td>Time to Peak Outflow (hours)</td>
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<tr>
<td>Maximum Storage (acre-feet)</td>
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<tr>
<td>Max. W.S. Elevation (feet-NGVD)</td>
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<tr>
<td>Minimum Freeboard (feet)</td>
<td>overtopped</td>
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<td>Maximum Depth over Dam (feet)</td>
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<tr>
<td>Duration of Overtopping (hours)</td>
<td>7.2</td>
</tr>
</tbody>
</table>

(a) One-half of PMF total runoff, including base flow. For PMF base flow = 2 cfs per square mile = 10 cfs ±
(b) Approximation assuming total losses are the same as for the PMF.
(c) Rainfall Excess = Rainfall for the Reservoir Surface. For the rest of the drainage area, losses are assumed to be 1.0 inch initially and 0.1 inch per hour thereafter.
(d) Equal to one-half of PMF value.
(e) If 3-foot high flashboards are in place and do not fail, total discharge capacity at top of dam = 950 cfs ±; for PMF, peak outflow = 6,870 cfs ± and dam overtopped by 3.0 feet; for 1/2 PMF, peak outflow = 3,430 cfs ± and dam overtopped by 1.6 feet.
SECTION 6
STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

The steep (1.25H:1V) downstream slope apparently was formed by dumping spoil from the lake bottom loosely on top of the original dam. This slope is very likely to slide downstream if it becomes saturated by seepage through the cracked core wall, heavy rain, or minor overtopping of the dam. The failure of this mass of material may or may not cut into the original slope of the dam.

b. Design and Construction Data

The design and construction data indicate that the downstream slope should be 2H:1V. The steeper existing downstream slope was discussed above.

No existing stability analysis was found for any part of the dam.

c. Operating Records

No operating records were found or operational problems reported which would adversely affect the stability of the dam.

d. Post-Construction Changes

The post-construction change was discussed in 6.1a above.

e. Seismic Stability

This dam is in Seismic Zone 1. According to Recommended Guidelines (Reference 1) a seismic stability analysis is not required.

6.2 STABILITY ANALYSIS

The concrete spillway is a gravity structure varying in height from about 4 feet to 20 feet. An independent structural stability analysis was performed on a representative section about 16 feet high. The cross section for analysis was chosen about 10 feet from the right training wall where the effects of lateral support due to the training wall are considered minimal. The cross section geometry is based on a 1939 reconstruction drawing (see Appendix G-l) and on visual observation (see Photos A-6B and A-7B). The following loading cases were analyzed:
Case 1 - Normal pool at flashboard crest 3 feet above spillway crest, full headwater uplift, no tailwater, silt load starting 3 feet below spillway crest based on observation.

Case 2 - Normal pool at spillway crest, no flashboards, ice load of 5 kips per linear foot for ice 1.0 foot thick, full headwater uplift, tailwater and silt load same as Case 1.

Case 3 - Half PMF pool at EL 376.6 or 6.6 feet above spillway crest, tailwater estimated at 5 feet deep or 11 feet below spillway crest, full headwater and tailwater uplift, no flashboards, silt load same as Case 1.

Case 4 - Full PMF pool at EL 378.2 or 8.2 feet above spillway crest, tailwater estimated at 6 feet deep or 10 feet below spillway crest, remaining conditions same as Case 3.

The results of the stability analysis are summarized in Table 6.1. The computations are included in Appendix D.

For all the loading cases analyzed, minimum satisfactory overturning stability is considered to be a factor of safety of 1.5 with the resultant passing through the middle third of the base. For sliding stability, because of the method of analysis used and the conservative assumptions that were made about foundation material properties, a minimum satisfactory factor of safety of 2.0 is considered appropriate for all the loading cases analyzed, rather than the customary 3.0. Both overturning and sliding stability must be satisfactory in order for stability of the section to be satisfactory.

As noted from Table 6.1, the spillway has unsatisfactory stability for all four primary loading cases. Included in the unsatisfactory rating are the normal summer condition and winter ice load condition, Cases 1 and 2 respectively. Case 1A, normal pool at spillway crest with no flashboards, which represents normal spring and fall conditions under present operating procedures, is the only case where the spillway appears to have acceptable stability, and then only by a small margin. This normal spring condition essentially prevailed on the day of the visual inspection.

Case 1B is the same as Case 1 except that the very large shear key at the heel of the section is assumed to help resist overturning. This causes the overturning stability to become barely satisfactory, but tensile stresses must exist in the concrete in order to allow the shear key to be effective. The concrete is assumed to be unreinforced since no data was found to the contrary. Development of tensile stresses in unreinforced concrete.
<table>
<thead>
<tr>
<th>CASE</th>
<th>FACTOR OF SAFETY (a)</th>
<th>LOCATION OF RESULTANT (b)</th>
<th>SLIDING FACTOR OF SAFETY (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spillway Section</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1- Normal Pool</td>
<td>1.24 unsatisfactory</td>
<td>0.22b</td>
<td>1.75 unsatisfactory</td>
</tr>
<tr>
<td>with Flashboards</td>
<td>1.63</td>
<td>0.38b</td>
<td>2.51</td>
</tr>
<tr>
<td>1A- no Flashboards</td>
<td>1.53 (tensile stresses)</td>
<td>0.39b</td>
<td>1.75 unsatisfactory</td>
</tr>
<tr>
<td>1B- with Flashboards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and U/S shear key</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2- Normal Pool,</td>
<td>1.05 unsatisfactory</td>
<td>0.05b</td>
<td>2.16</td>
</tr>
<tr>
<td>no Flashboards, Ice Load</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3- Half PMF Pool,</td>
<td>&lt;1.17 unsatisfactory</td>
<td>&lt;0.14b</td>
<td>&lt;1.57 unsatisfactory</td>
</tr>
<tr>
<td>no Flashboards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4- Full PMF Pool,</td>
<td>&lt;1.10 unsatisfactory</td>
<td>&lt;0.09b</td>
<td>&lt;1.45 unsatisfactory</td>
</tr>
<tr>
<td>no Flashboards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Right Training Wall of Spillway Discharge Channel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1- Normal Conditions</td>
<td>0.78 unstable</td>
<td>-0.14b</td>
<td>7.56</td>
</tr>
</tbody>
</table>

(a) Overturning factor of safety is ratio of resisting moments to driving moments taken about the toe.

(b) Distance from toe to point where resultant passes through base, expressed in terms of base dimension "b". Middle third of base is 0.33b to 0.67b.

(c) For spillway section, sliding factor of safety is ratio of shear resistance moment to driving moments taken about the center of a circular arc failure plane. For spillway training wall, sliding factor of safety is ratio of shear resistance force to driving forces taken along a horizontal failure plane.
concrete is itself considered unsatisfactory. Therefore, the stability of Case 1B must be considered just as unsatisfactory as Case 1.

For Cases 3 and 4, the 1/2 PMF and PMF conditions, it should be noted that the full weight of the flowing water on the face of the spillway was taken into account as a resisting force. Considering the relatively steep face of the spillway and the high head and discharge for the 1/2 PMF and PMF conditions, it is probable that the flowing water would exert little to no pressure - or even negative pressure - on face of the spillway. Therefore, the actual stability might be even more unsatisfactory than presently computed, even to the point where the spillway would become unstable under 1/2 PMF and PMF conditions.

In view of the apparent unsatisfactory stability of the spillway, it is recommended that a detailed structural stability investigation of the spillway be conducted to better assess its stability under all loading conditions. The investigation should include appropriate field and laboratory work to determine foundation material properties and structural details. Also, the effect of lateral support offered by the spillway abutments may need to be evaluated. The investigation should determine what modifications, if any, are necessary to achieve satisfactory stability.

The right concrete training wall of the spillway discharge channel is also a significant gravity structure. Its failure would threaten the safety of the embankment behind it. A section of this wall was analyzed under normal earth load conditions with an assumed normal water level in the embankment of 5 feet above the spillway channel floor. The cross section for analysis was chosen at the maximum unsupported height of about 21 feet which occurs at about the spillway toe. The results of the analysis are summarized in Table 6.1, while the computations are included starting on Appendix D-19.

As noted from Table 6.1, the training wall is critically unstable against overturning for normal conditions. Sliding stability does not appear to be a problem. Since the wall has not in fact failed, the present analysis must not reflect the true support system of the wall and/or the actual loading conditions. The wall was assumed to be unreinforced since no data was found to the contrary.

In view of the apparent instability of the right training wall of the spillway discharge channel, it is recommended that the training wall be included in the detailed structural stability investigation previously recommended for the spillway itself. Similar to the spillway study, the investigation of the right training wall should include determination of embankment loading conditions and structural details, the possible need to evaluate
the affects of lateral support offered by the spillway, and the
determination of any modifications necessary to achieve satis-
factory stability.
7.1 **ASSESSMENT**

**a. Safety**

Visual inspection of Tillson Lake Dam revealed the following deficiencies which affect the safety of the dam:

1) Discarded spoil and boulders on top of the original downstream slope and crest.

2) Multiple cracks in the concrete core wall.

3) Trees and shrubs on the entire downstream slope, the crest, and along the water line upstream.

4) Erosion adjacent to the spillway and along the upstream slope.

Hydrologic and hydraulic analysis indicates that maximum spillway discharge capacity without flashboards is only about 39% of the PMF peak outflow. The 1/2 PMF would overtop the earth embankment and would probably cause failure. It is judged that failure due to overtopping would significantly increase the hazard to loss of life downstream from that which would exist just prior to failure. Therefore, in accordance with Corps of Engineers' screening criteria for review of spillway adequacy, spillway capacity is considered "seriously inadequate" and the dam is assessed as "unsafe, non-emergency".

Structural stability analysis of the spillway section indicates unsatisfactory stability for normal summer conditions and winter ice load conditions, as well as for 1/2 PMF and PMF conditions. Normal spring and fall conditions (with flashboards removed) result in satisfactory stability by only a small margin. Structural stability analysis of the right training wall of the spillway discharge channel indicates critical instability for normal conditions.

**b. Adequacy of Information**

Available information together with that gathered during the visual inspection, while considered adequate for this Phase I Inspection, is deficient in the following respects:

1) The downstream slope and crest are covered with miscellaneous fill, boulders, and trees, making it impossible to observe their condition adequately.
2) There are no data available on material properties of the foundation under the spillway, embankment loading conditions behind the right training wall of the spillway discharge channel, and structural details inside the spillway and right training wall. Such data critically affect the structural stability analysis of these two sections.

3) Minor inconsistencies in the engineering data available, based on field observation and checking, are itemized in Section 2.4c.

c. Need for Additional Investigations

The following detailed engineering investigations should be performed by a registered professional engineer qualified by training and experience in the design of dams:

1) Perform a detailed hydrologic and hydraulic analysis to better assess spillway adequacy. This should include a more accurate determination of the site specific characteristics of the watershed.

2) Investigate the character of the spoil material on the downstream slope to determine whether it should be removed and, if so, provide the procedure for removal.

3) Determine whether major repairs should be made to the core wall.

4) Investigate the origin of the seeps through the floor of the spillway discharge channel.

5) Perform a detailed structural stability analysis of the spillway and of the right training wall of the spillway discharge channel to better assess their stability under all loading conditions. This should include investigation of foundation conditions, embankment loading conditions, and structural details. The large vertical crack in the right training wall should be taken into account.

d. Urgency

As recommended below in Section 7.2a, the flashboards should be removed from the spillway immediately. Also, a program to visually inspect the dam at least once a month should be instituted immediately. As recommended below in Section 7.2b, development of an emergency action plan should be completed within 3 months after receipt of this Phase I Inspection Report by the Owner. While the action plan is being developed, and within 3
months after receipt of this report by the Owner, the investigations recommended above in Section 7.1c should be started.

Any remedial work deemed necessary as a result of these investigations should be completed within 18 months after receipt of this report by the Owner.

Measures recommended below in Section 7.2c should be completed within 12 months after receipt of this report by the Owner.

7.2 RECOMMENDED MEASURES

The following work should be performed by the Owner. Where engineering assistance is indicated, the Owner should engage a registered professional engineer qualified by training and experience in the design of dams. Assistance by such an engineer may also be useful for some of the other work.

a. Complete Immediately

1) Remove the flashboards from the spillway and keep them removed pending the results of the detailed hydrologic and hydraulic analysis.

2) Institute a program to visually inspect - not just casually look at - the dam and its appurtenances at least once a month.

b. Complete Within 3 Months

Develop an emergency action plan outlining action to be taken to minimize the downstream effects of an emergency, together with an effective warning system.

c. Complete Within 12 Months

1) Remove trees and brush and their root systems from all surfaces of the dam and for 20 feet downstream of the toe in accordance with procedures established by an engineer. Continue to keep these same areas clear by cutting brush and trees and mowing grass at least annually.

2) Repair the eroded zones of the embankment adjacent to the spillway and along the upstream slope in accordance with a design by an engineer.

3) Monitor the seep adjacent to the outlet conduit and have the data evaluated in accordance with procedures established by an engineer.
4) Dewater and clean the outlet conduit and have it inspected by an engineer.

5) Restore the outlet conduit sluice gate to operation and exercise it regularly.

6) Contingent on the results of the detailed stability analysis by an engineer, repair the zones of eroded and deteriorated concrete of the spillway, discharge channel, and training walls in accordance with a design by the engineer.

7) Develop and implement effective routine operation and maintenance procedures for the dam and its appurtenances.

8) Institute a program of comprehensive technical inspection of the dam and its appurtenances by an engineer on a periodic basis of at least once every two years.

d. Complete Within 18 Months

The following remedial work should be completed by the Owner. A qualified, registered professional engineer should design and observe the construction of the remedial work.

1) Appropriate modifications as a result of the detailed hydrologic and hydraulic analysis.

2) Appropriate modifications as a result of investigating the spoil material on the downstream slope.

3) Appropriate modifications as a result of investigating the cracks in the core wall.

4) Appropriate modifications as a result of investigating the seeps through the floor of the discharge channel.

