

TECHNICAL MEMORANDUM

(830320)

Date: September 11, 2024
To: Theresa Perron, Town of Glover
From: Michael P. Hildenbrand, P.E. (D&K)
Cc: Charles W. Johnston, P.E. (D&K), Steve Hanna (Vermont Dam Safety)
Subject: Shadow Lake Dam
Sinkhole Investigation and Temporary Repair

Background

At the request of the Town of Glover, DuBois & King, Inc. (D&K) personnel performed a site visit on Thursday, August 8, 2024, to obtain observations (photos and measurements) of a sinkhole in the Shadow Lake Dam. Theresa Perron, Town of Glover, provided access to the site and answered questions during the site visit. The site visit was scheduled due to a forecasted rain event that may cause localized flooding for the coming weekend.

The Vermont Dam Safety Program (VTDSP) performed an inspection of the Shadow Lake Dam on July 19, 2024. The VTDSP provided the Town of Glover with a July 2024 Flood Inspection and Recommendations Letter, which downgraded the condition of the Dam from POOR (determined following the July 2023 Flood event) to UNSATISFACTORY “based on the increased severity of the sinkhole in comparison to the previous inspection and the potential for this sinkhole to lead to seepage/internal erosion/stability issues with the dam.”

Evaluation

The sinkhole is approximately 3 feet downstream from the dam crest and centered between the auxiliary spillway and the principal spillway gate house. The sinkhole (Figure 1) was observed to be approximately 2 feet wide, 4 feet long, and up to about 6 feet deep. The depth varied with the deeper end to the left side and shallower to the right side.



Figure 1 – Sinkhole

Stone with a concrete grout was observed in the lower section of the sinkhole (Figures 2 & 3). The stone may have provided a barrier to the sinkhole from being in a vertical alignment instead of the observed angled orientation.



Figure 2 – Masonry Stone



Figure 3 – Lower Sinkhole Section

Repair

D&K provided a brief outline of a repair option consisting of placing non-woven geotextile into the bottom of the sinkhole and approximately 1 foot up the sidewalls of the sinkhole. The sinkhole was then filled with 1 ½" crushed stone. A Town crew placed the geotextile and began backfilling the sinkhole while D&K personnel were onsite.

Next steps

The above repair is only considered temporary and a comprehensive repair to restore the embankment to its condition before the emergence of the sinkhole will be required. It is our understanding that a Dam Safety Order will be required to proceed with the repair and that a comprehensive geotechnical investigation and analysis will be necessary to support the repair efforts. Vermont Dam Safety Program has mandated that the Town maintain the lake level approximately two feet below the normal pool due to the presence of a sinkhole in the dam. Until this repair is complete, the Town should not raise the water level. The next steps are to perform additional site investigation including obtaining subsurface soils data to support a Dam Order Application.

Attachments:

- Vermont Dam Safety July 2024 Flood Inspection and Recommendations Letter
- D&K and Town of Glover Communications

Water Investment Division
Dam Safety Program
1 National Life Drive, Davis 3
Montpelier, VT 05620
Phone: 802-622-4093

MEMORANDUM

TO: Town of Glover – Dam Owner

FROM: Benjamin Green, P.E., Vermont Dam Safety Program (DSP) – Dam Safety Engineer
Steven Hanna, DSP – Dam Safety Engineer
Andrew Sampsell, P.E., DSP - Dam Safety Engineer

DATE: July 26, 2024

SUBJECT: July 2024 Flood Inspection and Recommendations
Shadow Lake Dam (State ID No. 81.02), Glover, Vermont
SIGNIFICANT Hazard Potential

Remnants of Hurricane Beryl caused high rainfall and flooding in areas of central and northern Vermont on July 10 and 11, 2024. Based on publicly available rain gage data, approximately 5 inches of rain fell in the Glover area, resulting in widespread flooding and damage to infrastructure. At Shadow Lake, reservoir levels rose above normal and activated the auxiliary spillway.

