



Jackson Dam (VT#93.01)

Dam Removal Feasibility Analysis

Caledonia County Natural Resources Conservation District

Prepared by:

SLR International Corporation

1 South Main Street, Waterbury, Vermont, 05676

SLR Project No.: 14658.00013

March 13, 2026

Executive Summary

This report presents the findings of a dam removal feasibility analysis of Jackson Dam (VT#93.01) in Hardwick, Vermont. The report evaluates the dam's history, current condition, geomorphic setting, sediment accumulation, and ecological and flooding impacts. The information presented in this report aims to guide decision making surrounding the future of Jackson Dam and Hardwick Lake and identifies key design considerations that will need to be addressed in future design stages.

The dam, constructed in 1920 and rebuilt in 1952, is in poor condition and classified as a Significant Hazard Dam. Its deterioration and visible structural deficiencies indicate an increasing risk of failure and emphasize a need for action.

The impoundment created by Jackson Dam has filled with a substantial volume of sediment, estimated between 640,000 and 2,520,000 cubic yards. In the event of failure, significant environmental degradation and infrastructure impacts are likely with large pulses of sediment released downstream. Impacts could persist for months if not years and would include smothered habitat, degradation of water quality, reduced channel stability that could cause the channel to suddenly change course, and loss of flood conveyance due to channel filling. A dam failure would be problematic for Hardwick, the Lamoille River Basin, public infrastructure, and private property.

Hydraulic modeling shows that dam removal paired with channel lowering and floodplain restoration would reduce water surface elevations during both large and small flood events, extending upstream to Cottage Street. Dam removal would also provide a long-term solution to reduce ice jam related flooding, which has been managed with winter drawdown of the dam. Dam removal would improve flood conveyance and restore a more natural river profile.

Dam removal would reconnect over 10 miles of high-quality trout habitat, restore sediment transport and reduce water temperature. While Hardwick Lake currently supports a variety of wildlife, the seasonally fluctuating impoundment limits the establishment of a stable ecosystem. The annual drawdown has released fine sediment smothering downstream habitat. If the dam was removed, the project area would transition from an open water lake to a river floodplain system with vegetated wetlands and riparian habitat.

Three dam removal alternatives were evaluated: no sediment removal, full sediment removal, and targeted sediment removal with stabilization in place. No removal presents unacceptable public safety, environmental, and regulatory risks due to expected sediment release. Full removal is cost prohibitive and invasive. The recommended approach is targeted sediment removal and stabilization, which removes sediment in the channel and floodplains, while allowing most sediment within Hardwick Lake to revegetate in place naturally. A drawdown period prior to dam removal is recommended for sediment to naturally stabilize and revegetate, and to refine the design and removal volumes using an adaptive management approach.

A cost opinion for the dam removal concept design is estimated between \$4 million and \$9 million, with an additional \$200,000 anticipated for design, permitting, and data collection. Key next steps include stakeholder engagement, expanded sediment probing, detailed survey and wetland delineation, hydraulic modeling, design development, permitting, bidding, and construction. Given the dam's deteriorating condition and hazard classification, a proactive and phased approach to removal is strongly recommended to avoid the risks associated with an uncontrolled failure and to restore flood resilience, ecological function, and long-term river stability.



Table of Contents

Executive Summary	i
1.0 Introduction	2
2.0 History	4
3.0 Existing Conditions of Jackson Dam	7
4.0 Dam Safety Assessment	11
5.0 River Channel Geomorphology	12
6.0 Sediment	16
7.0 Flood Mitigation	21
8.0 Wildlife	24
9.0 Dam Removal Alternatives	25
9.1 No Sediment Removal	26
9.2 Full Sediment Removal	26
9.3 Targeted Sediment Removal and Stabilization in Place	26
10.0 Concept Design	27
10.1 Dam Removal	27
10.2 Sediment Management and Site Restoration.....	27
10.3 Cost Estimate	29
10.4 Design Summary.....	29
11.0 Next Steps	30
12.0 References	31
13.0 Appendices	32



1.0 Introduction

Jackson Dam (VT#93.01, aka Hardwick Lake Dam, Jackson Bridge Dam) is located approximately 50 feet upstream of the VT Rt 15 bridge in the Town of Hardwick, Vermont on the Lamoille River (Figure 1). The dam, owned by Hardwick Electric Department (HED), is a concrete gravity dam founded on bedrock (Figure 2; Figure 3). With an upstream drainage area of 117 square miles, Jackson Dam impounds approximately 0.9 miles of the Lamoille River and 1.8 miles of Alder Brook creating Hardwick Lake. The lake has a surface area of 180 acres and a 900 acre-feet storage capacity at normal pool level (Green, 2024, Appendix A). SLR visited the dam in October 2025 to review current conditions of the dam, impounded area, channel, and floodplain. The dam is currently in poor condition, and the impoundment is filled with accumulated sediment and provides limited flood storage above the normal water level. This dam removal feasibility assessment documents the history of the dam, river channel geomorphology, preliminary estimates of sediment volume, results of sediment sampling, and flooding and wildlife impacts. We evaluated three dam removal alternatives and proposed a concept design and estimated a ballpark cost for the recommended alternative.