5) Appropriate modifications as a result of the detailed structural stability analysis of the spillway and of the right training wall of the spillway discharge channel.
APPENDIX A

PHOTOGRAPHS
TILLSON LAKE

ERODED AREA

APPROX. AREA OF DISCARDED BOULDERS & SPOIL

SEEPS

ERODED AREA

RIGHT
A-2A  Upstream slope of dam looking toward right abutment. Note erosion of training wall and upstream slope near spillway 4/8/81

A-2B  Top of dam looking toward left abutment - 4/8/81
A-3A  Downstream slope of dam from 20 feet downstream of toe at about Sta 3 + 00 - 4/8/81

A-3B  Crack at core wall and right training wall junction - 4/8/81
A-4A  Erosion at right side of downstream end of right training wall of spillway discharge channel. Eddy probably caused the erosion - 4/8/81

A-4B  Outlet conduit looking upstream. A seep is barely visible at the left side of the outlet conduit - 4/8/81
A-5A  Control tower and slide gate control mechanism - 4/8/81

A-5B  Spillway crest with flashboards, one section removed, looking downstream - 4/8/81
A-6A  Spillway discharge channel looking upstream. Note erosion at downstream end of left training wall and seep in middle through channel bottom - 4/8/81

A-6B  Spillway crest looking toward left abutment. Note erosion at ogee and channel transition and siltation upstream of weir - 4/8/81
A-7A  Left training wall and exposed core wall at spillway crest. Note cold joints and deteriorated condition of concrete 4/8/81

A-7B  Right training wall at spillway crest. Note spalling at training wall and ogee intersection and erosion and scaling of downstream side of ogee section - 4/8/81
A-8A Right training wall at downstream end of ogee section. Note vertical crack in wall and flow concentration and resulting erosion along base of wall - 4/8/81

A-8B Close-up of seep through floor of spillway discharge channel 4/8/81
A-9A  Reservoir shoreline looking upstream from dam. Note control tower at left - 4/8/81

A-9B  Downstream channel from spillway crest - 4/8/81
APPENDIX B

VISUAL INSPECTION CHECKLIST
PHASE I

VISUAL INSPECTION CHECKLIST

1. BASIC DATA
   a. General

<table>
<thead>
<tr>
<th>Name of Dam</th>
<th>Tillson Lake Dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fed. I.D.#</td>
<td>NY00083</td>
</tr>
<tr>
<td>DEC Dam No.</td>
<td>194 - 2420</td>
</tr>
<tr>
<td>River Basin</td>
<td>LOWER HUDSON</td>
</tr>
<tr>
<td>Location: Town</td>
<td>GARDINER</td>
</tr>
<tr>
<td>County</td>
<td>ULSTER</td>
</tr>
<tr>
<td>Stream Name</td>
<td>PALMAGHATT KILL</td>
</tr>
<tr>
<td>Tributary of</td>
<td>SHAWANGUNK KILL</td>
</tr>
<tr>
<td>Latitude (N)</td>
<td>41° 40.3'</td>
</tr>
<tr>
<td>Longitude (W)</td>
<td>74° 14.8'</td>
</tr>
<tr>
<td>Type of Dam</td>
<td>EARTH FILL W/ CONCRETE CORE WALL</td>
</tr>
<tr>
<td>Hazard Classification</td>
<td>HIGH</td>
</tr>
<tr>
<td>Date(s) of Inspection</td>
<td>APRIL 8, 1981</td>
</tr>
<tr>
<td>Weather Conditions</td>
<td>SUNNY &amp; WARM</td>
</tr>
<tr>
<td>Reservoir Level at Time of Inspection</td>
<td>370.17 ft</td>
</tr>
<tr>
<td></td>
<td>(2&quot; HIGHER THAN CONCRETE WEIR CREST)</td>
</tr>
</tbody>
</table>

b. Inspection Personnel (*Recorder) THOMAS BENNETT - CTM,
   EDWIN VOPELAK JR. - CTM, STEVE J. POULOS - GEI

c. Persons Contacted (Including Title, Address & Phone No.)

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Address</th>
<th>Phone No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEORGE SURINACH</td>
<td>Vice-President of Tillson Lake Rec. Park, Inc.</td>
<td>35 UTERBY RD., MALVERNE, NY 11565 (LEASER &amp; OPERATOR OF LAKE &amp; DAM)</td>
<td>(516) 489-0505</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HOME (516) 687-7859</td>
</tr>
</tbody>
</table>

ALSO WET HENRY CUNY, PRES. OF TILLSON LAKE REC. PARK & OPERATOR OF DAM AT SITE PRIOR TO INSPECTION

d. History

<table>
<thead>
<tr>
<th>Date Constructed</th>
<th>1930 - 1930's</th>
<th>Date(s) Reconstructed</th>
<th>1939 - 1956</th>
</tr>
</thead>
</table>

Designers

<table>
<thead>
<tr>
<th>Original</th>
<th>UNKNOWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1939</td>
<td>S. LEFEVRE</td>
</tr>
<tr>
<td>1956</td>
<td>T.W. WESTLAKE</td>
</tr>
</tbody>
</table>

Construction

| By               | UNKNOWN     |

Owner

| 141 REALTY, INC. | 100 SEACVIEW DR., SECAUCUS, NJ 07094 |

Attention:

| JOSEPH VANUE, PRESIDENT | (201) 348-4900 |

B-1
2. EMBANKMENT

a. Characteristics

GEI 1) Embankment Material. Probably glacial till. (An apparent former borrow area is on downstream side of right.)

GEI 2) Cutoff Type. None.

GEI 3) Impervious Core. Concrete core wall 18 in. thick at top. Cold joints in core wall to left of spillway and to right of spillway.

GEI 4) Internal Drainage System. None.

GEI 5) Miscellaneous. Appears that dredged material from pond has been discarded on crest and downstream slope. Both are very irregular.

b. Crest

GEI 1) Vertical Alignment. Irregular ± 1 ft.

GEI 2) Horizontal Alignment. Irregular due to piled spoil.


GEI 4) Surface Cracks. Core wall is cracked at spillway and at Sta 1+35, 1+18, 1+07, 1+50, and 1+60, core covered at stations beyond 1+75.

GEI 5) Miscellaneous. Crest is forested with trees to 10 in.

Outcropping Boulders.

b. Upstream Slope


GEI 2) Undesirable Growth or Debris, Animal Burrows. Trees to 8 in. Brush.

GEI 3) Sloughing, Subsidence or Depressions. Wave erosion at pool level. Eroded to core wall at spillway on both sides.
GEI 4) Slope Protection 3 to 12 in. stone to top of flashboards. Grass and brush and trees above.

GEI 5) Surface Cracks or Movement at Toe Not observable.

GEI d. Downstream Slope

GEI 1) Slope (Estimate - H:V) 1.25 H:1 V

GEI 2) Undesirable Growth or Debris, Animal Burrows Exposed. Trees to 20in. Pile of rocks at Sta 1+70 mid-slope.

GEI 3) Sloughing, Subsidence or Depressions A large amount of excess material has been placed where 1938 washout occurred. One woodchuck hole among the boulders.

GEI 4) Surface Cracks or Movement at Toe Not observable.

GEI 5) Seepage Damp at toe of pile of boulders (about 12 ft above tailwater). No seepage evident at bedrock / embankment interface, where exposed near toe at Sta. 1+25.

GEI 6) External Drainage System (Ditches, Trenches, Blanket)

None.

GEI 7) Condition Around Outlet Structure No movement.

Clear seepage at 6-10spm immediately to right of outlet structure. Iron stained on bottom. No silt.

GEI 8) Seepage Beyond Toe Seepage exits 18 in. below top of structure. None.

GEI e. Abutments - Embankment Contact

Good. Spillway is at left and founded on bedrock. Erosion on right side of downstream toe of spillway due to eddies during high water.
GEI 1) Erosion at Contact  None (see item above)

GEI 2) Seepage Along Contact  None

3. DRAINAGE SYSTEM
GEI a. Description of System  None

GEI b. Condition of System  N.A.

GEI c. Discharge from Drainage System  N.A.

4. INSTRUMENTATION (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.)  None

5. RESERVOIR
GEI a. Slopes  Gentle. 3H:1V at shore and 10H:1V up. Otherwise <10H:1V.

GEI b. Sedimentation  Not observed

GEI c. Unusual Conditions Which Affect Dam  None
6. AREA DOWNSTREAM OF DAM
   a. Downstream Hazard (No. of Homes, Highways, etc.)
      BRIDGE
      400' £, HOUSE 300' £/S BUT FAIRLY HIGH ABOVE CHANNEL, SEVERAL DWELLINGS
      FURTHER £/S
      GEI
   b. Seepage, Growth
      FULLY FORESTED, NO SEEPAGE
      OBSERVED
      GEI
   c. Evidence of Movement Beyond Toe of Dam. NONE NOTED
      ____________________
   d. Condition of Downstream Channel
      BRIDGE £/S, SOME TREE & BRUSH ENCROACHMENT.

7. SPILLWAY(S) (Including Discharge Channel)
   a. General
      CONCRETE Ogee SET ON MOSTLY BEDROCK
      RAILROAD RAILS & 1½" PIPES SUPPORT 3' WOODEN
      FLASHBOARDS W/ NO PROVISION FOR AUTOMATIC FAILURE
      DURING HIGH WATER, SPILLWAY SECTION ABOUT 4½ HIGH
      ON LEFT, 20' HIGH ON RIGHT, PROBABLY NOT A TRUE Ogee
      ____________________
   b. Condition of Service Spillway
      GENERALLY FAIR TO POOR
      LEFT TRAINING WALL AT SPILLWAY £/S END TOP 1½ OF CONCRETE
      IS CRUMBING, COLD JOINTS IN CONCRETE MINOR CRACKING & EFFLORESCENCE
      RIGHT TRAINING WALL CRACK FULL HEIGHT OF WALL ABOUT 20' FROM
      SPILLWAY CREST, LARGE SPALL AT RIGHT TRAINING WALL CONTACT £/S
      Ø£/S SIDE OF Ogee CREST, CRACK BETWEEN RIGHT TRAINING WALL &
   c. Condition of Auxiliary Spillway
      CORE WALL CONTACT, EROSION
      AT WATER LINE NEAR SPILLWAY ON £/S SIDE TRAINING WALL
      Ogee Section - EROSION, SCALING, & SPALLING ALONG ENTIRE Ø£/S FACE
      GENERAL - SOME HAIRLINE CRACKING, EFFLORESCENCE OF MOST SPILLWAY
      £/S TRAINING WALL CONCRETE, SPALLING AT CONSTRUCTION JOINTS
   d. NO AUXILIARY SPILLWAY
d. Condition of Discharge Channel

CONCRETE PROPERLY DEEP AS DEEP AS 1' BETWEEN
OGEE AND CHANNEL TRANSITION, CHANNEL BOTTOM SLAB CRACKING
AT 90° TO JOINTS IN SLAB, EROSION OF CHANNEL CONCRETE
ALONG BASE OF RIGHT TRAINING WALL WERE DISCHARGES
OVER SPILLWAY CONCENTRATED, SPALLING AT JOINTS OF CHANNEL BOTTOM.

8. RESERVOIR DRAIN/OUTLET

a. Type: Pipe __ Conduit __ Other __________

b. Material: Concrete __ Metal __ Other ______

c. Size: 30' X 38' INSIDE LENGTH ____________

At Outlet

SEE H-H DATA CHECKLIST, APPENDIX C

D. Invert Elevations: Entrance _____________ Exit _____________

E. Physical Condition (Describe)

Unobservable __ (CONDUIT SITLVED IN ABOUT 2' ±)

1) Material DIS EXPOSED END IS SCALD AND DISCOLORED

2) Joints UNOBSERVABLE Alignment UNOBSERVABLE

3) Structural Integrity UNKNOWN

4) Hydraulic Capability CONDUIT SITLVED IN 2' ±

f. Means of Control: Gate __ Valve __ Uncontrolled __

Operation: Operable __ Inoperable __ Other __________

Present Condition (Describe) GATE STEM & CONTROL MECHANISM
RUSTED + INOPERABLE, HANDWHEEL MISSING

G. Other Outlets (water mains, diversion pipes) __________

N/A
9. STRUCTURAL
   a. Concrete Surfaces  **MOST SURFACES SHOW SIGNS OF EROSION,**
      **HAIRLINE CRACKING, SCALING, AND EFFLORESCENCE, SPALLING AT**
      **SOME CONSTRUCTION JOINTS. CRUMBLING OF TOP OF EXPOSED**
      **COREWALL & PART OF TOP OF RIGHT TRAINING WALL.**
   b. Structural Cracking  **SEVERAL THROUGH CORE WALL [SEE I.D.4],**
      **LEFT TRAINING WALL [SEE I.B.5] & CHANNEL SLAB, ALSO COLD**
      **JOINTS IN MANY CONCRETE SURFACES**
   c. Movement - Horizontal & Vertical Alignment(Settlement)  **APPEARS OKAY**
   d. Junctions with Abutments or Embankments
      **Good condition**
   e. Drains - Foundation, Joint, Face
      **None.**
   f. Water Passages, Conduits, Sluices
      **DOWNSTREAM END OUTLET CONDUIT CONCRETE IS**
      **SCALING + DISCOLORED**
   g. Seepage or Leakage  **Two seeps from floor of spillway**
      **through cracks in concrete. Flowing clear at 1 gpm**
      **and 25 gpm. Iron stain where seeps exit. Seepage**
      **may be entering pavement through cracks higher**
      **up on the floor of spillway.**
h. Joints - Construction, etc. **MANY COLD JOINTS**
   WITH SPALLING AT SOME JOINTS, ESPECIALLY
   Ogee Discharge Channel contact and along
   Top of left training Wall.

i. Foundation **Bedrock is slatey and/or shale, closely**
   jointed. Strike 1130E Dip 23°N. Dam probably
   founded on bedrock all the way across, but
   at least to sta 0 to sta 1+2. [Old (1939)]
   Drawing shows foundation is hardpan beyond sta 2+20.

j. Abutments **Satisfactory**

k. Control Gates **Outlet Conduit Gate (only one)**
   IS INOPERABLE.

l. Approach & Outlet Channels **Approach is okay,**
   **Outlet Channel curves D/S toward toe & bottom**
   SLOPES TOWARD LEFT TRAINING WALL. THIS CAUSES FLOW TO
   BE CONCENTRATED AT Ogee "TOE" & ALONG BASE OF RIGHT
   TRAINING WALL & CAUSES CONCRETE EROSION AT THE LOCATIONS.

m. Energy Dissipators (Plunge Pool, etc.)
   **Rocks at D/S end of channel appears adequate**
   **Some erosion at D/S end right training wall (see 2.k)**

n. Intake Structures ____________________________
   **UNOBSERVABLE**

o. Stability ____________________________

p. Miscellaneous **N/A**

---

B-8
10. APPURTENANT STRUCTURES (Power House, Lock, Gatehouse, Service Bridge, Other)
   a. Description:_______________________
      CONTROL TOWER IN LAKE WITH CONTROL MECHANISM FOR SLIDE GATE, ACCESSIBLE ONLY BY BOAT
      
      
      
   b. Condition:_______________________
      ONLY OBSERVABLE FROM SHORE,
      CONTROL MECHANISM IS INOPERABLE,
      CONCRETE IS ERODED & STAINED,
      STEEL BRACKETS FOR MECHANISM & GATE APPEAR LOOSE & IN POOR CONDITION
      
11. MISCELLANEOUS MECHANICAL/ELECTRICAL EQUIPMENT
   a. Description:_______________________
      N/A
      
      
      
   b. Condition:_______________________
      
      
      
12. OTHER
APPENDIX C
HYDROLOGIC AND HYDRAULIC ENGINEERING DATA
CHECKLIST AND COMPUTATIONS

TABLE OF CONTENTS

| Hydrologic and Hydraulic Engineering Data Checklist | C-1 |
| Drainage Area Map | C-5 |
| Elevation - Area - Storage Computations | C-6 |
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| Overtopping Analysis (flashboards removed) | |
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| Overtopping Analysis (flashboards in place) | |
| Computer Input | C-17 |
| Computer Output | C-18 |
PHASE I INSPECTION
HYDROLOGIC AND HYDRAULIC ENGINEERING DATA CHECKLIST

Name of Dam: TILLSON LAKE DAM
Fed. Id. #: NY00083

1. AREA-CAPACITY DATA

<table>
<thead>
<tr>
<th>Elevation (ft.)</th>
<th>Surface Area (acres)</th>
<th>Storage Capacity (acre-ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Top of Dam **</td>
<td>376</td>
<td>28.5 EST.</td>
</tr>
<tr>
<td>b. Design High Water (Max. Design Pool)</td>
<td>373.5 ±</td>
<td>26.1 EST.</td>
</tr>
<tr>
<td>c. Auxiliary Spillway Crest</td>
<td>N/A</td>
<td>-</td>
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<tr>
<td>d. Pool Level with Flashboards</td>
<td>373</td>
<td>2.56 EST.</td>
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<tr>
<td>e. Service Spillway Crest</td>
<td>370</td>
<td>2.27</td>
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** Crest is irregular. "Elevation is" for exposed corewall & top of abutment.