Steven Hanna and Andrew Sampsell of the DSP inspected Shadow Lake Dam on July 19, 2024. At the time of the inspection, lake levels has receded to a few inches below the auxiliary spillway crest. The dam was last inspected by the DSP on July 18, 2023, following the July 2023 flood event. The last formal periodic inspection of the dam was conducted on June 28, 2023, and the dam was rated in POOR condition. The following are two notable changes from the previous inspections (see photographs below)

1. The sinkhole along the dam crest identified in the July 18, 2023 Rapid Inspection has increased considerably in size and depth. The sinkhole was measured to be approximately 5 feet in diameter and 5 feet deep. The owner was present during the inspection and noted that they were able to see active flow within the sinkhole during a previous site visit. It is therefore likely that the sinkhole extends into the dam embankment beyond what is visible. In addition to the sinkhole located on the dam crest, the owner showed the DSP a depression along the upstream face of the masonry block wall in close vicinity to the dam crest sinkhole. The owner indicated that the depression may be a location where water was seepage past the upstream masonry wall. It was noted that the masonry block wall has numerous additional un-mortared joints/gaps for water to seep through. The owner also pointed out that the sinkhole appeared to be expanding towards the direction of the bottom of the concrete auxiliary spillway. Historically, seepage flows have been observed at the base of this spillway. While it could not be confirmed that these two locations are directly connected, seepage flow was again observed below the base of the auxiliary spillway at the time of the inspection. The observed seepage was warm to the touch indicating it was likely near surface water from the lake and was flowing through the dam with a short travel time. The seepage did not appear cloudy or to be transporting embankment materials. Due to the location of the seepage, it was not possible to measure the flow rate but it was visually estimated to be 10 to 20 gallons per minute.
2. At the time of the inspection the owner was in the process of removing two timbers from the principal spillway debris rack to allow for increased discharge. This work was completed by the end of the inspection.

Based on the increased severity of the sinkhole in comparison to the previous inspection and the potential for this sinkhole to lead to seepage/internal erosion/stability issues with the dam, the condition of the dam is downgraded to **UNSATISFACTORY**. Given the **UNSATISFACTORY condition of the dam and the increased potential for an adverse issue**, the DSP is requesting the owner take the following actions:

1. Continue to regularly monitor the dam and report any unusual/unsafe conditions to the DSP.
2. Without delay, temporarily lower the water level until the sinkhole and other seepage pathways have been thoroughly investigated and repaired in accordance with an engineered and approved solution.
 - Systematically remove stoplogs to provide a minimum of 2 feet of drawdown in the lake to reduce loading on the dam and reduce seepage pressures in the embankment. This can likely be achieved by removing one stoplog from the principal spillway structure and once the water level has stabilized, additional stoplogs as needed.
3. Prepare an Emergency Action Plan (EAP) using the dam failure flood inundation maps from the hydraulic analysis performed by DuBois & King, Inc. and the standard SIGNIFICANT hazard potential dam template. Provide the EAP to the DSP for review and concurrence and also provide and review the EAP with the Local Emergency Management Director and Incident Commander.
4. Retain an Engineer experienced in the evaluation and design of dams to evaluate the sinkhole, seepage, and stability of the dam. This work should include field investigations to determine the source and severity of seepage, explore the type and consistency of the embankment and foundation soils and rock, and evaluate the seepage and structural stability of the dam. The work should also identify potential repair alternatives for review.
5. Work with the Engineer to develop a plan to improve the condition of the dam and bring it into compliance with current dam safety standards.
 - Review existing studies and past inspection reports to understand deficiencies.
 - Develop alternatives to address the immediate seepage, sinkhole, and stability concerns and additional deficiencies present at the dam.
 - Perform rehabilitation design and apply for approval of the proposed repair and rehabilitation project through the DSP and once approval is obtained, complete the project.

The DSP remains available to discuss the conditions at the dam and this memorandum. I can be reached at 802-622-4093 or Benjamin.green@vermont.gov.

Photo 1: Dam crest, sinkhole, principal spillway derbis rack timber removal (looking towards right abutment).



Photo 2: Dam crest, sink hole (looking towards left abutment).



Photo 3: Sinkhole on dam crest.



Photo 4: Example masonry blocks and gaps between joints upstream of sinkhole location.



Photo 5: Lake level a few inches below auxiliary spillway crest at the time of the inspection.



Photo 6: Water pooled below base of auxiliary spillway.



