Woidt Engineering

ROARING BROOK LAKE DAM
DEC DAM ID #213-2775
ENGINEERING ASSESSMENT REPORT

Town of Putnam Valley
Putnam County, New York

Prepared for:

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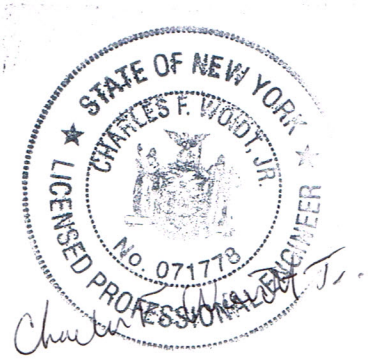

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(NYSDEC DAM ID # 213-2775)
ENGINEERING ASSESSMENT REPORT

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1.0 Purpose of Investigation

This investigation was conducted to comply with the requirements of NYCRR Part 673, Dam Safety Regulations, which include the completion of a Dam Safety Engineering Assessment. The Engineering Assessment generally includes:

- Record Review
- A complete visual dam safety inspection
- A hydrologic/hydraulic assessment
- A structural/stability assessment
- Confirmation of Dam Hazard Class
- Review of Emergency Action Plan and Inspection & Maintenance Plan
- Conclusions & Recommendations regarding the safety of the dam
- Preparation and submission of an Engineering Assessment Report

The engineering assessment was developed in accordance with TOGS 3.1.4 "Guidance for Dam Engineering Assessments". The investigation was conducted by Woidt Engineering & Consulting, PC (WEC) of Binghamton, NY, in association with Griffiths Engineering, LLC, of Binghamton, NY. Griffiths Engineering completed the stability analysis portion of the assessment.

2.0 Project Location & Dam Description

Roaring Brook Lake Dam is a concrete gravity dam with a reinforced earth embankment located in the Town of Putnam Valley, Putnam County, NY. The NYSDEC dam ID# is 213-2775. The dam is currently classified as a high hazard (Class C) dam per NYSDEC dam inventory. Roaring Brook Lake Dam has approximately 118 acres of surface area at normal pool and has a maximum dam height of approximately 23'. Records indicate that the last major dam reconstruction occurred in 1959. Additional repairs including installation of a new low flow drain valve occurred in 2013 (see section 9.0 for additional details).

The principal spillway for the dam consists of a 28' wide concrete weir controlled by stop logs. The stop logs (approximately 21" high) are typically installed in the spring and removed in late fall. As such, the maximum summer pool elevation is 16" above a 5" tall concrete lip that serves as the lowest crest elevation of the spillway. An 18" diameter CIP pipe equipped with a gate valve serves as the draw down drain for the lake (see photos, page 2). Typically, the lake is drawn down 4-5 feet below the concrete spillway crest elevation during the winter months. There is no formal auxiliary or emergency spillway. The main dam crest is approximately 450' in length and the dam crest and upstream slopes are armored with heavy placed rip-rap. A saddle dam is located to the east of the main dam and is approximately 150' in length. The saddle dam crest elevation is approximately 2' higher than the main dam crest elevation.

Primary Spillway with stop logs

Recently installed low flow drain valve

Pertinent dam information was obtained from review of a US Army Corps of Engineers "Phase I Inspection Report" (August 1981); a "Response to Phase 1 Requirements Report" prepared by Walter B. Satterthwaite Associates (April 1985); review of the dam owner files; review of NYSDEC Dam Safety files; field verification/detailed survey of spillway components; USGS mapping; and aerial photography.