2. DISCHARGES

<table>
<thead>
<tr>
<th>Volume (cfs)</th>
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<tbody>
<tr>
<td>a. Average Daily</td>
</tr>
<tr>
<td>b. Spillway @ Top of Dam (W/O Flashboards)</td>
</tr>
<tr>
<td>c. Spillway @ Design High Water (APPENDIX F3-12)</td>
</tr>
<tr>
<td>d. Service Spillway @ Auxiliary Spillway Crest Elevation</td>
</tr>
<tr>
<td>e. Low Level Outlet</td>
</tr>
<tr>
<td>f. Total (of all facilities) @ Top of Dam</td>
</tr>
<tr>
<td>g. Maximum Known Flood</td>
</tr>
<tr>
<td>h. At Time of Inspection</td>
</tr>
</tbody>
</table>

* Greater than spillway capacity w/ flashboards in place. Estimated at 500 cfs = 105 cfs for 1955 event based on 2' flow over flashboards per Appendix F3-9.
3. **TOP OF DAM**

   **Elevation 376**

   a. Type **EARTH FILL w/ CONC. CORE WALL + GRAVITY SPILLWAY SECTION**
   
   b. Width **VARIES AGR. 15'** Length **308' (253' W/O SPILLWAY)**

   c. Spillover **SERVICE SPILLWAY**

   d. Location **30' FROM LEFT ABUTMENT LOOKING D/S**

4. **SPILLWAY**

   **SERVICE**

   a. **373 W/O FLASHBOARDS**
   
   b. **Ogee (PROBABLY NOT A TRUE Ogee)**
   
   c. **55'**
   
   **AUXILIARY**

   a. **Elevation NONE**
   
   b. **Type**
   
   c. **Width**
   
   d. **N/A Uncontrolled**
   
   e. **FLASHBOARDS**
   
   f. **4 SECTIONS**
   
   g. **3' HIGH @ 1375' EACH Size/Length**
   
   h. **CONCRETE Invert Material**
   
   i. **Anticipated Length of Operating Service**
   
   j. **80' ± Chute Length**
   
   k. **~3' DUE TO Silt Height Between Spillway Crest & Approach Channel Invert (Weir Flow)**

   l. **Other**

   **w USGS ELEVATION FROM NEW YORK GAZETTE OF LAKES, REF. 25**

   C-2
5. OUTLET STRUCTURES/EMERGENCY DRAWDOWN FACILITIES

a. Type: Gate ___ Sluice ___ Conduit ✓ Penstock

b. Shape: Conc. Box Culvert w/ Control Gate on U/S End

c. Size: 3' x 3' ~ 170' Long (Measures 3'8" Wide at Outlet)

d. Elevations: Entrance Invert 341+ PER DRAWINGS

Exit Invert 355+ (Silted in about 2')

e. Tailrace Channel: Elevation N/A

6. FLOOD WATER CONTROL SYSTEM

a. Warning System: NONE

b. Method of Controlled Releases (mechanisms): CAN ONLY REGULATE

RELEASES BY REMOVING FLASHBOARDS, OUTLET CONDUIT

Silted in and Control Gate is inoperable

7. CLIMATOLOGICAL GAGES REFERENCES 21+22

a. Type: Non-Recording Precipitation Gage INDEX # 3138

b. Location: Town of Gardiner LAT. 41° 41', LONG. 74° 09'

c. Period of Record: 1956 TO PRESENT

d. Maximum Reading: UNKNOWN Date

8. STREAM GAGES REFERENCES 23+24

a. Type: Surface Water Station USGS GAGE # 01371500

b. Location: Wallkill River at Gardiner (Regulated)

LAT. 41° 41' 16", LONG. 74° 09' 56", ~ 5 MILES WEST OF DAM

c. Period of Record: 1924 - PRESENT

d. Maximum Reading: 30,800 cu. ft/483 cum Date Oct. 16, 1955

9. OTHER

PER REF. 24 MAXIMUM KNOWN DISCHARGE OF SHAWANGUNK KILL @ GANAHGOTE,
ABOUT 3.5 MILES N.E. OF DAM, = 14,000 cu. ft = 95.2 cusecs 8/19/55 + OF
DWAAR KILL @ DWAAR KILL, ABOUT 2 MILES S.W. OF DAM, = 1870 cu. ft = 179.8 cum 6/15/52

C-3
10. DRAINAGE BASIN CHARACTERISTICS

a. Drainage Area 4.780 SQ. MILES OR 3059.6 ACRES

b. Land Use - Type HEAVILY WOODED

c. Terrain - Relief SLOPES OF 10%-25%, ELEVATIONS FROM EL 370 TO EL 2450

d. Surface - Soil GLACIAL TILL

e. Runoff Potential (existing or planned extensive alterations to existing surface or subsurface conditions)

NONE KNOWN

f. Potential Sedimentation Problem Areas (natural or man-made; present or future)

NONE KNOWN

g. Potential Backwater Problem Areas for Levels at Maximum Storage Capacity (including surcharge storage)

NONE

h. Dikes - Floodwalls (overflow & non-overflow) - Low Reaches Along the Reservoir perimeter

Location N/A

Elevation

i. Reservoir

Length @ Maximum Design Pool ~1700' (AT SPILLWAY CREST) (feet)

Length of Shoreline (@ Service Spillway Crest) ~5300 (feet)
**Elevation - Area - Storage Computations**

Reservoir Volume: For storage above spillway crest, volume computed by method of conic sections, \( V = \frac{1}{3} (A_1 + A_2 + \sqrt{A_1 A_2}) \).

<table>
<thead>
<tr>
<th>Elevation (NGVD - ft.)</th>
<th>Area (acres)</th>
<th>Volume (acre-ft)</th>
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<tbody>
<tr>
<td>340</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>370</td>
<td>22.7 (3)</td>
<td>230 (2)</td>
</tr>
<tr>
<td>373</td>
<td>25.6 (Est.)</td>
<td>312 (3)</td>
</tr>
<tr>
<td>376.4 (4)</td>
<td>28.5</td>
<td>394</td>
</tr>
<tr>
<td>380</td>
<td>32.3 (5)</td>
<td>504</td>
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</tbody>
</table>

1. Construction drawing elevation base is approximately 90' lower than NGVD elevation per NY garette of lakes (Ref. 25).
2. Impounding capacity at spillway crest from reconstruction applications dated 5/15/59 & 5/4/56 (See Appendices F3.3-F3.11).
3. From USGS topographic mapping, reconstruction applications show 25 acres.
4. From field measurements, (top of exposed core wall) area.

<table>
<thead>
<tr>
<th>Drainage Area (acres)</th>
<th>(square miles)</th>
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<tr>
<td>Watershed direct to reservoir (Subarea 1)</td>
<td>3056.9</td>
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<tr>
<td>Reservoir surface (Subarea 2) @ Spillway Crest, El = 370</td>
<td>22.7</td>
</tr>
<tr>
<td>Total</td>
<td>3059.6</td>
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</table>

(5) Reconstruction applications show 3.5 sq. mi.
### DISCHARGE COMPUTATIONS

#### DAM APPURtenance

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<th>Spillway</th>
<th>Elevation (NGVD)</th>
<th>Size</th>
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<td>Crest EL = 370</td>
<td>55' Crest Length</td>
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</tr>
<tr>
<td>Crest EL = 373</td>
<td>55' Crest Length</td>
<td></td>
</tr>
</tbody>
</table>

#### Dam

| Crest EL = 376 | 25' Crest Length |
| Low Point, Top of Core Wall | (Excludes Spillway) |

#### Outlet Conduit

| Invert El = 341 |
| 3' x 3' Concrete Box |
| (Measures 3.8' Wide at Outlet) |

#### For Flow Over Spillway

\[
Q = 3.33 \times 10^{-5} \times H_{SP}^{1.5}
\]

**Formulas for Critical Flow Over:**

- Narrow-Crested Weir, Reference 9
- Broad-Crested Weir, Reference 9

#### Elevation

<table>
<thead>
<tr>
<th>Elevation (NGVD)</th>
<th>H_{SP} (feet)</th>
<th>H_{DA} (feet)</th>
<th>Q_{OUTLET} (cfs)</th>
<th>Q_{SP} (cfs)</th>
<th>Q_{DA} (cfs)</th>
<th>Q_{TOTAL} (CFS)</th>
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<td>Flashboard Crest</td>
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<td>Top of Dam</td>
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</table>

**Hand computation to match computation by HEC-1.0 program.**
DRAINAGE AREA DATA FOR HEC-1DB MODEL

SUBAREA 1: AREA TRIBUTARY DIRECTLY TO RESERVOIR
AREA = 4.745 SQUARE MILES

LOSS RATES: 1.0" INITIALLY
0.1"/HOUR - CONSTANT LOSS RATE

UNIT HYDROGRAPH PARAMETERS: USE SNYDER METHOD

A = DRAINAGE AREA = 4.745 SQUARE MILES
L = LENGTH OF MAIN WATERCOURSE TO UPSTREAM LIMIT OF
   DRAINAGE AREA = 4.73 MILES
L = LENGTH ALONG MAIN WATERCOURSE TO POINT OPPOSITE
   THE CENTROID OF THE DRAINAGE AREA = 2.46 MILES
C = SNYDER'S BASIN COEFFICIENT = 2.2 (FROM REF. 20)
C' = SNYDER'S PEAKING COEFFICIENT = .650 (FROM REF. 20)
K = STANDARD LAG IN HOURS = C_k(L/La)^0.3 = 4.59 HOURS

USE K = 4.6 HOURS

SUBAREA 2: RESERVOIR SURFACE, AREA = 0.35 SQ. MILES = 9.27 ACRES

LOSS RATES: NONE BECAUSE RAINFALL = RUNOFF FOR WATER SURFACE

UNIT HYDROGRAPH PARAMETERS:

FOR U.H. W/ 5 MINUTE DURATION + 1" RAIN

\[ Q = \frac{A(1")}{K} = \frac{22.7 \text{ acres}(1")}{5 \text{ minutes}} \left( \frac{43560 \text{ sq. ft}}{1 \text{ acre}} \right) \left( \frac{1 \text{ ft}}{12 \text{ inches}} \right) \left( \frac{1 \text{ minute}}{60 \text{ seconds}} \right) \]

\[ Q = 27.5 \text{ cfs} \text{ (w/o loss rate)} \]
**FLOOD HYDROGRAPH PACKAGE (HEC-11)**

**DAM SAFETY VERSION**

**JULY 1978**

**LAST MODIFICATION 26 FEB 79**

---

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<tr>
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<th>DOAM</th>
<th>INSPECTION</th>
<th>DARCHSl-91-01</th>
<th>OVERTOPPING ANALYSES</th>
<th>FLU2</th>
<th>#70 FLASHBOARDS</th>
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<td>MIN</td>
<td>IDAY</td>
<td>INR</td>
<td>MTG</td>
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<td>0</td>
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</table>

**MULTI-PLAN ANALYSES TO BE PERFORMED**

- RTIOD = 1.00
- RPLAN = 1
- NATION = 2
- LATIO = 7

---

**SUB-AREA RUNOFF COMPUTATION**

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<tr>
<th>SUBAREA 1</th>
<th>RUNOFF</th>
<th>COMPUTATION</th>
<th>HYDROGRAPH DATA</th>
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**PREDIC DATA**

- TPE = 4.00
- CP = 0.65
- NTA = 0

**LOSS DATA**

- LSTK | STA | OILK | RTI1 | ERA1 | STK1 | TST1 | CST1 | ALSD1 | RTIP |
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**UNIT HYDROGRAPH DATA**

- TPE = 4.00
- CP = 0.65
- NTA = 0

**RECESSION DATA**

- STATE = -2.00
- DRC5M = 0.00
- RTI0R = 1.00

**UNIT HYDROGRAPHIC ENG-OF-PERIOD ORDINATES**

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<tr>
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<tbody>
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**SUB-AREA RUNOFF COMPUTATION**

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<th>SUBAREA 2 (RESERVOIR) RUNOFF COMPUTATION</th>
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<th>ICMP</th>
<th>ICEW</th>
<th>ITAPE</th>
<th>JF1</th>
<th>JF2</th>
<th>INAME</th>
<th>IISTAGE</th>
<th>IAUTO</th>
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<tr>
<td></td>
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**TSPE COMPUTED BY THE PROGRAM IS 0.000**

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**RECESSION DATA**

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**END-OF-PERIOD FLOW**

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**COMBINE HYDROGRAPHS**

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<th>ICEW</th>
<th>ITAPE</th>
<th>JF1</th>
<th>JF2</th>
<th>INAME</th>
<th>IISTAGE</th>
<th>IAUTO</th>
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**HYDROGRAPH ROUTING**

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**Routing DATA**

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### Peak Flow and Storage Summary

**Summary for Multiple Plan-Ratio Economic Computations**

Flows in cubic feet per second (cubic meters per second)

Area in square miles (square kilometers)

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**Ratios Applied to Flows**

1. 4.75
2. 0.03
3. 12.30
4. 19.43
5. 97.53

**Area in Square Miles (Square Kilometers)**

- 6.75
- 0.03
- 5.05
- 12.30
- 19.43
- 97.53
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**Note:** INFLOW(2), OUTFLOW(0), and OBSERVED FLOW(*) are variables indicating water flow data at different stations.
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**Note:** The table above contains data related to flood hydrography, with columns for different dates and hydrographic data. The specific values are not legible due to the image quality.
# APPENDIX D

## STABILITY ANALYSIS

### TABLE OF CONTENTS

<table>
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<th>Section</th>
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<tbody>
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<td>Spillway Section</td>
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<td>Right Training Wall of Spillway Discharge Channel</td>
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STABILITY ANALYSIS OF SPILLWAY

Cross section for analysis (10' from right training wall, less than max. height and somewhat freed from effects of lateral support of training wall, see Photos 1-6A, 6B & 7B, & dwg. Appendix G, NGVD base 90' higher than old dwg. base)

EL 373

Flashboards (neglect wt.)