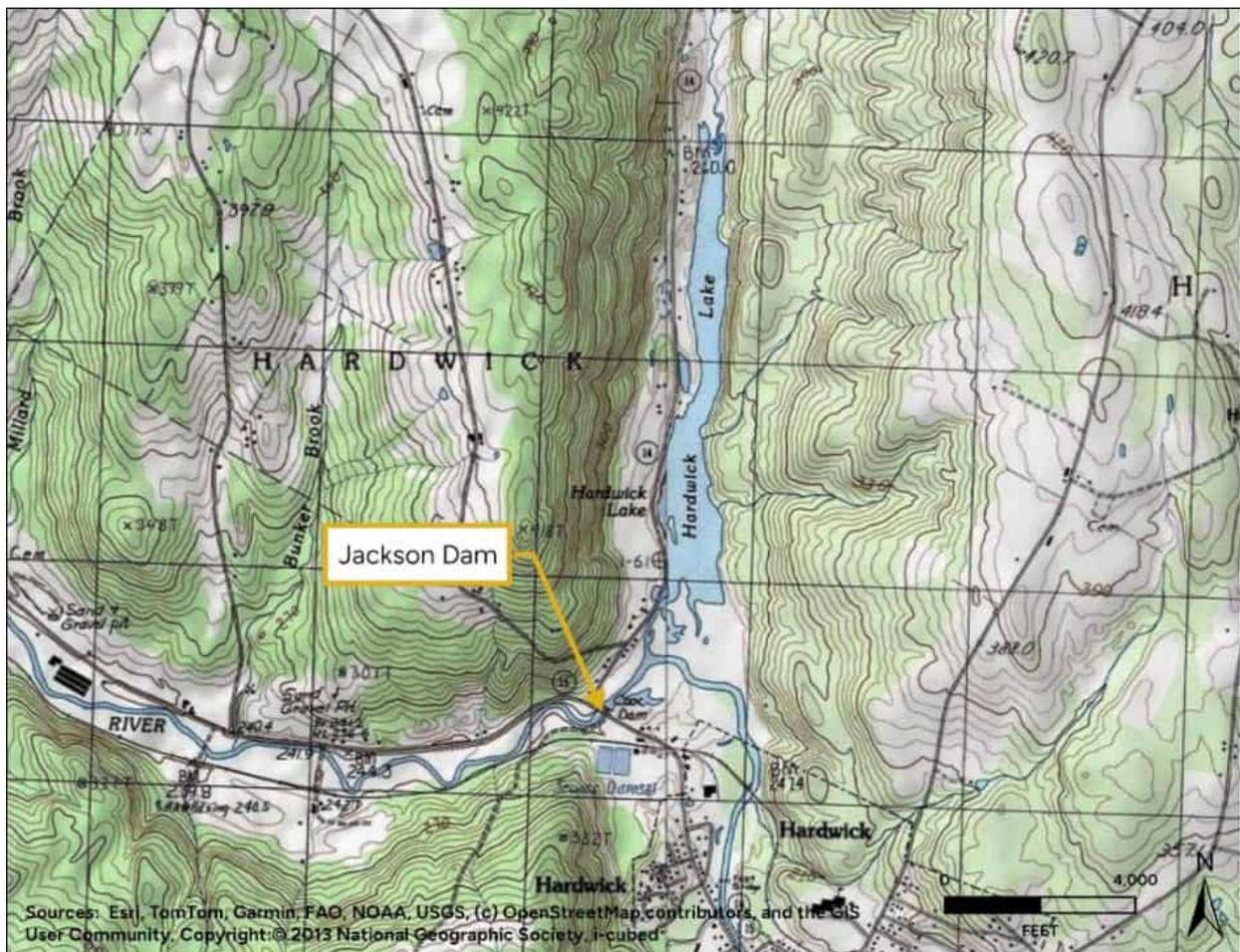


Figure 1: Location map (USGS)