Photo 7: Seepage flow emanating from stones below base of auxiliary spillway.



Photo 8: Downstream slope standing on right side of dam looking towards left side of dam.





Charles Johnston <cjohnston@dubois-king.com>

Shadow Lake Dam - Sinkhole Inspection and Follow-up

Charles Johnston <cjohnston@dubois-king.com>

Wed, Aug 7, 2024 at 1:36 PM

To: theresa@townofglover.com, Michael Hildenbrand <mhildenbrand@dubois-king.com>

Theresa,

We have discussed the sinkhole situation at Shadow Lake Dam and we would like to propose the following:

- My colleague, Michael Hildenbrand, will make a site visit to the dam tomorrow morning to observe the sinkhole and collect photos and measurements. We would like a representative of the Town on site to orient him and answer questions.
- The Town will fill the sinkhole to extent practical by placing a geotextile fabric within the hole and covering with 1/2-inch crushed stone. This is intended to be a temporary patch of the hole to protect it during upcoming flooding.
- D&K will review the data Micheal collected and develop a permanent fix to the sinkhole. This will involve a summary letter and conceptual sketch.
- D&K will coordinate a conference call with VT Dam Safety to outline our repair approach and confirm the emergency repair does not require permitting or other constraints.
- The Town will provide a contractor to excavate the area and repair per D&K outlined fix. D&K will be on site during the repair to document the repair.
- D&K will create post-repair report that highlights the details of the repair for the Town to submit to Vermont Dam Safety.

D&K will complete to scope of work above on a time and expense basis. Much of the condition of the sinkhole is unknown to us, however we are estimating the total budget to be \$7,500. I have attached DuBois & King's Standard Contract Terms and Conditions and Standard Rates. As the information and details of the project become more defined D&K will communicate if we expect that project will require additional time.

If this is acceptable to you (the Town), please respond to this email accordingly so I can forward to my accounting group. Michael will reach out to you directly regarding timing of the site visit and whom can meet him on site.

Thank you,

Charles W. Johnston, P.E.

DuBois & King Inc.

6 Green Tree Drive

So Burlington VT 05403

(D) 802.728.7217

(C) 802.989.4402

**D&K Standard T&C and Rates.pdf**

126K



Charles Johnston <cjohnston@dubois-king.com>

Fwd: Shadow lake

Theresa Perron-Janowski <theresa@townofglover.com>
To: Charles Johnston <cjohnston@dubois-king.com>

Wed, Aug 14, 2024 at 1:10 PM

Could you take the time to read their email below and make comment on what their concerns are?
Theresa Perron

----- Forwarded message -----

From: **David Prince** <dpprince321@gmail.com>

Date: Wed, Aug 14, 2024 at 9:12 AM

Subject: Shadow lake

To: Theresa Perron-Janowski <Theresa@townofglover.com>, Steve Walcott <sgwalcottvt@gmail.com>

At the State of Vermont's request the Town of Glover ended the 80 plus years practice of lowering Shadow lake 2-3 feet in the fall. This change has resulted in high springtime water levels, some extreme for the past 10 years. The ice movement and months of high water have created damage and shoreline erosion never before experienced. The Shadow lake association payed for an engineering analysis of the dam to determine why we were having such long durations of high water every spring in recent years. The report indicates that the primary spillway has a very limited ability to return the lake to normal levels during and after the annual spring melt. Adding to this problem is the primary spillway valve only operates to a 60% open position exacerbating an already bad situation. This has lead to unacceptable water levels for months at a time. It also increases the likelihood of damage to the dam if a storm similar to those the past 2 July's were to occur earlier during the spring high water. The high water also adds additional pressure and water saturation to the earthen dam. In 2023 Shadow lake never returned to the normal level after the spring melt. 2024 is looking much the same. The freezing and thawing of water in and flowing through the blocks and soils of the dam during winter months cause damage and can be reduced by going back to the past practice of a 2-3 foot water level reduction in the fall. Also reduced is the likelihood of a July type storm overtopping the dam during the annual spring melt.