EL 370 NGVD

0.67 H: IV t

Critical failure plane for overturning assuming unframed H concrete for overturning

EL 354

10H: IV

11.3

Silt

6.7

Critical failure plane for overturning assuming unframed concrete

1.5' 4.5'

1.5' 4.5'

18.4° surface for sliding

Probable critical failure
CASE 1 - Normal pool at flashboard crest, full HW uplift, silt 3' below spillway by observation, negligible TW, by observation

Overturning

Resisting Forces

Moment Arm About toe = Mr

WD = Wd + load = 95.70 k as before

WD

X

D - Drawing Forces

D = water pressure

D2 = submerged silt pressure, where

Kp = 0.376, "p" = 30 ft.,

K = 0.376 + 0.03 x 0.5 = 1.69 k X 15/3 = 8.44
CASE I - Overturning (Cont'd)  x Moment Arm about toe = M0

\[ U = HW \text{ uplift} \]
\[ = (1/2 \times 21 \times 0.0624) 15.5 = 10.16 \text{ kN} \]
\[ 15.5 \times 3/3 = 104.94 \text{ kN m} \]

\[ FS = \frac{\Sigma M_0}{\Sigma M_0} = \frac{259.83}{209.69} = 1.24 \]

Resultant shear at toe = \[ d = \frac{\Sigma M_T}{\Sigma V} \]
\[ = \frac{\Sigma M_T - \Sigma M_0}{W_D - U} \]
\[ = \frac{259.83 - 209.69}{25.70 - 10.16} \]
\[ = \frac{50.14}{0.22} = \frac{+3.23 \times 0.5}{15.5} = +0.22 \]

\[ \frac{15.5}{15.5} < 1/3 \]

CASE 1A - Same as Case 1, except no flashboards.

\[ W_0 = \text{dead load} = 25.70 \text{ kN per sheet} \times \text{sheet 2} = 259.83 \text{ kN} \]

\[ D_1 = \text{water pressure} = (1/2 \times 18 \times 0.0624) 18 = 10.11 \text{ kN} \times 19/3 = 60.65 \text{ kN} \]

\[ D_2 = \text{sub. sil: press. same as Case 1, sheet 2} = 8.44 \text{ kN} \]

\[ U = HW \text{ uplift} = (1/2 \times 21 \times 0.0624) 15.5 = 8.70 \times 15.5 \times 3/3 = 89.95 \text{ kN} \]

\[ FS = \frac{\Sigma M_0}{\Sigma M_0} = \frac{259.83}{159.04} = 1.63 \]

Resultant shear at toe = \[ d = \frac{\Sigma M_T}{\Sigma V} = \frac{\Sigma M_T - \Sigma M_0}{W_D - U} \]
\[ = \frac{259.83 - 159.04}{25.70 - 8.70} \]
\[ = \frac{100.79}{17.0} = \frac{5.93 \times 0.5}{15.5} = 0.38 \]

\[ 0.38 > 1/3 \]
CASE 1 B - Same as Case 1, except assume that:

- Unusually large cross section of key
- Possible reinforcement in key to take tension

Resisting Forces

\[ W_s = \text{dead load} = 26.70 \text{k per sheet} \times 2 \times 2 = 259.83 \text{kFt} \]
\[ W_5 = \text{dead load of u/s shear key} = 5 \times 8 \times 0.150 = 6 \text{kFt} \]
\[ R = \text{submerged head pan pressure}, \quad \text{where} \]
\[ h' = 1.40 \quad \text{kFt} - 6.00 = 7.76 \quad \text{ft} \]
\[ 75 * \text{cf} = 0.075 \text{kFt} \]
\[ k = 0.2 \quad \text{of horiz. earth press. at rest} = 0.5 \]
\[ R = (\frac{1}{2} \times 5 \times 0.075 \times 0.5)5 = 0.47 \text{kFt} \times \frac{5 \times 2}{3} = 1.56 \]

Driving Forces

\[ D_1 = \text{water pressure} \]
\[ D_1 = (\frac{1}{2} \times 26 \times 0.0624)26 = 21.09 \text{kFt} \times \frac{26}{5} = 77.33 \]
\[ D_5 = \text{submerged u/s pressure} = \text{same as Case 1} \]
\[ (\frac{1}{2} \times 1 \times 0.075 \times 0.5)5 = 1.25 \text{kFt} \times \frac{5 \times 2}{3} = 1.56 \]

**Note:** The page contains calculations and diagrams related to soil mechanics, specifically focusing on the forces involved in a case study at Tillson Lake Dam.
CASE I B - Overturning (cont'd)

\( u = \frac{1}{1.2} \) up lift

\( V = \frac{1}{2} \times 26 \times 0.0624 = 15.5 \) tons

\( M = 12.57 \) k ft

\( h = 15.5 \times 2 \times 12 = 330.39 \) k ft

\( \frac{2}{12} = \frac{1}{15.5} \)

FS = \( \frac{M_o}{M} = \frac{330.39}{215.70} = 1.53 \)

Resultant from toe = \( d = \frac{2}{15} + \frac{2}{12} = 25.70 + 6.13 \)

\( d = 114.69 = 6.00 \times \frac{6}{15.5} = 0.396 > \frac{1}{16} \)

What is max. tensile stress in concrete?

\( F_c = \text{max. tensile stress in concrete} \)

\( M_c = \frac{330.39}{15.5} \)

\( M_c = \frac{330.39}{15.5} \times \frac{1}{12} + \frac{1}{8} \times 8 \times 15.5 \)

\( M_c = 259.83 \)

\( W_o \text{ key} = 2.06 \times \frac{H}{2} \times (12.83) = 26.49 \)

\( F_c = 70.56 \times \frac{0.99}{15.5} = 7.1 \)

\( F_c = 0.99 \text{ ksi} = (7 \text{ psi}) \)

\( F_c = 3 \times 6 \text{ psi} \text{ (ACI Code)} \text{, assume } F_c = 3000 \text{ psi} \text{ conc.} \)

\( F_c = 3 \times 6 \times (3000 \div 160) = \text{320 psi} \)

\( F_c = 7 \text{ psi} \ll 160 \text{ psi} = F_c \text{ OK, but tension in concrete not a good condition unless reinforcement present.} \)
CASE 1 - SLIDING

Rock foliations strike N 30° E - almost parallel with spillway crest - but dip 28° N., i.e., u/s, see dwg. Appendix G-1 for direction. Since dip angle is large and is against direction of sliding, critical failure surface is a circular arc of best fit. To analyze use method of slices. (Reference 30) to compute moments about center of arc. This takes into account reduction in net driving moment caused by weight of sliding mass acting in opposite direction. (Reproduce dwg. from sheet 1)

Center 9' up & 3' d/s of u/s crestline, 
R = 32'

\[ \text{Scale} \quad \frac{1/4"}{1'} \]

---

**Sheet No. 6 of 18**

**Calculated by:** 978

**Date:** 4/15/81

**Checked by:**  

---

**Drawing Dimensions:** 614.4 x 798.7

**Document Type:** C. T. Male Associates, P.C.

---

**Drawings Information:**

- **Engineers**: C. T. Male Associates, P. C.
- **Surveyors**: Land Surveyors
- **Architects**: Architects
- **Landscape Architects**: Landscape Architects
- **Planners**: Planners

**Address:** 3000 Troy Road, Schenectady, N. Y. 12309

---

**Contact Information:**

- **Phone:** (518) 765-9976
CASE 1 - SLIDING (cont'd)

**Vertical Load - Slice 1**

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<td>Concrete, same as on sheets 1 &amp; 2</td>
<td>( 3.52 k ) ((3.5 - 0.5) = -4.40 )</td>
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<td>( w_2 )</td>
<td>Concrete, same as on sheets 1 &amp; 2</td>
<td>( 2.26 k ) ((4.56 + 0.5) = 14.52 )</td>
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<td>( w_3 )</td>
<td>Concrete</td>
<td>((8'x16.3'x1) 0.150 k cf = 19.56 k ) ((8'x9') = -3) = -19.56</td>
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<td>( \Sigma V_1 )</td>
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<td>( \Sigma M + 19.56 )</td>
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\[ X_1 = \frac{\Sigma M}{\Sigma V_1} = 0.78 \]

**Vertical Load - Slice 2**

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<td>( w_5 )</td>
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<td>((2'x9') 0.150 = 2.170 ) (9.2 + 4.5 + 0.5 = 25.65 )</td>
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<tr>
<td>( w_6 )</td>
<td>Concrete</td>
<td>((2'x3') 0.150 = 0.90 ) (9.2 + 6.0 + 4.5 + 0.5 = 21.85 )</td>
</tr>
<tr>
<td>( w_7 )</td>
<td>Hardpan sand</td>
<td>((3'x6') 0.140 = 2.52 ) (9.2 + 4.5 + 0.5 = 20.16 )</td>
</tr>
<tr>
<td>( w_8 )</td>
<td>Hardpan</td>
<td>((1/2'x2'x6') 0.140 = 0.84 ) (9.3 + 4.5 + 0.5 = 14.88 )</td>
</tr>
<tr>
<td>( w_9 )</td>
<td>Hardpan</td>
<td>((1/2'x1'x3') 0.140 = 0.31 ) (9.3 + 6.0 + 4.5 + 0.5 = 1.52 )</td>
</tr>
<tr>
<td>( \Sigma V_2 )</td>
<td></td>
<td>( \Sigma M = 36.61 )</td>
</tr>
</tbody>
</table>

\[ X_2 = \frac{\Sigma M}{\Sigma V_2} = 0.36 \]

**Vertical Load - Slice 3**

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Load Calculation</th>
<th>Moment Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( w_{10} )</td>
<td>Concrete</td>
<td>((1'x4.5') 0.150 = 0.68 k ) (4.54 + 9 + 4.5 + 0.5 = 10.07 )</td>
</tr>
<tr>
<td>( w_1 )</td>
<td>Rock fill ( 165'cf ) typical</td>
<td>((1/2'x3'x4.5') 0.165 = 1.11 k ) (4.56 + 9 + 4.5 + 0.5 = 30.26 )</td>
</tr>
<tr>
<td>( \Sigma V_3 )</td>
<td></td>
<td>( \Sigma M = 28.83 )</td>
</tr>
</tbody>
</table>

\[ X_3 = \frac{\Sigma M}{\Sigma V_3} = 0.15 \]

D-7
CASE 1 - SLIDING (Cont'd)

Typical slice contact

Line of action of \( E V_n \) and \( U \) passes through center, i.e. no moment

\[ T = \text{shear force mobilized by driving forces} = \text{developed from normal effective force on slice contact} \]

\[ T = N \tan \phi + CA \]

\[ N = \Sigma E V_n - U = \Sigma E V \cos \alpha - U \]

\[ \phi = \text{angle of sliding friction} \]

For slice 1, concrete/rock contact, assume \( \phi = 50^\circ \) due to rough interface caused by rock formations.
### CASE 1 - SLIDING (Cont'd)

For Slice 2, hardpan/rock contact, assume $\phi_2 = 36^\circ$ for till

For contact along rock foliations, assume $\phi_3 = 40^\circ$

\[ U_1 = H_1 w_1 p_1 = \left( \frac{26 \times 15 + 26 \times 15}{2} \right) \frac{8}{2} = 26 \times 1.124 \left( \frac{14.6}{22.6} \right)^4 \]

\[ U_2 = 26 \times 0.060 \left( 14.6 - 5.2 \right)^2 \frac{2}{22.6} = 6.68 K = U_2 

\[ U_3 = \frac{1}{2} \times 26 \times 0.060 \left( 5.2 \right)^2 \frac{2}{22.6} = 0.97 K = U_3 

**Resisting Forces**

**Moment Arm**

**Resisting Forces**

- $T_1$: shear force along slice 1 contact

\[ T_1 = (\Sigma V \cos K - U_1) \tan 0^\circ = (25.34 \cos 0^\circ - 10.68) \tan 50^\circ = 17.47 K 

\[ T_2 = (11.49 \cos 0^\circ - 6.68) \tan 36^\circ = 3.13 K 

\[ T_3 = (1.79 \cos 30^\circ - 0.97) \tan 10^\circ = 0.49 K 

\[ T_1 \times 32 = 674.88 

**Driving Forces**

- $P_1$: water pressure

\[ P_1 = \frac{1}{2} \times 26 \times 0.060 \times 26 = 81.09 K \times \left[ (26 \times 9.3) + 6 \right] = 492.13 

- $P_2$: submerged silt pressure

\[ P_2 = 0.03 K \times 5 \times 0.5 \times 15 = 1.69 K \times (15 \times 9.3) + 12 = 37.13 

\[ \Sigma V = \Sigma V_1 + \Sigma V_2 + \Sigma V_3 

\[ \Sigma V_1 = \Sigma V_2 = \Sigma V_3 = 0 

\[ \Sigma V_1 = Z_1 \times 15.77 = 23.34 K \times 0.78 = -19.77 

\[ \Sigma V_2 = Z_2 \times 8.36 = -11.49 \times 8.36 = -96.06 

\[ \Sigma V_3 = Z_3 \times 15.77 = -1.79 \times 15.77 = -28.23 

\[ \Sigma V_1 = 385.20 \]

\[ FS = \frac{\Sigma M_r}{\Sigma M_p} = \frac{674.88}{385.20} = 1.75 \]
CASE I - SLIDING (cont'd)

Check Possible Horizon Failure Plane thru W's Shear Key

- $R_s$ = resistance to sliding = $a + \text{least } V_c A$ where $A$ = shear area of concrete key and $V_c$ = conc. shear strength,
- $V_c = 2.0 \sqrt{f_c}$ (ACI Code), assume $f_c = 3000$ psi,
- then $V_c = 2.0 \sqrt{3000} = 100$ psi; say $V_c = 100$ psi = 14.4 ksf.
- $R_s = 14.4 (8 \times 1) = 115.2$ k.
- $H_s$ = horizontal shear force $= D_1 + D_2$
  - $D_1 =$ water pressure down to failure plane $= EL 352$
    - $= 12 \times 21 \times 0.0624 \times 21 = 13.76 \text{ K}$ (see sheet 2)
  - $D_2 =$ submerged silt pressure $= 1.69 \text{ K}$ from sheets B.4.9
- $H_s = D_1 + D_2 = 15.45 \text{ K}$
- $ES = R_s/H_s = 115.2 / 15.45 = 7.46 > 1.75$ using circular arc

Circular arc remains as critical failure surface.