Pertinent Dam Data includes:

Top of Dam (Main Dam): **Crest Elevation = 776.2 to 776.9**
Top of Dam (Saddle Dam): **Crest Elevation = 778.7 to 779.0**
Normal Pool: **Elevation 773.2 (with stop logs removed), Elevation 774.5 (with all stop logs in place)**
Service Spillway: **28' long concrete weir with stop logs**
Auxiliary Spillway: **no formal auxiliary spillway**
Embankment Crest Length: **450' (Main Dam), 150' (Saddle Dam)**
Drainage Inflow area: **1.69 square miles**
Storage @ Normal Pool: **1143 acre-ft. (with stop logs), 970 acre-ft. (stop logs removed)**
Storage @ Dam Crest: **1368 acre-ft.**
Maximum Dam Height: **23' +/-**
Surface Area @ Normal Pool: **118 acres (without stop logs), 125 acres (with stop logs)**

3.0 Records Review

The following records pertaining to the design, construction, operation, maintenance, and inspection of Roaring Brook Lake Dam were reviewed as part of this assessment.

Table 1 - Summary of Reviewed Documents
Roaring Brook Lake Dam

Document	Date	Entity	Description
Phase 1 Inspection Report	8/1981	USACOE	National Phase 1 Dam Inspection Report
Dam Safety Inspection Reports	8/2008, 10/2014,	Woidt Engineering	Dam Safety Inspection Reports
Visual Inspection Reports	5/10/2010, 9/1/2011, 5/14/14	NYSDEC Dam Safety	Visual Inspection Report
IMP	6/28/2011	Woidt Engineering	Inspection & Maintenance Plan
EAP	6/28/2011	Woidt Engineering/ Putnam County EMO	EAP Document & Inundation Mapping
Response to Phase 1 Dam Safety Requirements	4/1985	Walter B. Satterthwaite Associates, Inc.	Engineering assessment responding to Phase 1 comments

4.0 Emergency Action Plan and Inspection & Maintenance Plan Review

Woidt Engineering, in conjunction with the Town of Putnam Valley and the Putnam County Office of Emergency Management, prepared an Emergency Action Plan (EAP) in the fall and winter of 2010/2011. The final EAP was forwarded to NYSDEC Dam Safety Section in June of 2011. Discussions with the dam owner indicated that they have not reviewed the EAP or updated the contract notification chart since 2012. As such, the dam owner should review the EAP and forward any changes to Dam Safety by January 2015.

Roaring Brook Lake Dam is owned and maintained by the Town of Putnam Valley. The dam appeared to be well maintained on the date of the last visual inspection and in accordance with the IMP plan (see section 6.0).

5.0 Hazard Class Review

In 2011, WEC conducted a downstream hazard site review and also performed sunny and rainy day dam break model runs using HEC-HMS and HEC-RAS to verify the hazard class of the dam. From the results of our investigation, WEC concurs that the current hazard class of the dam, “C” (High), is appropriate due to the depth and velocities of flooding at multiple residential and commercial structures located within the inundation extents downstream of the dam.

6.0 Visual Inspection

A full visual inspection of the dam was performed by WEC in August of 2008 and again in October of 2014. Griffiths Engineering was also involved with the October 2014 visual inspection to specifically look at the structural condition of the dam, spillway and concrete training walls and spillway chute. During the latest 2014 inspection, the reservoir level at the time of inspection was approximately at the normal pool elevation of 773.2 with the stop logs removed. The complete inspection reports and photo documentation are provided in Appendix C.

7.0 Hydrologic & Hydraulic Analysis/Spillway Capacity

WEC completed a hydrologic and hydraulic assessment for Roaring Brook Lake Dam to assess the spillway capacity of the dam. Inflow hydrographs were developed using the Soil Conservation Service (SCS) Unit hydrograph method contained in the HydroCAD software package. "CN" values were estimated from review of land use, aerial photography and Putnam County Soil Mapping. Predominant soil types consist of Hydrologic Soil Group B & C soils for the inflow area upstream of the dam. Land cover primarily consists of residential areas, wooded areas and areas of brush cover and meadow.