Figure 2: Jackson Dam looking upstream on the Lamoille River from Route 15



Figure 3: Jackson Dam looking downstream from the impoundment



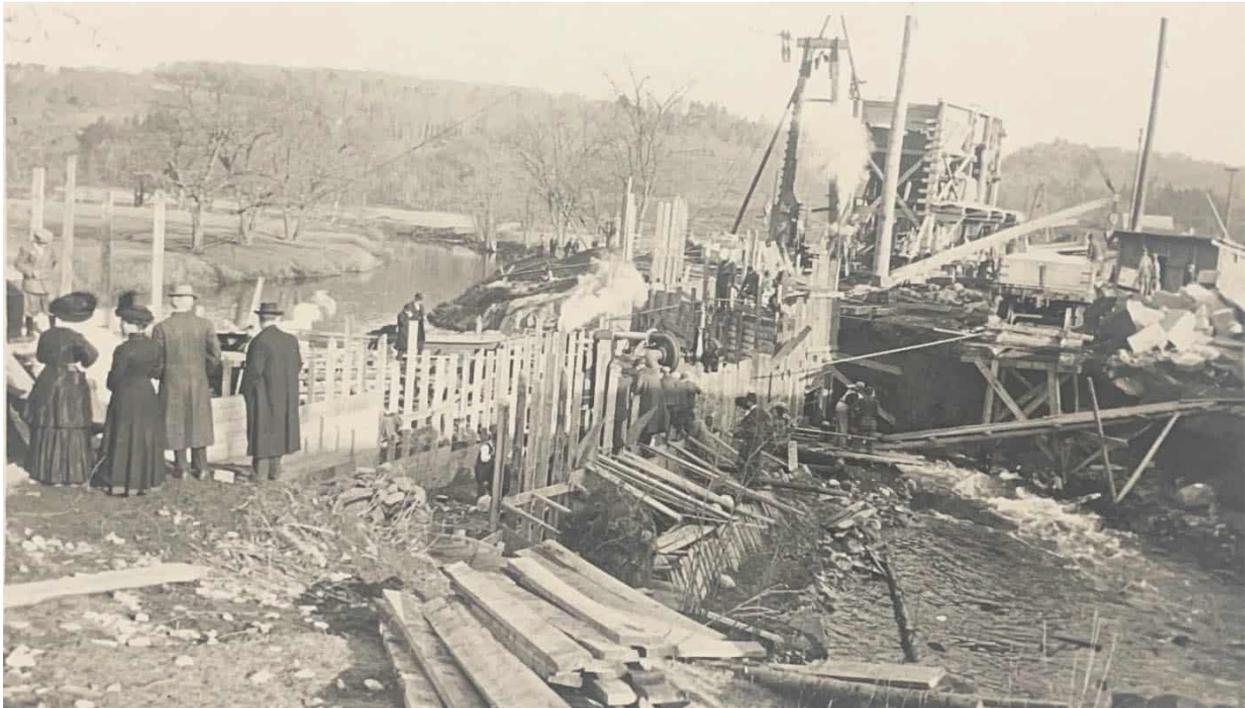


Figure 5: Construction of Jackson Dam (Hardwick Historical Society, 1912)