CASE 1A - SLIDING - Same as Case 1, except no flashboards

Use same critical failure plane & theory as Case 1, sheet 6.
CASE 1A - SLIDING (cont'd)

\[ U_1 = \frac{H_1}{\gamma} = 23 \times 0.0624 \times \left( \frac{14.6 + 5.6}{22.6} \right) \frac{8}{2} = 9.45 \text{ k} \]

\[ U_2 = 23 \times 0.0624 \times \left( \frac{14.6 + 5.6}{22.6} \right) \frac{3.4}{2} = 6.03 \text{ k} \]

\[ U_3 = \frac{1}{2} \times 23 \times 0.0624 \times \left( \frac{5.2}{22.6} \right) \frac{5.2}{2} = 0.86 \text{ k} \]

Resisting Forces

\[ T_i = \text{shear force along slice } i \text{, contact } = \left( \Sigma V \cos \alpha - U_i \right) \times \text{area} \]

where \( \Sigma V \) all slices same as Case 1A, sheet 1

\[ T_1 = (25.34 \cos 0^\circ - 9.45) \times 50^\circ = 18.94 \]

\[ T_2 = (11.49 \cos 17^\circ - 6.03) \times 36^\circ = 3.60 \]

\[ T_3 = (1.79 \cos 30^\circ - 0.86) \times 40^\circ = 0.58 \]

Driving Forces

\[ D_1 = \text{water pressure} \]

\[ = \frac{1}{2} \times 23 \times 0.0624 \times 23 = 16.50 \]

\[ \sqrt{\left( 23 \times 9 \right) + 9} = 401.62 \]

\[ D_2 = \text{submerged silt pressure same as Case 1, sheet 9} = 37.13 \]

\[ \Sigma V_1 = \text{wet. silt slice 1 same as Case 1, sheet 9} = -19.77 \]

\[ \Sigma V_2 = \text{wet. silt slice 2 same as Case 1, sheet 9} = -96.06 \]

\[ \Sigma V_3 = \text{wet. silt slice 3 same as Case 1, sheet 9} = -28.23 \]

\[ \Sigma M_0 = 294.69 \]

\[ FS = \frac{\Sigma M_r}{\Sigma M_b} = \frac{739.84}{294.69} = 2.51 \]

\[ -144.06 \]
CASE 4 - Normal Pool plus Ice Load. Flashboards are normally removed for winter. May recommended ice load (Ref. 1) = 10 k/ft² of ice 2" thick. Use 25/ft² of ice 10" thick as appropriate for conditions at this dam.

Overturning:

Resisting Forces

\[ M_R = 259.8 \text{ kN-m} \]

Driving Forces

\[ M_D = 246.54 \text{ kN-m} \]

\[ F_S = \frac{M_R}{M_D} = \frac{259.83}{246.54} = 1.05 \]

Resultant from toe:

\[ d = \frac{\Sigma M}{W_D - U} = \frac{259.83 - 246.54}{15.70 - 8.70} \]

\[ d = \frac{13.29}{7.0} = 0.17 \times 7.5 = 1.26 > 1.25 \]

\[ d = \frac{13.29}{7.0} = 0.17 \times 7.5 = 1.26 > 1.35 \]
CASE 2 - SLIDING Use same critical failure plane & theory as Case 1, sheet 6.

Resisting shear force = f(\Sigma V U). Since \Sigma V \& U for all slices same as for Case 1A, sheet 11, \Sigma M_k = 739.84

Driving Forces x Moment from about arc center = \Sigma M

Hydrostatic pressure, \Sigma H, uplift \& \Sigma V's same as Case 1A, sheet 11. \Sigma M_D = 342.19

\[ \Sigma M_D = 342.19 \]

\[ \Sigma M = 294.69 \]

\[ \Sigma M_o = 739.84 \]

\[ FS = \Sigma M_o / \Sigma M_D = 2.16 \]
CASE 3 - 1/2 PMF pool, no flashboards, full headwater & tailwater upset, remainder same as Case 1A.

Estimate Tailwater for Flood Conditions

For 1/2 PMF & PMF, dam is overtopped per H&H analysis, Table 5.1. For PMF, max. H.S. EL 376.6 - spillway EL 370 = 6.6' over spillway.

PMF - 378.2 - EL 370 - 6.6 = 8.2'

Per. Appendix C-7, spillway = 3.33 L = 55' clear.

So, for PMF, H = 6.6, Q = 3100,

PMF, H = 8.2, Q = 4300

Assume uniform flow in spillway discharge, channel where:

Q = 1.486 AR^1/2 (Manning's equation, Ref. B)

where N = roughness coefficient = 0.014 for concrete channel
A = cross sectional area of flow, ft²
R = hydraulic radius = A/wetted perimeter (P), ft.
S = slope of energy gradient, assume equal to avg. slope of channel, see draw. Appendix G-1

Average Spillway Discharge Channel X-Sect. For 7 to 8' D/S of spillway toe, looking downstream (see draw. Appendix G-1)

<table>
<thead>
<tr>
<th>d_n</th>
<th>Top Width</th>
<th>A</th>
<th>P</th>
<th>R²g = (K/P)²/3</th>
<th>Q = 33.57 AR²/3</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>10</td>
<td>15</td>
<td>18.4</td>
<td>1.08</td>
<td>543 cfs</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>60</td>
<td>26.9</td>
<td>1.71</td>
<td>3448 &gt; 1/2 PMF</td>
</tr>
<tr>
<td>4</td>
<td>13.3</td>
<td>26.6</td>
<td>17.9</td>
<td>1.30</td>
<td>1164 cfs</td>
</tr>
<tr>
<td>5</td>
<td>16.7</td>
<td>41.8</td>
<td>22.4</td>
<td>1.52</td>
<td>2131 &lt; 1/2 PMF</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>60</td>
<td>26.9</td>
<td>1.71</td>
<td>3448 &lt; 1/2 PMF</td>
</tr>
<tr>
<td>7</td>
<td>23.3</td>
<td>81.6</td>
<td>31.3</td>
<td>1.90</td>
<td>5705</td>
</tr>
</tbody>
</table>

D-14
CASE 3 - Estimate Tailwater (cont'd)

By interpolation, for 1/2 AMF, \( Q = 3100 \text{ cfs} \), \( d_n = 5.7 \text{', say 5.0} \)

\( Q_d \) for PMF \( Q = 4300 \text{ cfs} \), \( d_n = 6.5 \text{', say 6.0} \)

(Round down to be conservative for stability)

CASE 3 - 1/2 AMF Overtopping

\( \frac{1}{2} \text{ AMF EL 370,6} \)

\( \text{EL 370} \)

\( \text{EL 367} \)

\( s_Ir \)

\( s_{IIr} \)

\( s_{IIIr} \)

\( s_{IVr} \)

\( s_{Vr} \)

\( s_{VIr} \)

\( s_{VIIr} \)

\( s_{VIIIr} \)

\( s_{IXr} \)

\( s_{Xr} \)

\( s_{XIr} \)

\( s_{XIIr} \)

\( s_{XIIIr} \)

\( s_{XIVr} \)

\( s_{XVr} \)

\( s_{XVIr} \)

\( s_{XVIIr} \)

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\( s_{XXIXr} \)

\( s_{XXXr} \)

\( s_{XXXIr} \)

\( s_{XXXIIr} \)

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CASE 3 - Overturning (cont'd)

\[ FS = \frac{EM_r}{EM_d} = \frac{263.40}{225.76} = 1.17 \]

Resultant from toe \( d = \frac{EM_r}{2V} = \frac{EM_r - EM_d}{2V} = 263.40 - 225.76 \)

\[ d = 37.64/17.0 = 2.21 \times \frac{15.5}{60} = 0.14 < \frac{1}{3} \]

CASE 3 - Sliding Use same critical failure plane as Case 1, sheet 6.

\[ V/2AMF \text{ EL 376.6} \]

Wt. of flowing water more than counterbalanced by flood uplift.
C.T. MALE ASSOCIATES, P.C.
ENGINEERS SURVEYORS ARCHITECTS
LANDSCAPE ARCHITECTS PLANNERS
3000 TROY ROAD, SCHENECTADY, N.Y. 12309
(518) 765-0976

C.W.SHEET:-L~30
XAWXS C
A
4r,'z/-go
V
44M.

[Image 0x0 to 614x799]

CASE 3- SLIDING (cont'd)
Resisting shear force = \( 4(EV\times U) \). Since \( EV \times U \) for all slides same as for Case IA, sheet 11, \( EM_R = 739.84 \)

Driving Forces \( x \) Moment arm about toe center = \( MD \)

Normal HW pressure, silt pressure uplift \( \frac{EV \times U}{5} \)

\( P_f \) = Flood HW pressure = \( 6.6 \times 0.0624 \times 73 = 9.47 \)

\( x(23/2 + 9) = 194.18 \)

\( TW = \) Flood + Trailwater \( \frac{1}{2} \times 5 \times 0.0624 \times 5 = 0.78 \)

\( X[5 \times 2 + 11.5 + 9] = 0.1859 \)

\( EM_D = 470.28 \)

FS = \( \frac{EM_R}{EM_D} = \frac{739.84}{470.28} = 1.57 \)

CASE 4- P.M.F. Overturning - Refer to Case 3, sheet 15 methodology.

\( TW = \frac{1}{6} \times 8 \times 0.0624 \times X = 2.00 \times 8 = 5.32 \)

\( EM_R = 265.15 \)

Driving Forces \( x \) Moment arm about toe = \( MD \)

Normal HW pressure, silt pressure uplift \( \frac{EV \times U}{5} \)

\( P_f \) = Flood HW pressure = \( 1/3 \times 79.2 \times 8.2 = 9.21 \times 18/2 = 82.89 \)

\( EM_D = 241.93 \)

FS = \( \frac{EM_R}{EM_D} = \frac{265.15}{241.93} = 1.09 \)

Resultant from toe = \( d = \frac{EM_T}{EV} = \frac{EM_R - EM_D = 265.15 - 241.93}{WD - U} = 25.70 - 8.70 \)

\( d = 23.22/17.0 = 1.37 \times 1.55 = 0.96 < 1.0 \)

D-17
CASE 4 - PMF Sliding - Refer to Case 3, sheet 16 methodology.

Two dh = 6', so dv = 6'.

Resisting shear force = tf(VE + U). Since V = U for all slices, it's same as for Case 3, sheet 17. ZM = 739.84

Driving Forces

Normal HW pressure, silt pressure, uplift

D = flood HW pressure @ EL 378.2, 18.2' above spillway = 8.2 x 0.0604 x 23 = 11.77 x (23/2 + 9) = 241.26

TW = flood tailwater = 0.12 x 6 x 0.0604 x 6 = 0.12 x [(6 x 6) + 10.5 + 9] = 0.76.40

ZMD = 509.55

FS = ZMR/ZMD = 739.84 / 509.55 = (1.45)

D-18
STABILITY ANALYSIS OF RIGHT TRAINING WALL

CROSS SECTION FOR ANALYSIS (AT MAX. UNSUPPORTED
HEIGHT WHICH OCCURS JUST D/S OF SPILLWAY TOE, SEE
Dwg. Appendix G-1 & Photos Appendix A)

Dead Volume x Unit Wt(y) = W 

\[
W_1 = \frac{6.3}{2} \times 21 \times 1 \times 0.150 \times 11 \div 3 = 9.92 \quad \frac{6.3}{3} + 1 = 30.75
\]

\[
W_2 = 1 \times 21 \times 1 \times 0.150 = 3.15 \quad 0.5 = 1.58
\]

\[
W_D = 13.07 \quad \Sigma M = 32.33 \quad \text{ft-k}
\]

[Diagram showing stability analysis with assumed failure plane, assumed toe, and concrete.]
CASE 1 - Normal conditions, full uplift at heel due to assumed water level in embankment, no tailwater.

Assume:
- Earth = lightly compacted glacial till
  \( \rho_e = 135 \, \text{#}/\text{ft}^3 \), \( 
  \rho_w = 60.4 = 72.6 \div 75 \, \text{#}/\text{ft}^3
  \)
- Coefficient of horizontal earth pressure at rest = \( k_a = 0.5 \) ± empirical

Resisting Forces

\( W_d = \text{dead load} = 13.07 \) as before

\( R_1 = \text{wt. of earth} = \frac{4.5}{2} \times 15 \times 0.135 = \frac{4.5 \times 75 + 1.3}{2} = 19.61 \)

\( R_2 = \text{wt. of earth} = 1.5 \times 0.135 \)

\( R_3 = \text{wt. of submerged earth} = \frac{1.5}{2} \times 5 \times 0.075 = \frac{1.5 \times 75 + 4.5 + 1.3}{2} = 19.91 \)

\( R_4 = \text{wt. of water} = \frac{1.5}{2} \times 5 \times 0.0624 = \frac{1.5 \times 75 + 1.56}{2} = 1.56 \)

\( \Sigma M_r = 75.31 \text{ ft k} \)
**Driving Forces**

\[ D_1 = \text{Earth pressure} \]
\[ = (\frac{1}{2} \times 15 \times 0.135 \times 0.5) \times 15 = 7.59 \times (15/3) + 5 = 75.90 \]

\[ D_2 = \text{earth pressure} \]
\[ = (15 \times 0.135 \times 0.5) \times 5 = 5.06 \times 5/2 = 12.65 \]

\[ D_3 = \text{submerged earth pressure} \]
\[ = (\frac{1}{2} \times 5 \times 0.075 \times 0.5) \times 5 = 0.47 \times 5/3 = 0.78 \]

\[ D_4 = \text{water pressure} \]
\[ = (\frac{1}{2} \times 5 \times 0.0624) \times 5 = 0.78 \times 5/3 = 1.30 \]

\[ U = \text{uplift} \]
\[ = (\frac{1}{2} \times 5 \times 0.0624) \times 7.3 = 1.14 \times 7.3 \times 7/3 = 5.55 \]

\[ E M_0 = 96.18 \text{ F.K.} \]

**Overturning**

\[ F S = \frac{E M_0}{2 M_0} = \frac{75.31}{96.18} = 0.78 < 1.0 \text{ unstable} \]

Resultant force outside base since \( F S < 1.0 \)

Resultant from \( d = \frac{E M_T}{E V} = \frac{12,300 - M_0}{E V} = \frac{75.31 - 96.18}{E V} \)

\[ 2 V D_T + 2 R - U = 13.07 + 8.11 - 1.14 \]

\[ d = \frac{-20.87}{20.04} = -1.04 \times 6 = -0.146 \]