The total drainage area entering the dam impoundment is 1.69 square miles (see Drainage Area Map - Appendix A). The drainage area was broken into three subareas. Two of the subareas were routed through natural storage areas (see drainage area map - Appendix A). Lag time's (T_{lag}) for the inflow hydrographs were computed utilizing travel time methodology from NCRS TR-55 procedures, with Tlag = 0.6 X Tc (time of concentration).

The 24 hour precipitation value for the Probable Maximum Precipitation (PMP) was obtained from HMR-51 All Season PMP for a 24-hour, 10 square mile storm. The full Probable Maximum Flood (PMF) inflows to the dam were developed in the HydroCAD Version 10.0 computer program based on the PMP rainfall (32.0 inches). The PMP rainfall was adjusted such that the peak discharge for the 0.50PMF inflow hydrograph was 50% of the PMF hydrograph peak discharge. It is noted that the SCS rainfall distribution (Type III) was used in lieu of the HMR-52 rainfall distribution due to the very small drainage area to the dam. Reservoir routings for the dam were performed assuming maximum normal summer pool conditions with all stop logs in place (elevation 774.5). Stage-storage relationships were developed from review of aerial photography, available elevation data and USGS mapping. Stage-discharge rating curves for the dams were developed using hydraulic routing methods imbedded within the HydroCAD software for a weir configuration for the primary spillway (Twin 6' Wide X 3' high openings) and an asymmetrical weir for the main and saddle dam crest elevations. The peak outflow and reservoir stages for selected storm events for the dam are presented in Table 2.

Table 2 – Discharges/Stages for Various Storm Events
Roaring Brook Lake Dam

Storm Event	Peak Inflow (cfs)	Peak Outflow (cfs)	Maximum Stage	Peak Overtopping Flow (cfs)	Maximum Overtopping depth (ft)	Overtopping Duration (hours)
0.50 PMF	4574	2090	777.9	1465	1.7	16
PMF	9152	5221	779.9	4113	3.7	19

Lowest Top of Main Dam =776.2, Normal Pool Elevation = 774.5 (with stop logs), 773.2 (without stop logs), Lowest Top of Saddle Dam = 778.7

As can be observed from Table 2, Roaring Brook Lake Dam spillway capacity does not have enough spillway capacity to pass the routed 0.50PMF storm event without overtopping the crest of the main dam.

Review of the HydroCAD output indicates that the spillway capacity to the low point in the main dam crest elevation is approximately 202cfs. For the 0.50PMF storm, which is the spillway design storm for an existing small, high hazard Dam, the lowest point of the main dam crest will overtop for approximately 16 hours with a maximum overtopping depth of 1.7'. The saddle dam crest will not be overtopped during the 0.50PMF event as the crest elevations are higher than the main dam. A low area adjacent to the left abutment of the saddle dam will experience some minor flow (64 cfs peak flow) during the 0.50PMF event. Selected HydroCAD computer output is included in Appendix B.

8.0 Stability Assessment

The stability analysis for the dam was conducted by Griffiths Engineering. The stability analysis with supporting calculations, observations and recommendations are included in Appendix D.

9.0 Outlet Works Assessment

In accordance with 1989 NYSDEC Guidelines for Design of Dams, the low level drain of a dam is required to have adequate capacity to discharge 90% of the storage below the lowest spillway crest within 14 days, assuming no inflow into the reservoir.

The existing drawdown system consists of one 18" diameter CIP pipe that is controlled by a gate valve. Using this system, WEC utilized HydroCAD version 10.0 to assess the drawdown time to remove 90% of the storage between the maximum normal summer pool elevation (774.5) and the invert elevation of the reservoir drain (756.0). The results of the HydroCAD drawdown analysis (Appendix B) revealed that it will take over 17 days to remove 90% of the normal storage utilizing the existing 18" drain pipe, which is slightly more than the recommended 14 day period per NYSDEC Dam Safety Guidelines.