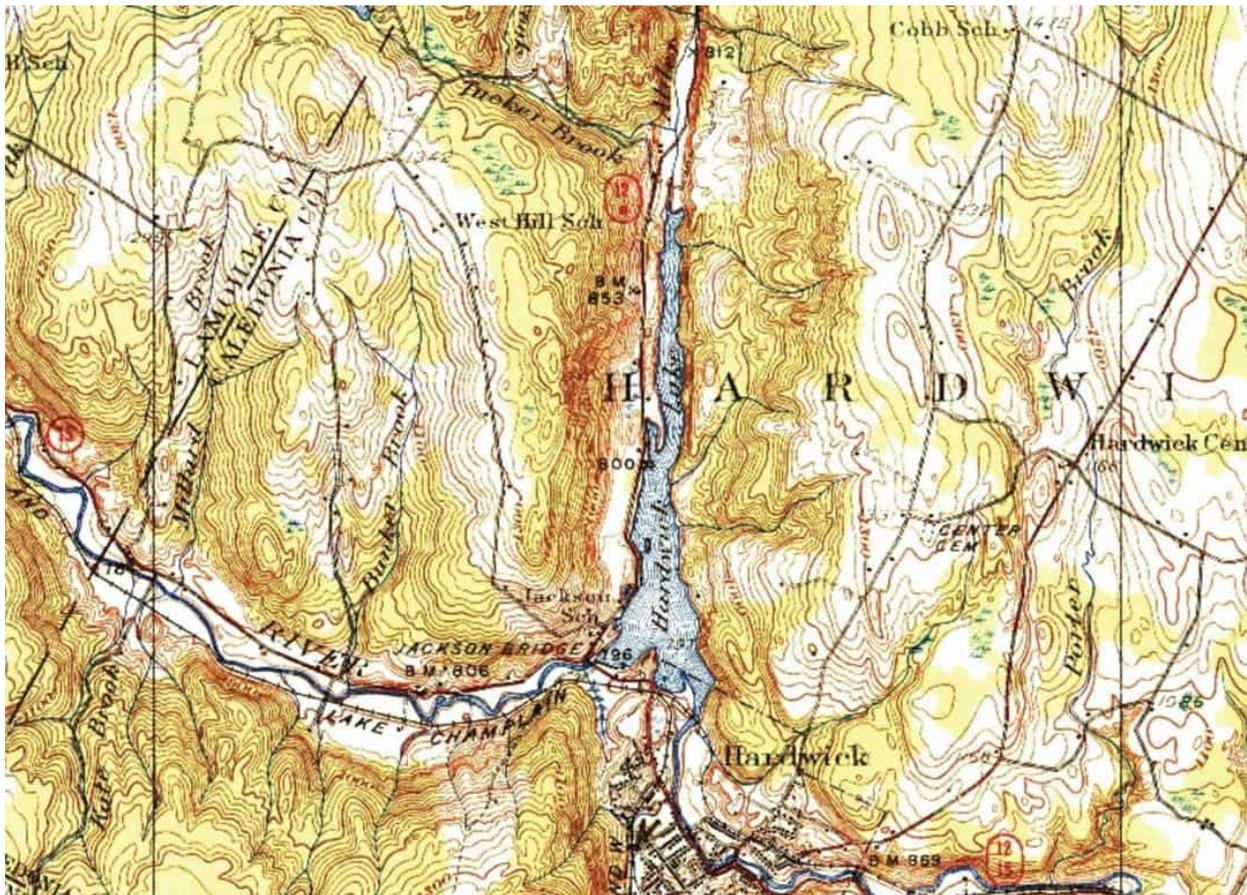


Figure 6: Map of Hardwick Lake from USGS topographic map (USGS, 1938)

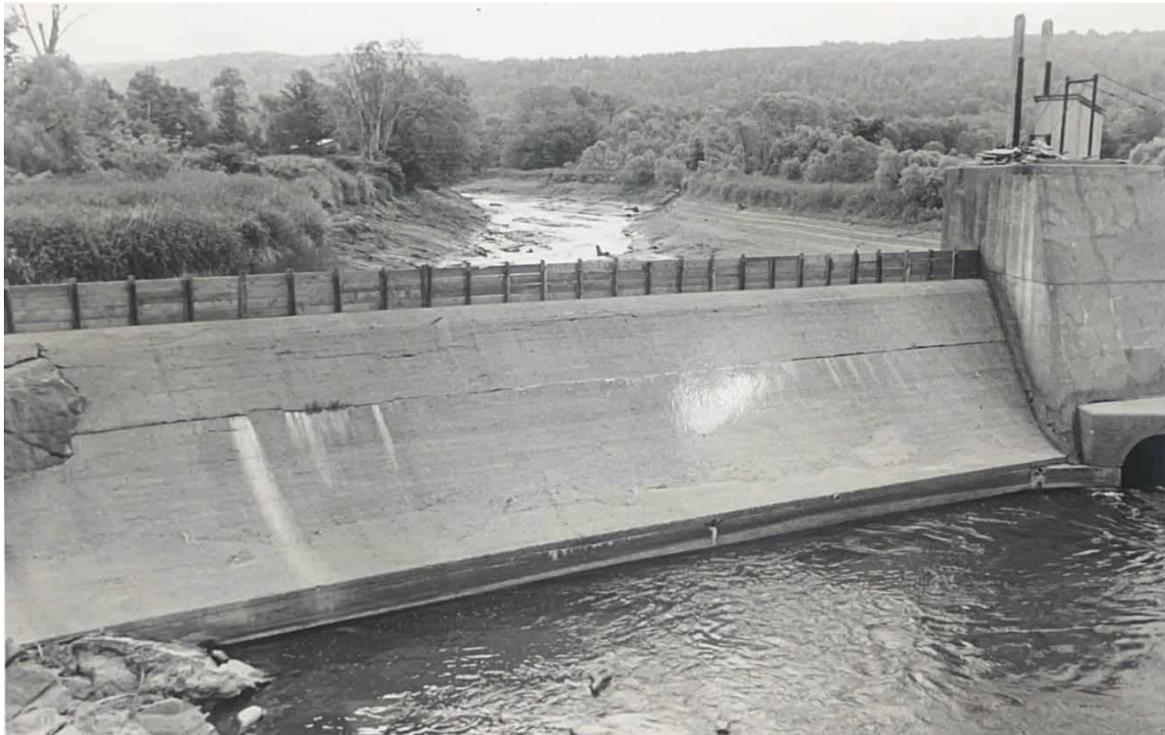


Figure 7: Jackson Dam with lowered impoundment (Hardwick Historical Society)

In 1999, the winter drawdown released a large volume of fine sediment downstream. This was a concern to Vermont Agency of Natural Resources (ANR) Department of Fish and Wildlife who performed a survey of the Lamoille River downstream of the dam and observed a thick layer of fine sediment smothering the river habitat. It is unclear if the winter draw down in 1999 released an unusually large amount of sediment or if this was just the first time a periodic flushing came to the attention of ANR. This prompted ANR Environmental Enforcement Officers to discuss remedial actions to prevent further habitat degradation (Bongiovanni, 2000). Mitigation actions included dam removal or partial removal of the dam. HED was requested to provide an estimated valuation of the dam as a resource to the utility department.