This would ONLY be for the winter months until the water recedes back to the normal pool level after the spring melt. Theresa could you please ask the Dam engineers if this idea of returning to the past practice until alterations to the dam can be made would be supported? It could be part of a short term solution to a lot of problems if the Vermont dam safety and the engineers agree.

Please let me know their thoughts on this as it will affect how the Shadow lake association proceeds in the future.

Thank you

David Prince SLA Dam committee

Sent from my iPhone

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Theresa Perron
Town Administrator/Recycling Coordinator
Town of Glover, Vermont
802-525-7199



Charles Johnston <cjohnston@dubois-king.com>

Fwd: Shadow lake

Charles Johnston <cjohnston@dubois-king.com>

Thu, Aug 15, 2024 at 7:03 PM

To: Theresa Perron-Janowski <theresa@townofglover.com>

Cc: Michael Hildenbrand <mhildenbrand@dubois-king.com>, Andrew Hoak <ahoak@dubois-king.com>

Theresa,

I have been discussing this email with the rest of the D&K Team and the Vermont Dam Safety program.

As the owner of the dam, the Town is responsible for maintaining Shadow Lake at a level that reflects their comfort with the associated risks. Previous reports from D&K have indicated that when the water level is kept at the normal pool, the dam does not have sufficient hydraulic capacity to manage the design flood without risking overtopping. Such overtopping could lead to head-cutting and potentially result in a breach. To address this issue and mitigate damage during high-flow events, such as spring snowmelt, the Town has decided to implement a seasonal drawdown strategy.

The individual from the Lake Association notes "At the State of Vermont's request the Town of Glover ended the 80 plus years practice of lowering Shadow lake 2-3 feet in the fall." My understanding is that the State of Vermont Dam Safety Program did not require the Town to stop lowering the lake levels. Instead, there has been an effort by the State of Vermont Lakes and Ponds Program (Watershed Management Division) to prevent the lowering of the pond. I believe there has been an assessment and petition to reclassify Shadow Lake to be regulated differently by the 'Vermont Water Quality Standards'. I am not certain if this measure has been implemented, nor am I an expert in these regulations and how it may affect Shadow Lake. I recommend you contact Ben Green (Vermont Dam Safety) and Laura Woods (Lakes and Ponds) regarding the legal requirements of maintaining the lake level.

Additionally, the Dam Safety Program has mandated that the Town maintain the lake level approximately two feet below the normal pool due to the presence of a sinkhole in the dam. According to discussions with Ben Green, this lowered level should be maintained until a permanent repair to the sinkhole is completed. When I was informed of the situation, there was a sense of urgency to visit the site and assess the sinkhole before the onset of another potential flood event. My understanding was that the sinkhole could be temporarily filled, followed by a comprehensive repair to restore the embankment to its condition before the emergence of the sinkhole. After speaking with Ben Green this afternoon, I learned that the Vermont Dam Safety Program will require a full permit to proceed with the repair. This requirement stems from the possibility that the sinkhole may be indicative of a more significant geotechnical issue with the dam. Consequently, a comprehensive geotechnical investigation and analysis will be necessary to support the repair efforts.

The engineering effort required to conduct the geotechnical evaluation and secure the necessary permit for the repair extends beyond the scope outlined in my August 7th email. This undertaking will involve developing a detailed geotechnical plan, performing borings and test pits, conducting seepage and stability analyses, and engineering the remediation of the dam. Currently, D&K does not have the capacity to address this expanded scope due to our involvement in numerous other projects and limited resources. While we may be able to assist in the future, this would necessitate maintaining the lake level at its reduced level for the remainder of the year and likely into the following spring and summer.

I recommend that Michael Hildenbrand prepare a memorandum summarizing the site visit from last week and outlining the State's requirements for the Town. This summary will enable the Town to seek alternative engineering support to design and implement the necessary repairs promptly, allowing the lake to return to normal levels and be utilized for recreation for the remainder of the season. Should the Town be unable to secure other engineering resources, D&K would be pleased to discuss potential assistance and provide an estimated timeline for our involvement.

Please let me know if you have additional questions. If my approach makes sense, please respond accordingly and Michael Hildenbrand will finalize the memorandum to you. I am happy to coordinate a conference call to go through this with you or the Selectboard if need be.

Charles Johnston

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