10.0 Conclusions, Recommendations, Schedule and Statement of Conformance

Conclusions

1. The hydrologic and hydraulic analysis identified that Roaring Brook Lake Dam has inadequate spillway capacity to pass the 0.50PMF storm event without overtopping the main dam crest. This assumes that all the stop logs are installed and the maximum normal summer pool of 774.5 is used in the hydraulic analysis. Under this condition, all storm events exceeding approximately 4% of the routed PMF storm event will begin to overtop the crest of the main dam.

2. The 18" drawdown drain pipe used to lower the Roaring Brook Reservoir does not have enough capacity to remove 90% of the reservoir volume below the maximum normal summer pool elevation with a 14 day period. Additionally, as noted in the 2014 Inspection Report, a new butterfly valve was installed on the downstream end of the drain pipe, essentially pressuring the outlet pipe through the dam.

3. The overall condition and maintenance of the dam is good.

4. The computed factors of safety for slope sliding, overturning and slope stability were deemed acceptable based on analysis and site observations by Griffiths Engineering who performed the stability analysis (Appendix D). This includes the design storm condition (0.50PMF) where the main dam is actively overtopping.

5. The EAP and inundation mapping were submitted to NYSDEC in 2011 and have not been reviewed and updated by the owner since 2012.

6. A formal, written Inspection & Maintenance Plan (IMP) was reviewed and is being followed by the dam owner.

7. The Hazard Class of "C" (high) was confirmed due to the estimated depth of flooding and flow velocities at multiple residential and commercial structures as well as roadway crossings located downstream of the dam.

Recommendations

1. It is recommended that drawdown capacity improvements be investigated such that 90% of the reservoir volume can be removed within 14 days (assuming no inflow). Initial analysis conducted by WEC showed that installation of a supplemental 12" diameter siphon could draw down 90% of the reservoir volume within the recommended 14 day time period.

2. The location of the control valve at the downstream end of the drain pipe causes concern of potential piping around the outlet pipe since it is now constantly under hydrostatic pressure. It is recommended that further investigations be conducted to determine if the control can be installed at the inlet of the drain pipe.

3. The EAP should be reviewed by the owner and updated by January 2015. Any changes to the EAP should be noted in the 2015 Annual Certification Form that should be submitted to NYSDEC Dam Safety by January 31st, 2015.

4. Past studies as well as this engineering assessment has identified that the dam does not have sufficient capacity to pass the 0.50PMF storm event without significant overtopping of the main dam. Although the stability assessment suggests that the dam will be stable under the design storm event, the depth and duration of the overtopping of the main dam could create erosion at the downstream toe of the dam. As such, it is recommended that a more detailed analysis of toe scour and its effect on the main dam stability be conducted to confirm if potential erosion at the toe of the dam could compromise the stability of the dam. It is noted that the dam crest, upstream slope and downstream face are currently armored with large rip-rap (dam crest and upstream slope) and concrete/stone and mortar (downstream face).

5. It is recommended that the visual inspections, performed by a professional engineer trained in dam safety, occur every two years; therefore the next inspection should occur in 2016. The minor items identified in the 2014 Inspection report should be addressed and videotaping of the low flow outlet pipe should be completed as part of the 2016 inspection report.

Schedule

1. It is recommended that Item #1 be investigated and a supplemental drawdown system be installed by the end of October 2015.

2. Item #2 should be investigated by underwater diving means by the fall of 2015. Identified repair plans (if deemed necessary) should be advanced in 2016.

3. Item # 3 be completed by the dam owner by the end of January, 2015 and the EAP should be reviewed and updated if necessary on an annual basis thereafter.

4. The additional investigations identified in item #3 should be completed by the end of 2015. Spillway capacity improvements and/or stability/erosion mitigation recommendations (if deemed necessary) should be identified and implemented within 3 years.

Statement of Conformance

With the exception of updating the EAP, spillway capacity and drawdown capability deficiencies, it is WEC's opinion that Roaring Brook Lake Dam is in general conformance with current NYSDEC Dam Safety regulations.