**Sliding**

- Assume 3000 psi concrete, \( w/ \) shear stress \( V_c = 2.0 \times \sqrt{3000} = 110 \text{ psi} \), or \( V_c = 100 \text{ psi} \)
- \( V_c = 14.4 \text{ kips} \)

Resistance: \( R_s = \text{shear of concrete} = V_c A = 14.4 \times 7.3 = 105.12 \text{ k} \)

Sliding Force: \( H_s = D_1 + D_2 + D_3 + D_4 = 13.90 \text{ k} \)

\[ FS = R_s / H_s = 105.12 / 13.90 = 7.56 > 2.0 \text{ ok} \]

Sliding below failure plane should be no problem because of embedment.
Tensile Stress in Concrete For Overturning Stability

\[ T_c = \max \text{ tensile stress in concrete} \]
\[ T_c \text{ allowable } = 3 \text{ to } 6 \sqrt{f_c} \text{ (ACI Code)} \]
\[ \text{Assume } f_c = 3000 \text{ psi; concrete tension } \]
\[ T_{ca} = 3 \text{ to } 6 \sqrt{3000} \approx 160 \text{ to } 320 \text{ psi} \]

\[ FS = \frac{Z M_{r}}{W_{o}} \text{, or } Z M_{r} = (FS) W_{o} \]
\[ \frac{1}{2} T_{c} \times 7.3 \times 1 \frac{1}{2} T_{c} \times 7.3 \times 1 + \frac{1}{2} T_{c} \times 7.3 \times \frac{1}{2} T_{c} \times 7.3 \times \frac{1}{2} T_{c} \times 7.3 \times \]
\[ 17.76 T_{c} = (FS) W_{o} - Z M_{r} \]
\[ T_{c} = (FS) 96.18 - 75.31 \]

For \( FS = 1.0 \) (safety stable)
\[ T_{c} = (1.0) 96.18 - 75.31 = 118 \text{ kips} \times 1000 \text{ ft} \times \frac{sf}{2} = 8 \text{ psi} \]
\[ K = \frac{144 \text{ in}^2}{1} \]
\[ 8 \text{ psi} \times 160 \text{ psi} = T_{ca} \geq 2 \]

For \( FS = 1.5 \) (acceptable stability)
\[ T_{c} = (1.5) 96.18 - 75.31 = 3.88 \text{ kips} = 27 \text{ psi} \]
\[ K = 17.76 \]

For Resultant in Middle 1/3 (also req'd for acceptable stability)
\[ d = \frac{1}{3} b \min = \frac{7.3}{3} = \frac{Z M_{r}}{W_{o}} \Sigma M_{c} - E M_{o} + 17.76 T_{c} \]
\[ 7.3 \left( 13.07 + 8.11 - 1.14 + 3.65 T_{c} \right) = 75.31 - 96.18 + 17.76 T_{c} \]
\[ 17.76 T_{c} = 20.87 \]
\[ 17.76 + 8.98 T_{c} = 20.87 \]
\[ -8.88 T_{c} = 7.78 \text{ kips} = 54 \text{ psi} \geq 27 \text{ psi} \]

Will still stand because concrete controls
is in tension less than allowable, but 54 psi < 160 psi = T_{ca} 1!

Factors: - possible reinforcement
- support by spillway

D-22
REFERENCES

This is a general list of references pertinent to dam safety investigations. Not all references listed have necessarily been used in this specific report.

1. "Engineering and Design, National Program For Inspection of Non-Federal Dams", ER 1110-2-106, Dept. of the Army, Office of the Chief of Engineers, 26 September 1979, with Change 1 of 24 March 1980. Included as Appendix D of the ER is "Recommended Guidelines For Safety Inspection of Dams".


5. HMR 51, "All-Season Probable Maximum Precipitation, U.S. East of 105th Meridian for Areas from 1000 to 20,000 Square Miles and Durations from 6 to 72 Hours", U.S. Dept. of Commerce, NOAA, National Weather Service, 1974.


APPENDIX F
AVAILABLE ENGINEERING DATA AND RECORDS

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APPENDIX F
SECTION F1

LOCATION OF AVAILABLE ENGINEERING DATA AND RECORDS

1. **Owner:** U & U Realty, Inc.
   100 Seaview Drive
   Secaucus, NJ 07094
   Attn: Joseph Uane, President
   201-348-4900

   Available: No data.

2. **Operator (Leasee):** Tillson Lake Recreation Park, Inc.
   Gardiner, NY 12525
   Attn: Henry S. Cuney, President
   914-564-2718
   George Surinach, Vice-President
   (Mr. Cuney's Son)
   35 Utterby Rd.
   Malverne, NY 11565
   516-887-7859

   Available: No data.

3. **Designer:** Unknown.

4. **Construction Contractor:**
   Unknown, but owner was:
   Hassey A. Tillson
   Walden, NY (deceased)

5. **Designer For 1939 Reconstruction:**
   Solomon LeFevre
   New Paltz, NY
   (business status unknown, not contacted)

6. **Designer For 1956 Reconstruction:**
   T.W. ("Don") Westlake, P.E.
   Holmes Rd.
   RD 1, Box 66
   Newburgh, NY
   (business status unknown, not contacted)
7. **Construction Contractors For Reconstructions:** Unknown

8. **Agency:** NYS Department of Environmental Conservation  
   50 Wolf Rd.  
   Albany, NY 12233  
   Attn: George Koch, P.E., Chief, Dam Safety Section  
   518-457-5557

   **Available:** Drawings, letters and report describing failures and reconstructions, applications for reconstruction, and inspection report.
PHASE I INSPECTION

CHECKLIST FOR GENERAL ENGINEERING DATA & INTERVIEW WITH DAM OWNER

Name of Dam: Tillson Lake Dam  Fed. Id. #: NY 00083
Date: April 8, 1981  Interviewer(s): Thomas P. Benedum

Dam Owner/Representative(s) Interviewed, Title & Phone:

George Surinich, V-P of Tillson Lake Recreation Park
Bus. 516-489-0505, Home 516-887-7859, Malverne, NY 11565
(Son of Operator)

1. OWNERSHIP (name, title, address & phone #)
   U&S Realty Inc., 100 Seaview Dr, Secaucus, NJ 07094
   Attn: Joseph Vanue, President 201-348-4900

2. OPERATOR (name, title, address & phone # of person responsible for day-to-day operation)
   Henry S. Cuiney, President, Tillson Lake Recreation Park, Inc. (lessee)
   Gardiner, NY 12525, 914-564-2718 (on site inspection)
   Also George Surinich, see above.
   a. Operator Full/Part Time: Part Time

3. PURPOSE OF DAM
   a. Past Recreation. Original owner Hassey A. Tillson

4. DESIGN DATA
   a. Designed When: Unknown, suspect 1920's - 1930's
   b. By (name, address, phone #, business status): Unknown
   c. Geology Reports: None Known
   d. Subsurface Investigations: None Known
   e. Design Reports/Computations (H&H, stability, seepage): None Known
Design Drawings (plans, sections, details) None Known

Design Specifications None Known

Other 1939 & 1956 reconstruction drawings (see Appendix G-1 & G-2) show some details of original design.

5. CONSTRUCTION HISTORY

a. Initial Construction
   1) Completed When unknown, suspect 1920's - 1930's
   2) By (name, address, phone #, business status) Actual contractor unknown. Original owner: Hassey A. Tillson, Walden, NY (deceased)
   3) Borrow Sources/Material Tests None Known
   4) Construction Reports/Photos No photos known. See Appendix F3-1 for short description of construction by a victim of the first failure of the dam.
   5) Diversion Scheme/Construction Sequence None Known
   6) Construction Problems None Known
   7) As-Built Drawings (plans, sections, details) None Known
   8) Data on Electrical & Mechanical Equipment Affecting Safe Operation of Dam No electrical at the dam. No data on the gate mechanism.
   9) Other None

F2-2
b. Modifications (review design data & initial construction items as applicable & describe) 1939 raised conc. core wall to rt. of spillway 2.0' below top of embankment to about same elevation. Put 2.5' high flashboards on spillway, leaving 3.5' of freeboard to top of core wall on rt., but only 1.5' on left due to left core wall not being raised as intended. (See 9-Other)

c. Repairs & Maintenance (review design data & initial construction items as applicable & describe) 1939 repaired breach in core wall just to rt. of spillway & replaced washed out embankment. Engineer was Le Fevre as noted in 5b-Modifications. See Appendix F3-1 thru F3-8 & App. G-1.

1956 replaced about 30' of 1/8 end of rt. training wall & conc. bottom of spill. disch. channel. (See 9-Other)

6. OPERATION RECORD

a. Past Inspections (dates, by, authority, results) Only record - Apr. 03, 1973 by NYS - DEC, see Appendix F3-18.

b. Performance Observations (seepage, erosion, settlement, post-construction surveys, instrumentation & monitoring records) No instrumentation, monitoring records, or other items recorded.

c. Post-Construction Engineering Studies/Reports None known except those in conjunction with 1939 & 1956 repairs, see Appendix F3 & Appendix G.

d. Routine Rainfall, Reservoir Levels & Discharges None known.
e. Past Floods That Threatened Safety (when, cause, discharge, max. pool elevation, any damage)

- Sept. 21, 1938 flood, embankment washed out, dam o/f, see Appendix F3-1.
- Aug. 1955 flood, "spillway charge" dam breached, see Appendix F3-9.

f. Previous Failures

- Sept. 21, 1938, dam o/f & breached; Aug. 1955, partially o/f & wash out dam up (See 6-E Past Floods).

g. Earthquake History (seismic activity in vicinity of dam)

None known

7. VALIDITY OF DESIGN, CONSTRUCTION & OPERATION RECORDS (note any apparent inconsistencies)

- Flashboards now 3' high & don't resemble 1956 design (See App.)
- Outlet conduit reported 3' square, but measures about 3.8' square end & send. (See 9-OTHER)

8. OPERATION & MAINTENANCE PROCEDURES

a. Operation Procedures in writing? No. Obtain copy or describe. (reservoir regulation plan, normal pool elevation, status of operating facilities, who operates & means of communication to controller, mode of operating facilities, i.e., manual, automatic, remote)

Flashboards up May 1 and Sept. Normally removed by operator's son Oct. April. But only 1 of 4-13' 9" sections removed this past winter.

Outlet conduit sluice gate (30"Ø) normally shut. (See 9-OTHER)

b. Maintenance Procedures in writing? No. Obtain copy or describe.

Flashboards are repaired/replaced as req'd.

- 1979, diver casually looked at outlet sluice gate while looking for lost watch. His verbal report was that there was a build-up of debris in port & it looked corroded.
Emergency Action Plan & Warning System in Writing? **No**

Obtain copy or describe. (actions to be taken to minimize the D/S effects of an emergency)

- Some thought given, but no plan in place.
- Would assume that operator would contact Ulster Co. Sheriff's Dept. thru section #77, who rents house on lake from U&W.

9. **OTHER**

56) **Modifications** *(1939 cont'd)* Breach in core wall was repaired (see 5C-Repairs). Engineer was Solomon DeFeo, New Paltz, NY (business status unknown, not contacted). See Appendix F3-1 thru F3-B & Appendix G-1. Contractor unknown.

- 1956 raised conc. core wall to left of spillway 2.5' to match rest of dam. Raised left training wall of spillway discharge channel, about 1.5' extended and 16' wall d/s. Some concrete work to promote better flow may have been done on trough along right side of spillway discharge channel. The d/s part of the right training wall on the spillway discharge ch. was replaced, as was the d/s end of the core, bottom of the spillway discharge ch. Engineer was R.W. (Don) Westlake, P.E., Holmes Rd., RD1, Box 26, Newburgh, NY (business status unknown, not contacted). See Appendix F3-9 thru F3-17 & Appendix G-2. The flashboard work proposed on Appendix G-3 appears not to have been done. Contractor unknown.

5C) **Repairs** *(1956 cont'd)* core wall was undermined & washed out. Replaced part of d/s toe of embankment which had been washed out. Engineer was Westlake as noted in 56-modifications. See Appendix F3-9 thru F3-17 & Appendix G-2.

7) **Validity** Dike shown on 1956 reconstruction diag. (Appendix G-2) to the left of the spillway is not apparent in field.

8a) **Operation** The impervious core can only be reached by boat. Handwheel is missing. Last operated 15-20 yrs ago.

- Lake used to be drained for cleaning every 10 yrs. Last done in 60's per memory.
- Operator visits dam at least twice a week during summer & randomly at other times.

7) **Validity** 1939 & 1956 reconstruction diags. (see Appendix G) show that core wall was to be raised 2.5', for a total of 6.5' over spillway crest. Measurement shows only about 2.0' added, total 6.0' over spillway crest.
## APPENDIX F
### SECTION F3
### COPIES OF ENGINEERING DATA AND RECORDS

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The State Conservation Dept.
Albany, N.Y.

Gentlemen:

On the night of Sept. 21st at about 8:30 o'clock, our farm was subjected to a violent flood. For some days previous there had been intermittent rain. The brook, running some 50 to 100 ft. below the house, had risen somewhat, but not in any sense to dangerous proportions. On a number of previous occasions we saw it considerably higher and after receding left us entirely no damage. On the night in question, however, a private dam (Tillson Lake) about three quarters of a mile upstream burst. This dam held back thirty five acres of water, thirty five feet deep in the channel. While this dam had an ample spillway to take care of high waters, it was the constant practice of the owners to keep this spillway planked up. Only when there was already threatening high water was any attempt made to remove the planks or to open the 3' square drain, a difficult job in both cases even in normal weather to say nothing of its being an impossible job during a storm. To open the drain it was necessary to row out to a concrete tower. To remove the planks from the spillway was at all times dangerous, for it required working at a 35' height against water pressure. There were no mechanical means to remove these planks which quite completely blocked the entire spillway. Such were the conditions on the night of Wednesday, Sept. 21st. It was a physical impossibility to do either of the two jobs. The high water then proceeded, aided somewhat by high velocity wind, to spill with considerable volume and force over the dam proper.