There was an effort in 2002 to pursue the removal of Jackson Dam and the restoration of Alder Brook spearheaded by Vermont Department of Environmental Conservation (VTDEC), the Vermont Natural Resources Council (VNRC), and the Lamoille River Anglers Association. However, community sentiment did not favor dam removal and Hardwick residents decided to keep the dam in place by a vote of 403 to 159 (Brown, 2013).

In July 2006, the Vermont Council on Rural Development released its pilot report for its Creative Communities Program in Hardwick. This identified key issues that were important to residents, one of which was expanding recreation in the Hardwick Lake area (Brown, 2013). This highlighted the importance of Hardwick Lake as a recreational and cultural asset for the community and reflected ongoing public support for preserving the dam.

In 2011, the dam overtopped during Tropical Storm Irene (Green, 2024). That year there was renewed interest in evaluating Jackson Dam and VTDEC with support from the Town of Hardwick pursued funding to explore the future of Jackson Dam and Hardwick Lake. This resulted in the report released in 2013 by Northern Rivers Land Trust which explored the natural



features of Hardwick Lake and the species it supports, and the possible costs and benefits associated with keeping the dam in place, continued winter drawdown, and removal (Brown, 2013).

3.0 Existing Conditions of Jackson Dam

Jackson Dam is a concrete gravity dam with a principal spillway, auxiliary spillway and outlet works founded on bedrock with a total length of 523 feet (Figure 8; Figure 9). There is an emergency spillway to the river right side of the principal spillway that is 38 feet. The principal spillway has a total length of 144 feet and is divided by a 17 feet wide structure that contains the gate operated low-level outlet which has a diameter of 6 feet. The right section of the spillway is an ogee weir that is 82 feet wide. The left section of the spillway is formed around a bedrock ledge. Both sections of the spillway are fitted with slots and receivers for flashboards, although these have not been used in many years. On the left side of the spillway is a structure with gate operated mid-level outlets both with diameters of 6 feet, although the right outlet has been plugged and abandoned. A non-overflow concrete wall extends from the left side of the structure approximately 300 feet. A training wall extends from the mid-level outlets to the left abutment of the Rt 14 Bridge (Green, 2024).



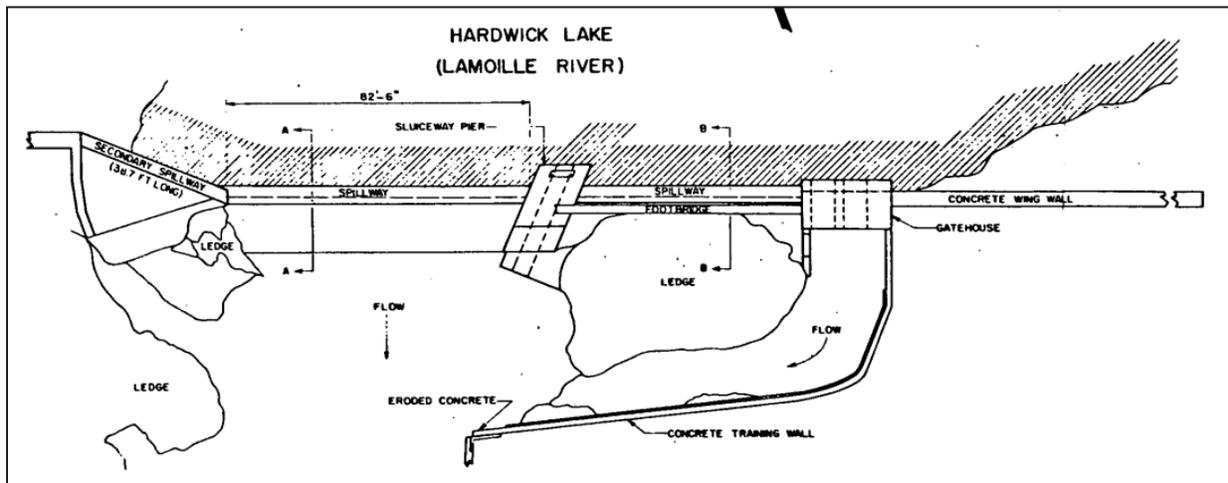


Figure 8: Jackson Dam plan adapted from reconstruction plans in 1952 and modified by field observations (USACE, 1980)



Figure 9: Approximate dimensions of Jackson Dam

Jackson Dam has a maximum height of 23 feet (Figure 10). The top of the principal spillway is 16.2 feet above the downstream streambed. There is a footbridge that extends over the left spillway that provides access to the gate operated low-level outlet. Based on plans from the 1952 repair, the downstream streambed has an elevation of 778.6 feet, and the low-level and mid-level outlets have inverts of 780 and 786 feet respectively. When the dam is drained during the annual winter drawdown, the elevation of the low-level outlet is only 1.4 feet above the natural streambed elevation (Figure 11).