At this point I wish to describe briefly the construction of the dam. At the right (facing upstream from below the dam) there was a spillway shaped somewhat like a half funnel except that the sides were more square than round. The left hand side of this spillway was a concrete wall at right angles to the dam proper and running diagonally from the bed stream to the top of the dam. The lead off of the spillway was concrete. A few feet to the left of this wall and running at the very bottom of the original channel was the three foot square concrete drain running from a point some distance in the lake directly under the concrete tower to a point on the other side of the dam a few feet beyond the edge of the dirt fill. The rest of the dam other than the spillway, was a concrete wall 28" wide at the base, 12" wide at the top and approximately 35' high. Through this concrete there were some steel reinforcing bars of about 3/4" diameter. These bars appeared to be spaced about four or five feet apart. On both sides of this concrete wall there was a rock and dirt fill. Since the spillway was planked shut, the rising water spilled directly over the dam proper and kept washing away quite rapidly the down stream part of the fill, leaving the concrete wall entirely unsupported since it stood there without any other permanent bracing. The answer - it burst from top to bottom about 100 feet wide.
A number of people caught in the rush of water very narrowly escaped with their lives; bridges were promptly washed away; houses flooded; many, many trees uprooted, and general damage that goes with a flood. My farm is approximately three quarters of a mile below this dam, and while others were closer to it than we were our farm was the hardest hit because the water upon coming to our land concentrates between two high banks giving it great volume and force. Hundreds of tons of gravel, rocks and boulders, some of the latter weighing from five to ten ton, were deposited on our lawn but a few feet from the house. The foundation of the corner of the house was undermined, cellar flooded and contents destroyed; one hundred pullets were drowned and swept away, likewise a stack of straw all the winter bedding for the cattle; a tractor was carried 60 ft. and turned over considerably damaged; farm machinery, wagons, etc. swept away and recovered in a damaged condition. Many of our prize shade trees are gone. The well was flooded leaving us still without drinking water. The electric meter and switches in the cellar are so water soaked we are still without light or power. Two bridges leading from the farm to the outside road, our only means of travel, were washed away. Our two gardens have been made completely useless being strewn with boulders, gouged with numerous holes and the top soil gone. And worse yet, the course of the brook has been so altered that the next high water can do us several times the damage suffered this time.

It should be unnecessary to mention in detail all the havoc that a flood can cause. Our harvesting of corn and other important fall work has been unceremoniously interrupted by the emergency of this flood. While we realize the problem created by floods, all people hereabouts are of one opinion, to wit, that this one was caused unnecessarily. This dam probably was originally passed by State inspectors; the spillway, even in my own opinion, was constructed large enough to take care of a swollen stream. But why, in the name of common sense, a spillway is so constructed and then its purpose nullified by being planked up, (something that should never have been permitted at any time regardless of weather conditions) I don't know.

It seems quite certain that reconstruction of this Tillson Lake dam will start within a few days, so herein is the purpose of this letter. If the owners of this dam are permitted to do a job no better than the last in the way of construction and reinforcement; if they are permitted to plank up the spillway and thereby again endanger lives and cause thousands of dollars worth of damage, I for one along with my neighbors, most strenuously object. It seems to me in view of the seriousness of the damage just done and the possibility of its repetition, that somewhat more stringent regulations be enforced. It is not pleasant to anticipate these calamities with every rainy spell and to feel in constant uncertainty of the security of one's family and property, to say nothing of the inability to sustain such financial losses. It is difficult for a farmer to sustain himself under normal conditions.

I should like to have some assurance from you or whatever authorities have jurisdiction in these matters, that this will be given due consideration and action.

Yours truly,
(Signed) Fred Briehl

DEC  F3-2
Application for the Construction or Reconstruction of a Dam

Application is hereby made to the Superintendent of Public Works, Albany, N. Y., in compliance with the provisions of Section 948 of the Conservation Law (see last page of this application) for the approval of specifications and detailed drawings, marked Reconstruction "Tillson Lake" Dam, near Rutsonville, N. Y., herewith submitted for the reconstruction of a dam herein described. All provisions of law will be complied with in the erection of the proposed dam. It is intended to complete the work covered by the application about June 1, 1939.

1. The dam will be on Brook flowing into Shawangunk Kill in the town of Gardiner, County of Ulster and 5.5 miles north-west of Wallkill N. Y. (give exact distance and direction from a well-known bridge, dam, village main cross-roads or mouth of a stream)

2. Location of dam is shown on the Newburgh and Killenville quadrangle of the United States Geological Survey.

3. The name of the owner is W. A. Tillson,

4. The address of the owner is Walden, N. Y.

5. The dam will be used for Lake for Summer Club and bungalows

6. Will any part of the dam be built upon or its pond flood any State lands? no

7. The watershed above the proposed dam is 3.5 (including Palmarcatt) square miles.

8. The proposed dam will create a pond area at the spillcrest elevation of 25. acres and will impound 10,000,000 cubic feet of water.
9. The maximum height of the proposed dam above the bed of the stream is 32 feet 6 inches.

10. The lowest part of the natural shore of the pond is 15 feet vertically above the spillcrest, and everywhere else the shore will be at least 50 to 1200 feet above the spillcrest.

11. State if any damage to life or to any buildings, roads or other property could be caused by any possible failure of the proposed dam 1.5 miles of farm land to the Shawangunk Kill. Stream crosses an improved County Road near the Kill.

12. The natural material of the bed on which the proposed dam will rest is (clay, sand, gravel, boulders, granite, shale, slate, limestone, etc.) Hudson River Slate.

13. Facing down stream, what is the nature of material composing the right bank? Hudson River Slate.

14. Facing down stream, what is the nature of the material composing the left bank? Hudson River Slate.

15. State the character of the bed and the banks in respect to the hardness, perviousness, water bearing, effect of exposure to air and to water, uniformity, etc. Slate dips 50 degrees to west and the harder strata resist wear, and form riffles, which have withstood the flow of water for ages along bed of stream for several hundred ft.

16. Are there any porous seams or fissures beneath the foundation of the proposed dam? No.

17. Wastes. The spillway of the above proposed dam will be 55 feet long in the clear; the waters will be held at the right end by a concrete wall 6.5 feet long in the clear; the top of which will be 3.5 feet above the spillcrest, and have a top width of 3.5 feet; and at the left end by a concrete wall, the top of which will be 6.5 feet above the spillcrest, and have a top width of 3.5 feet.

18. The spillway is designed to safely discharge 1250 cubic feet per second.

19. Pipes, sluice gates, etc., for flood discharge will be provided through the dam as follows:

1 - 30" x 30" sluice gate

20. What is the maximum height of flash boards which will be used on this dam? 2.5 ft.

21. Apron. Below the proposed dam there will be an apron built of concrete 55 feet long across the stream, 5.5 feet wide and 2 to 5 feet thick.

22. Does this dam constitute any part of a public water supply? No.
INSTRUCTIONS

Read carefully on the last page of this application the law setting forth the requirements to be complied with in order to construct or reconstruct a dam.

Each application for the construction or reconstruction of a dam must be made on this standard form, copies of which will be furnished upon request to the Chief Engineer, Division of Engineering, Department of Public Works, Albany, N. Y. The application must be accompanied by three sets of plans, and specifications. The information furnished must be in sufficient detail in order that the stability and safety of the dam can be determined. In cases of large and important dams assumptions made in calculating stresses and stability should be given.

Samples of materials to be used in the dam and of the material on which the dam is to be founded may be asked for, but need not be furnished unless requested.

If the dam constitutes a part of a public water supply, application should be made to the Water Power and Control Commission under Article XI of the Conservation Law.

An application for the construction or reconstruction of a dam must be signed by the prospective owner of the dam or his duly authorized agent. The address of the signer and the date must be given as provided for on the last page of the application form.
SECTION 948 OF THE CONSERVATION LAW

§ 948. Structures for impounding water; inspection of docks; penalties. No structure for impounding water and no dock, pier, wharf or other structure used as a landing place on waters shall be erected or reconstructed by any public authority or by any private person or corporation without notice to the superintendent of public works, nor shall any such structure be erected, reconstructed or maintained without complying with such conditions as the superintendent of public works may by order prescribe for safeguarding life or property against danger therefrom. No order made by the superintendent of public works shall be deemed to authorize any invasion of any property rights, public or private, by any person in carrying out the requirements of such order. The superintendent of public works shall have power, whenever in his judgment public safety shall so require, to make and serve an order directing any person, corporation, officer or board, constructing, maintaining or using any structure hereinbefore referred to, remove, repair or reconstruct the same within such reasonable time and in such manner as shall be specified in such order, and it shall be the duty of every such person, corporation, officer or board, to obey, observe and comply with such order and with the conditions prescribed by the superintendent of public works for safeguarding life or property against danger therefrom, and every person, corporation, officer or board failing, omitting or neglecting so to do, or who hereafter erects or reconstructs any such structure hereinbefore referred to without submitting to the superintendent of public works and obtaining his approval of plans and specifications for such structures when required so to do by his order or who hereafter fails to remove, erect or to reconstruct the same in accordance with the plans and specifications so approved shall forfeit to the people of this state a sum not to exceed five hundred dollars to be fixed by the court for each and every offense; every violation of any such order shall be a separate and distinct offense, and, in case of a continuing violation, every day's continuance thereof shall be and be deemed to be a separate and distinct offense. This section shall not apply to a dam where the area draining into the pond formed thereby does not exceed one square mile, unless the dam is more than ten feet in height above the natural bed of the stream at any point or unless the quantity of water which the dam impounds exceeds one million gallons; nor to a dock, pier, wharf or other structure under the jurisdiction of the department of docks, if any, in a city of over one hundred and seventy-five thousand population. This section as hereby amended shall not impair the effect of an order heretofore made by the conservation commission or commissioner, under this section prior to the taking effect of chapter four hundred and ninety-nine of the laws of nineteen hundred and twenty-one, nor require the approval by the superintendent of public works of plans and specifications heretofore approved by such commission or commissioner under this section.

The foregoing information and accompanying plans and specifications are correct to the best of my knowledge and belief.

[Signature]
Owner

By: [Authorized agent of owner]

Address of signer: [Address]
Date: [May 12, 1939]
Mr. J. S. Bixby
District Engineer
Poughkeepsie, N.Y.

Dear Sir:

There is being sent to you enclosed herewith approved plans for the reconstruction of a dam owned by H. A. Tillson, Walden, N.Y. The dam is located in the Town of Gardner, Ulster County, 5.5 miles northwest of Wallkill, N.Y. This dam failed sometime ago due to the fact that the spillway was obstructed by flash boards during flood.

Very truly yours,

T. F. FARRELL
Chief Engineer

JFN/CG

enc
Mr. S. LeFevre,
Forest Glen,
New Paltz, N.Y.

Dear Sir:

An application and plans filed by you for the reconstruction of a dam in the Town of Gardner, Ulster County, 5.5 miles northwest of Wallkill, N.Y., for Mr. H. A. Tillson, are hereby approved to the extent of our authority under the provisions of section 943 of the Conservation Law.

This dam is designated by us as 194-842 Lower Hudson Watershed.

One set of plans for this dam, stamped with the approval of this department, is being sent to you enclosed herewith.

Very truly yours,

T. F. Farrell
Chief Engineer
4-30-56

REPORT ON TILLISON LAKE DAM
Rutsonville, N. Y.
Owner - Dominick Porco

Results To Dam From Rain and Flood of August 1955

North Core Wall
A portion of this wall had not been built higher during the reconstruction of 1939, and the top of the wall is still at elevation 284. The lake level topped this by several inches, and the overflowing water scoured the earth somewhat. The sluice gate has not been operative for years and could not be opened to help lower the water level.

Spillway Side Walls
At the lower end of the spillway the walls were of insufficient height to carry the flow. The overflowing on the northeast side resulted in scouring the earth to slate rock close below the surface. But on the southwest side, a portion of the toe of the earth dam was washed out, and a section of spillway wall and bottom were undermined and washed out.

Depth of Water Above Flashboards - August 1955 Flood
Judging by the amount of scouring at the north core wall, the wall was topped by several inches; and the depth of water above flashboards would thusly have been about 2 feet.

Note - With the raising of the north core wall, the top of wall will then be 4 feet above top of flashboards.
Proposed Reconstruction - 1956

The proposed reconstruction is shown on Dwg. 1, Job No. 56-12 of T. W. Westlake, P. E.

Specifications
Specifications for the work are outlined on the drawing.

Outline of Work and Completion Dates

<table>
<thead>
<tr>
<th>Work</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Core wall and Dike</td>
<td>5-30-56</td>
</tr>
<tr>
<td>Spillway Sidewall and Bottom Rebuilding</td>
<td>7-30-56</td>
</tr>
<tr>
<td>Filling In Washed Out Areas</td>
<td>7-30-56</td>
</tr>
<tr>
<td>Rip Rap, Or Concrete Walls To Raise Pool Level</td>
<td>8-30-56</td>
</tr>
<tr>
<td>Repair Sluice Gate</td>
<td>10-30-56</td>
</tr>
</tbody>
</table>

(All work to be completed by 10-30-56)
Application for the Construction or Reconstruction of a Dam

Application is hereby made to the Superintendent of Public Works, Albany, N.Y., in compliance with the provisions of Section 948 of the Conservation Law (see third page of this application) for the approval of specifications and detailed drawings, marked 1956 Reconstruction of "Tillson Lake" Dam near Rutsonville, N.Y.

herewith submitted for the (reconstruction) of a dam herein described. All provisions of law will be complied with in the erection of the proposed dam. It is intended to complete the work covered by the application about Nov. 1, 1956

1. The dam will be on Brook flowing into Shawangunk Kill in the Gardiner town of Ulster County of Ulster and 5.5 miles northwest of Wallkill, N.Y. (Give exact distance and direction from a well-known bridge, dam, village, main cross roads or mouth of a stream)

2. Location of dam is shown on the Newburgh and Ellenville quadrangle of the United States Geological Survey.

3. The name of the owner is Dominick Porco

4. The address of the owner is R. D. 1, Route 9W, Newburgh, N.Y.

5. The dam will be used for Lake for Summer Club and Bungalows

6. Will any part of the dam be built upon or its pond flood any State lands? no

7. The watershed above the proposed dam is 3.5 (including Palmaghett) square miles.

8. The proposed dam will create a pond area at the spillcrest elevation of 25 acres and will impound 10,000,000 cubic feet of water.

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9. The maximum height of the proposed dam above the bed of the stream is 23 feet 6 inches.

10. The lowest part of the natural shore of the pond is 15 feet vertically above the spillcrest, and everywhere else the shore will be at least 50 to 1200 feet above the spillcrest.

11. State if any damage to life or to any buildings, roads or other property could be caused by any possible failure of the proposed dam: 1.5 miles of farm land to the Shawangunk Kill; some individual homes; stream crosses under an improved Cty. Road near the Kill

12. The natural material of the bed on which the proposed dam will rest is (clay, sand, gravel, boulders, granite, shale, slate, limestone, etc.) Hudson River Slate

13. Facing downstream, what is the nature of material composing the right bank? Hudson River Slate

14. Facing downstream, what is the nature of the material composing the left bank? Hudson River Slate

15. State the character of the bed and the banks in respect to the hardness, perviousness, water bearing, effect of exposure to air and to water, uniformity, etc.: Slate dips 50 degrees to the west, and the harder strata resist wear for several hundred feet downstream from the spillway.

16. Are there any porous seams or fissures beneath the foundation of the proposed dam? No; there are no signs of boils on the downstream face.

17. Wastes. The spillway of the above proposed dam will be 55 feet long in the clear; the waters will be held at the right end by a concrete wall, the top of which will be 6.5 feet above the spillcrest, and have a top width of 3.5 feet; and at the left end by a concrete wall, the top of which will be 6.5 feet above the spillcrest, and have a top width of 3.5 feet.