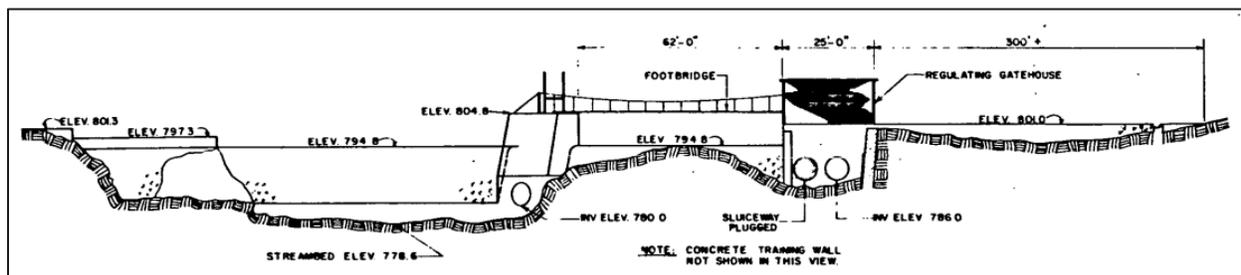


Figure 10: Jackson Dam plan cross section (USACE, 1980)



Figure 11: Jackson Dam during winter draw down (Knight, 2001)

Jackson Dam was rebuilt in 1952. During this process, most of the dam was resurfaced by trimming down the existing concrete 8-12 inches and doweling reinforcement bars into the existing structure to reinforce the new concrete. In addition, a new conduit and gate were installed for the low and mid-level outlets. This repair did not address the east wing wall (Haybrook, 1953). Prior to repairs, the auxiliary spillway on the west side of the dam was composed of granite blocks. This section was repaired with concrete, and it is unknown if the granite blocks were removed (USACE, 1980).

Jackson Dam was inspected in November 2001 by Knight Consulting Engineers, Inc. It was reported that a long horizontal crack exists on the upstream and downstream face of the primary spillway and outlet structure (Figure 11; Figure 12). The concrete cap from the 1952 repairs is failing as a result of either settlement of the foundation due to improperly designed footing or the potential undermining of the low-level outlet pier. In addition, there was surface deterioration of



the 300-ft non-overflow wall to the left of the dam. The mid-level outlet structure on the left of the spillway had some cracking and there was undermining to the foundation area (Figure 13) (Knight, 2001) (Tucker, 2002).

Engineers at DuBois & King Inc. provided an estimated cost of repair for the dam based on deficiencies identified in the dam inspection. It was recommended to remove the concrete cap and repair the foundation in the main spillway section of the dam. In addition, repairs to the 300-foot non-overflow wall, structural concrete repairs to the mid-level outlet structure and repairs of the outlet gate were recommended. The cost of repairs was estimated to be approximately \$600,000 in 2001 (Tucker, 2002). Repair costs are likely to be significantly higher today due to continued deterioration, inflation, and additional dam safety review and design criteria.

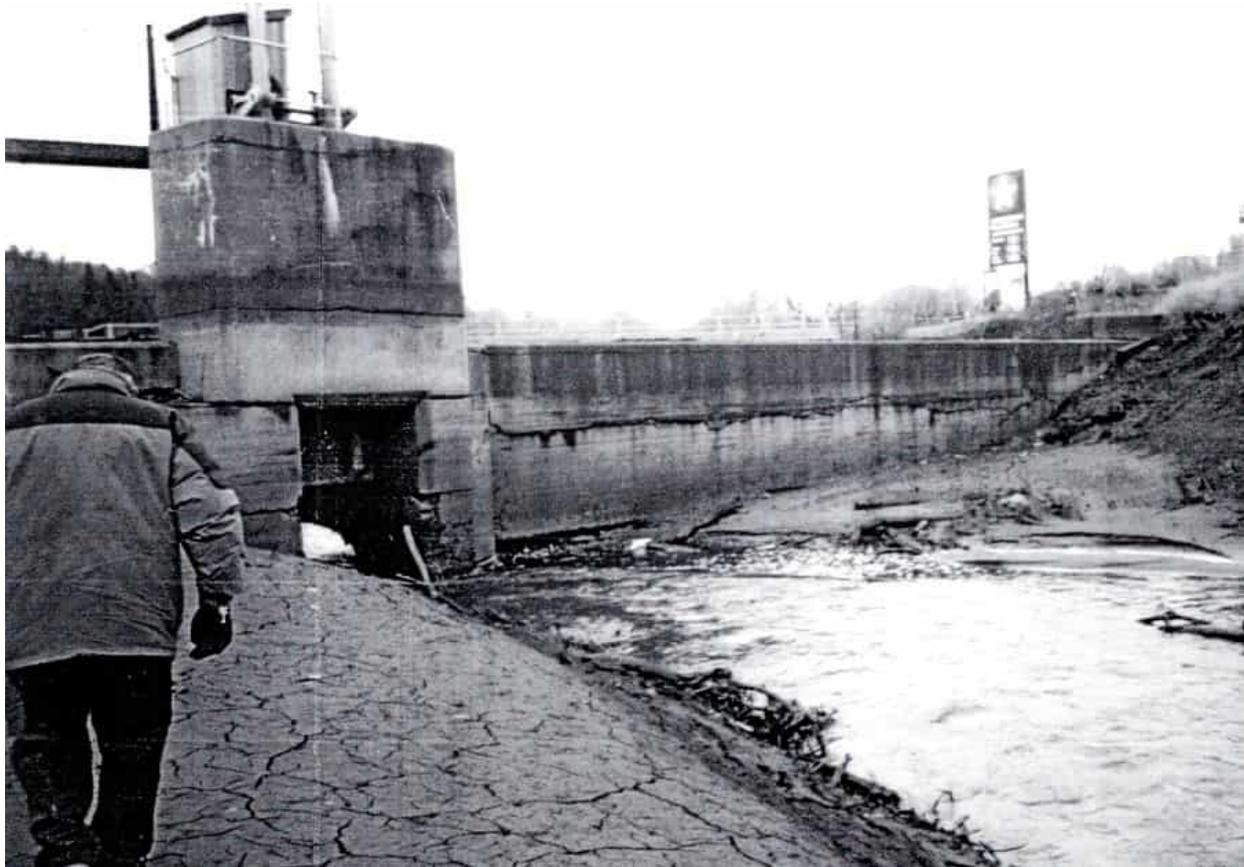


Figure 12: Upstream face of Jackson Dam with large horizontal crack (Knight, 2001)



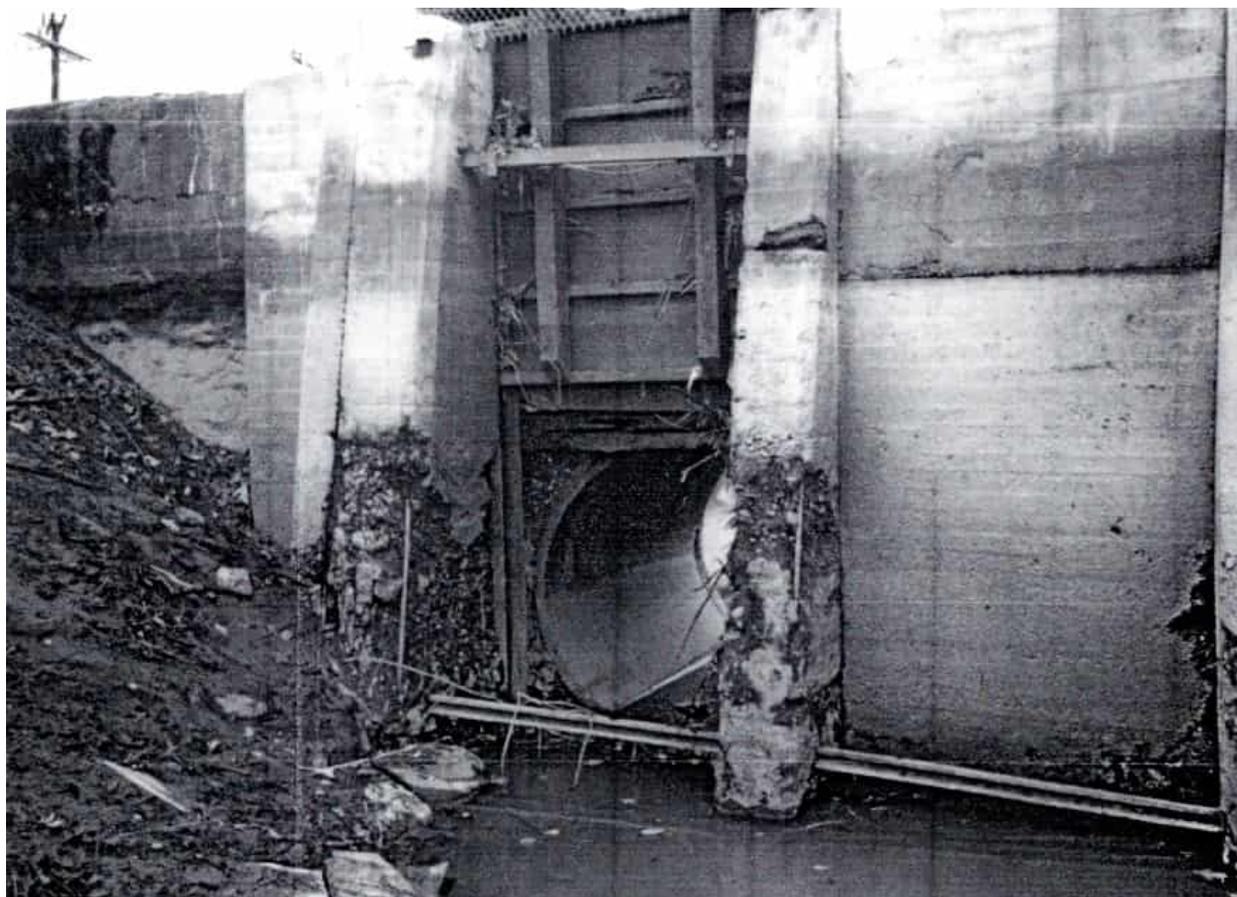


Figure 13: Mid-level outlet from upstream of dam (Knight, 2001)

Despite the identified structural deficiencies and surface deterioration of Jackson Dam, none of the identified repair recommendations were implemented. Because all subsequent Dam Safety inspections have occurred when the impoundment was full, there have been no additional opportunities to document the condition of the dam under low water conditions that would allow for better access for inspection. In addition, since the 2001 inspection, the Lamoille River has experienced four major flood events in 2011, 2019, 2023, and 2024, which may have further exacerbated the dam's deteriorating condition.