18. The spillway is designed to safely discharge 1250 cubic feet per second. (based on flow depth of 3.5')

19. Pipes, sluice gates, etc., for flood discharge will be provided through the dam as follows: one 30" x 20" sluice gate

20. What is the maximum height of flash boards which will be used on this dam? 2.5 feet

21. Apron. Below the proposed dam there will be an apron built of concrete 55 feet long across the stream, 5.5 feet wide and 2 to 5 feet thick.

22. Does this dam constitute any part of a public water supply? No
INSTRUCTIONS

Read carefully on the third page of this application the law setting forth the requirements to be complied with in order to construct or reconstruct a dam.

Each application for the construction or reconstruction of a dam must be made on this standard form, copies of which will be furnished upon request to the Department of Public Works, Albany, N. Y. The application must be accompanied by three sets of plans, and specifications. The information furnished must be in sufficient detail in order that the stability and safety of the dam can be determined. In cases of large and important dams assumptions made in calculating stresses and stability should be given.

Samples of materials to be used in the dam and of the material on which the dam is to be founded may be asked for, but need not be furnished unless requested.

If the dam constitutes a part of a public water supply, application should be made to the Water Power and Control Commission under Article XI of the Conservation Law.

An application for the construction or reconstruction of a dam must be signed by the prospective owner of the dam or his duly authorized agent. The address of the signer and the date must be given as provided for on the last page of the application form.

SECTION 948 OF THE CONSERVATION LAW

§ 948. Structures for impounding water; inspection of docks; penalties. No structure for impounding water and no dock, pier, wharf or other structure used as a landing place on waters shall be erected or reconstructed by any public authority or by any private person or corporation without notice to the superintendent of public works, nor shall any such structure be erected, reconstructed or maintained without complying with such conditions as the superintendent of public works may by order prescribe for safeguarding life or property against danger therefrom.

No order made by the superintendent of public works shall be deemed to authorize any invasion of any property rights, public or private, by any person in carrying out the requirements of such order. The superintendent of public works shall have power, whenever in his judgment public safety shall so require, to make and serve an order, setting forth therein his findings of fact and his conclusions therefrom, directing any person, corporation, officer or board, constructing, maintaining or using any structure hereinbefore referred to, either remove the said structure or to repair or reconstruct the same within such reasonable time and in such manner as shall be specified in such order, and it shall be the duty of every such person, corporation, officer or board, to obey, observe and comply with such order and with the conditions prescribed by the superintendent of public works for safeguarding life or property against danger therefrom, and every person, corporation, officer or board failing, omitting or neglecting so to do, or who hereafter erects or reconstructs any such structure hereinbefore referred to without submitting to the superintendent of public works and obtaining his approval of plans and specifications for such structures when required to do so by his order or hereafter fails to remove, erect or to reconstruct the same in accordance with the plans and specifications so approved shall forfeit to the people of the State a sum not to exceed five hundred dollars to be fixed by the court for each and every offense; every violation of any such order shall be a separate and distinct offense, and, in such case of a continuing violation, every day's continuance thereof shall be and be deemed to be a separate and distinct offense. Such order shall not contain any provision to compel the owner to make repairs or proceed with reconstruction as specified in this section by any type of construction other than that of the dam itself. In addition to said forfeiture upon the violation of any such order, the superintendent of public works shall have power to enter upon the lands and waters where such structures are located, for the purpose of removing, repairing or reconstructing the same, and to take such other and further precautions which he may deem necessary to safeguard life or property against danger therefrom. In removing, repairing and reconstructing such dam the superintendent shall not deviate from the method, manner or specifications contained in the original order. The superintendent of public works shall certify the amount of the costs and expenses incurred by him for the removal, repair or reconstruction aforesaid, or in anywise connected therewith, to the board of supervisors of the county or counties in which the said lands and waters are located, whereupon it shall be the duty of such board of supervisors to add the amount so certified to the assessment rolls of such locality or localities as a charge against the real property upon which the dam is located designated or described by the superintendent of public works as chargeable therewith, and to issue its warrant or warrants for the collection thereof. Thereupon it shall become the duty of such locality or localities through their proper officers to collect the amounts so certified in the same manner as other taxes are collected in such locality or localities, and when collected, to pay the same to the superintendent of public works.
who shall thereupon pay the same into the treasury. Any amount so levied shall thereupon become a lien upon the
real property affected thereby, to the same extent as any tax levy becomes and is a lien thereon.

Any person in interest may, within thirty days from the service of any such order, appeal to the supreme court
to determine the reasonableness of such order. At any time during such appeal to the supreme court upon at least
three days' notice, the party appealing may apply for an order directing any question of fact to be tried and deter-
mined by a jury, and the court shall thereupon cause such question to be stated for trial accordingly and the findings
of the jury upon such question shall be conclusive. Appeals may be taken from the supreme court to the appellate
division of the supreme court and to the court of appeals in such cases, subject to the limitations provided in the
civil practice act.

This section shall not apply to a dam where the area draining into the pond formed thereby does not exceed
one square mile, unless the dam is more than ten feet in height above the natural bed of the stream at any point or
unless the quantity of water which the dam impounds exceeds one million gallons; nor to a dock, pier, wharf or
other structure under the jurisdiction of the department of docks, if any, in a city of over one hundred and seventy-
five thousand population. This section as hereby amended shall not impair the effect of an order heretofore made
by the conservation commission or commissioner under this section prior to the taking effect of chapter four hun-
dred and ninety-nine of the laws of nineteen hundred and twenty-one, nor require the approval by the superintend-
ent of public works, of plans and specifications theretofore approved by such commission or commissioner under
this section.

The foregoing information is correct to the best of my knowledge and belief, and the construction will be
carried out in accordance with the approved plans and specifications.

[Signature]

Owner

By [Authorized Agent]

Address of owner: R. D. 1, Route 9W, Newburgh, N. Y. Date: 4-30-56

[Signature]

Authorized Agent of Owner.
Comments

The dam was originally built without backboards.

\[ \text{Spillway} \left[ \frac{1}{4} \right] \]

and was supposed to have a capacity

\[ Q = 3.0 \times 10^5 \times \sqrt{3.5^3} = 1210 \text{ c.f.s.} \]

This allowed only 0.5 freeboard which was not enough. The water level was raised 2 feet by putting on 7 + 1 flashboards and raising the elevation of the dam. This left the spillway opening 1.5 x 4.

The flashboards were strong enough not to float out. However, they are not strong enough to handle it. Probably the best way is to have the flashboards put out when the water level gets to not more than 1" above flashboards, providing there are not flash other people's lands.

A flume gate should be made to work. Other repairs are noted on, etc. Report subject to final thoughts on ratio 3

\[ \frac{23.9}{640} = 0.04 \text{ is very small.} \]
Spillway Design:

\[ Q = 3.5 \times 55 \times \sqrt{3.5} = 1250 \text{ c.f.s.} \]

Actual Run:\n
\[ Q = \frac{Q}{A} \quad A = 3.5 \times 640 = 2240 \text{ ft}^2 \]

Wedge 6% grade with curb,

\[ V = 2 \quad \frac{21.350}{2} = 12610 = 710 \text{ Ml/h}, \quad T = 3.5 \text{-ft.} \]

\[ I = \frac{4.06}{3.5} = 1.16 \text{ in.} \text{ per ft.} \]

\[ Q = 3.5 \times 1.16 \times 2240 = 910 \text{ c.f.s.} \] (2500 c.f.s. too high.)

Flashboards should go out when water is 1' above the top of them.
\[\begin{align*}
\text{Water in} & \\
\text{h'} & = 2.5 \\
& \downarrow \\
\text{h} & = 1.4 \\
& \downarrow \\
\text{h} & = 1 \\
& \downarrow \\
\text{x} & = 1" \text{ Pipe} \\
\text{L} & = 5 = 5 + \text{h} \\
\hline
12 & \left[ \frac{62.5 \times 2.5 \times 2.5 \times 2.5 \times 2.5}{3} \right] + 62.5 \times 5 \left( \frac{3.5 - 2.5}{2} \right) \left( \frac{2.5 \times 2.5}{2} \right) = 0.87 \\
& \frac{1.875}{1.325} = 1.325 \\
\text{Final} & \\
\text{h'} & = 2.5 \\
& \downarrow \\
\text{h} & = 1.4 \\
& \downarrow \\
\text{x} & = 1" \text{ Pipe} \\
\text{L} & = 5 = 5 + \text{h} \\
\hline
\text{stirr} & = \frac{2 \times 1.4 \times 1.4}{1.325} = 141.12 \div 10" \\
& \downarrow \\
\text{r} & = 9
\end{align*}\]
## DEC DAM INSPECTION REPORT

<table>
<thead>
<tr>
<th>RB</th>
<th>CTY</th>
<th>YR. AP.</th>
<th>DAM NO.</th>
<th>INS. DATE</th>
<th>USE</th>
<th>TYPE</th>
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<tbody>
<tr>
<td>01</td>
<td>56</td>
<td>39</td>
<td>1</td>
<td>2/20</td>
<td>042373</td>
<td>002</td>
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</tbody>
</table>

### AS BUILT INSPECTION
- Location of Spillway and outlet
- Size of Spillway and outlet
- Elevations
- Geometry of Non-overflow section

### GENERAL CONDITION OF NON-OVERFLOW SECTION
- Settlement
- Joints
- Undermining
- Settlement of Embankment
- Downstream Slope
- Cracks
- Surface of Concrete
- Deflections
- Leakage
- Crest of Dam
- Joints
- Settlement of Embankment
- Deflections
- Leakage
- Settlement of Embankment

### GENERAL CONDITION OF SPILLWAY AND OUTLET WORKS
- Auxiliary Spillway
- Joints
- Mechanical Equipment
- Service or Concrete Spillway
- Plunge Pool
- Stilling Basin
- Spillway Toe
- Drain
- Hazard Class
- Inspector

### COMMENTS:
- Dam in good condition
- Trees growing on downstream slope

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DEC DAM INSPECTION REPORT CODING

1. River Basin - Nos. 1-23 on Compilation Sheets
2. County - Nos. 1-62 Alphabetically
3. Year Approved -
4. Inspection Date - Month, Day, Year
5. Apparent Use -
   1. Fish & Wildlife Management
   2. Recreation
   3. Water Supply
   4. Power
   5. Farm
   6. No Apparent Use
6. Type -
   1. Earth with Aux. Service Spillway
   2. Earth with Single Conc. Spillway
   3. Earth with Single non-conc. Spillway
   4. Concrete
   5. Other
7. As-Built Inspection - Built substantially according to approved plans and specifications

Location of Spillway and Outlet Works

1. Appears to meet originally approved plans and specifications.
2. Not built according to plans and specifications and location appears to be detrimental to structure.
3. Not built according to plans and specifications but location does not appear to be detrimental to structure.

Elevations

1. Generally in accordance to approved plans and specifications as determined from visual inspection and use of hand level.
2. Not built according to plans and specifications and elevation changes appear to be detrimental to structure.
3. Not built according to plans and specifications but elevation changes do not appear to be detrimental to structure.

Size of Spillway and Outlet Works

1. Appears to meet originally approved plans and specifications as determined by field measurements using tape measure.
2. Not built according to plans and specifications and changes appear detrimental to structure.
3. Not built according to plans and specifications but changes do not appear detrimental to structure.

Geometry of Non-overflow Structures

1. Generally in accordance to originally approved plans and specifications as determined from visual inspection and use of hand level and tape measure.
2. Not built according to plans and specifications and changes appear detrimental to structure.
3. Not built according to plans and specifications but changes do not appear detrimental to structure.

General Conditions of Non-overflow Section

1. Adequate - No apparent repairs needed or minor repairs which can be covered by periodic maintenance.
2. Inadequate - Items in need of major repair.

(Items) For boxes listed on condition under non-overflow section.
1. Satisfactory.
2. Can be covered by periodic maintenance.
3. Unsatisfactory - Above and beyond normal maintenance.

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General Condition of Spillway and Outlet Works

1. Adequate - No apparent repairs needed or minor repairs which can be covered by periodic maintenance.
2. Inadequate - Items in need of major repair.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Adequate No apparent repairs needed or minor repairs which can be covered by periodic maintenance.</td>
</tr>
<tr>
<td>2.</td>
<td>Inadequate - Items in need of major repair.</td>
</tr>
</tbody>
</table>

Maintenance

1. Evidence of periodic maintenance being performed.
2. No evidence of periodic maintenance.
3. No longer a dam or dam no longer in use.

Hazard Classification Downstream

1. (A) Damage to agriculture and county roads.
2. (B) Damage to private and/or public property.
3. (C) Loss of life and/or property.

Evaluation - Based on Judgment and Classification in Box Nos.

Evaluation for Unsafe Dam

1. Unsafe - Repairable.
2. Unsafe - Not Repairable.
3. Insufficient evidence to declare unsafe.

<table>
<thead>
<tr>
<th>River Basin</th>
<th>County</th>
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<tbody>
<tr>
<td>LOWER HUDSON</td>
<td>Albany</td>
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<td>UPPER HUDSON</td>
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<td>TRENT</td>
<td>3 Brock</td>
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<td>SUSQUEHANNA</td>
<td>4 Brock</td>
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<td>CHENANGO</td>
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<td>OSWEGO</td>
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<td>ALLEGHENY</td>
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APPENDIX G
DRAWINGS

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<th>Page</th>
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<td>G-1</td>
</tr>
<tr>
<td>1956 Reconstruction, by T.W. Westlake</td>
<td></td>
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<tr>
<td>Overall Plan - April 25, 1956</td>
<td>G-2</td>
</tr>
<tr>
<td>Flashboard Details - May 10, 1956</td>
<td>G-3</td>
</tr>
</tbody>
</table>
FROM DEC
REduced TO 40% OF ORIGINAL
FROM DEC
REduced to 50% of ORIGINAL
GENERAL NOTES:
1. All work indicated on this plan to be done immediately, except the stone core - this is to be removed at end of the 32 summer season.
2. The engineer or his agent in charge of the work reserves the right to change the plans and specifications at any time.

CONCRETE NOTES:
1. Concrete to be 3500 psi strength.
2. Min. Cover of concrete over crown to be 18 in.
3.增强已有的混凝土结构，准备于3月起进行。
4. Min. Embed 36 in. in concrete, concrete to extend, both ways with 10 in. grade control, level at end of core.
5. Pouring new concrete to State Bank, where possible.

T. W. WESTLAKE
Professional Engineer
HOLMES PARK, R.I., NEWBURY, N.H.
TILLSON LAKE DAM
SUMMONVILLE, N.H.

1956 RECONSTRUCTION
Plan View of Spillway

1/6 = 1'

FROM DEC
REDUCED TO 70% OF ORIGINAL
DATE
ILME