4.0 Dam Safety Assessment

Jackson Dam is classified as a Significant Hazard dam (Appendix A). Although a dam failure analysis has not been performed, dam failure would likely result in property losses and damage to downstream infrastructure. There are numerous crossings of the Lamoille downstream of the dam that would likely be impacted including VT Rt 15 bridge (B66), McAllister Farm Rd Bridge (B25), Kate Brook Rd Bridge (B30), Fisher Covered Bridge (LVRT), VT Rt 15 Bridge (B51), and Wolcott Dam, a High Hazard class dam. Additionally, as both Rt 15 and the LVRT parallel the river downstream of the dam, impacts to this infrastructure are also likely.

After the July 10, 2023 flooding event a rapid inspection found that the dam had overtopped as a result of the flood event.



Due to its deteriorating condition, the dam was rated as Poor in 2010, 2011, 2015, 2019, 2023, and 2024. The dam has visible concrete cracking and efflorescence, potential leakage, deteriorating outlet structures, and settlement on the crest (Green, 2024). The dam needs to be removed or rebuilt to reduce risks. Operation at the lower level now used during winter was recommended for consideration until a permanent solution can be pursued.

The dam falls under the jurisdiction of 10 VSA Chapter 43 Dams and Section 37, the Vermont Dam Safety Rule. The estimated maximum storage capacity is 87,120,000 cubic feet (2,000 acre-feet) which exceeds the 500,000 cubic feet (11.5 acre-feet) threshold for state jurisdiction so any alterations, repairs, rehabilitation, or removal of the dam will require a Dam Order from the Dam Safety Program.

Discussions with the Dam Safety Program indicate that additional work is needed on the structure to bring the structure back into safe operation conditions and to meet dam safety requirements. Repair would require an engineered design to bring the dam up to current standards and add overtopping protection. Modifications to accommodate the Inflow Design Flood (1,000-yr storm) would be necessary. While an Emergency Action Plan was produced in 1993, it requires revisions to bring up to date. The “do nothing” alternative is not acceptable.

5.0 River Channel Geomorphology

The existing Stream Geomorphic Assessments (SGA) on the Lamoille River provide limited information due to the impoundment formed by the dam (R25-A), but both the upstream (R26-B) and downstream (R23-A) reaches have been assessed in Phase 2 SGA.

The upstream reach, which spans from the Main St Bridge in Hardwick to the LVRT bridge upstream of the dam, is cobble dominated, has a moderate incision ratio (1.35), and the extensive bank armoring indicates stage II channel evolution and stream bed degradation (Figure 14) (O’Brien, 2009). The downstream reach, which spans from Jackson Dam to the Rt 15 crossing in Wolcott, is incised (1.5), the numerous sediment bars indicate stage III channel evolution and major channel adjustment, and the disruption in sediment transport from the dam upstream may be associated with the historic channel degradation through the reach (Figure 15) (Bear Creek Environmental, 2010). Alder Brook reaches have not been assessed.

Jackson Dam is located in a channel slope transition zone on the Lamoille River where the steep headwaters (1%) flatten out just downstream of Hardwick’s downtown area and the river transitions to a lower slope (0.1%) and is surrounded by broader floodplains.





Figure 14: Lamoille River upstream of Jackson Dam and the LVRT Bridge looking downstream



Figure 15: Lamoille River downstream of Jackson Dam and the Rt 15 Bridge looking downstream

Jackson Dam impounds approximately 0.9 miles of the Lamoille River up to the upstream LVRT bridge. Directly upstream of the dam, the channel is deep, and the riverbed is filled in with fine sediment. There is a large area of wetlands on river left that appears to be previously open water that has filled in with sediment over time (Figure 16). Similarly, between the confluence with Alder Brook and the eastern slope of Hardwick Lake, the right bank of Lamoille River has likely filled overtime through sediment deposition from both the Lamoille River and Alder Brook. Further upstream near the LVRT bridge, the channel has some free-flowing areas, yet soft sediment exists indicating the dam is still influencing the channel. Approximately 400 feet upstream of the LVRT bridge there is a stable riffle which appears to be outside the influence of the dam at low flow. During flood conditions, the backwater from the dam extends up to the Cottage Street Bridge.

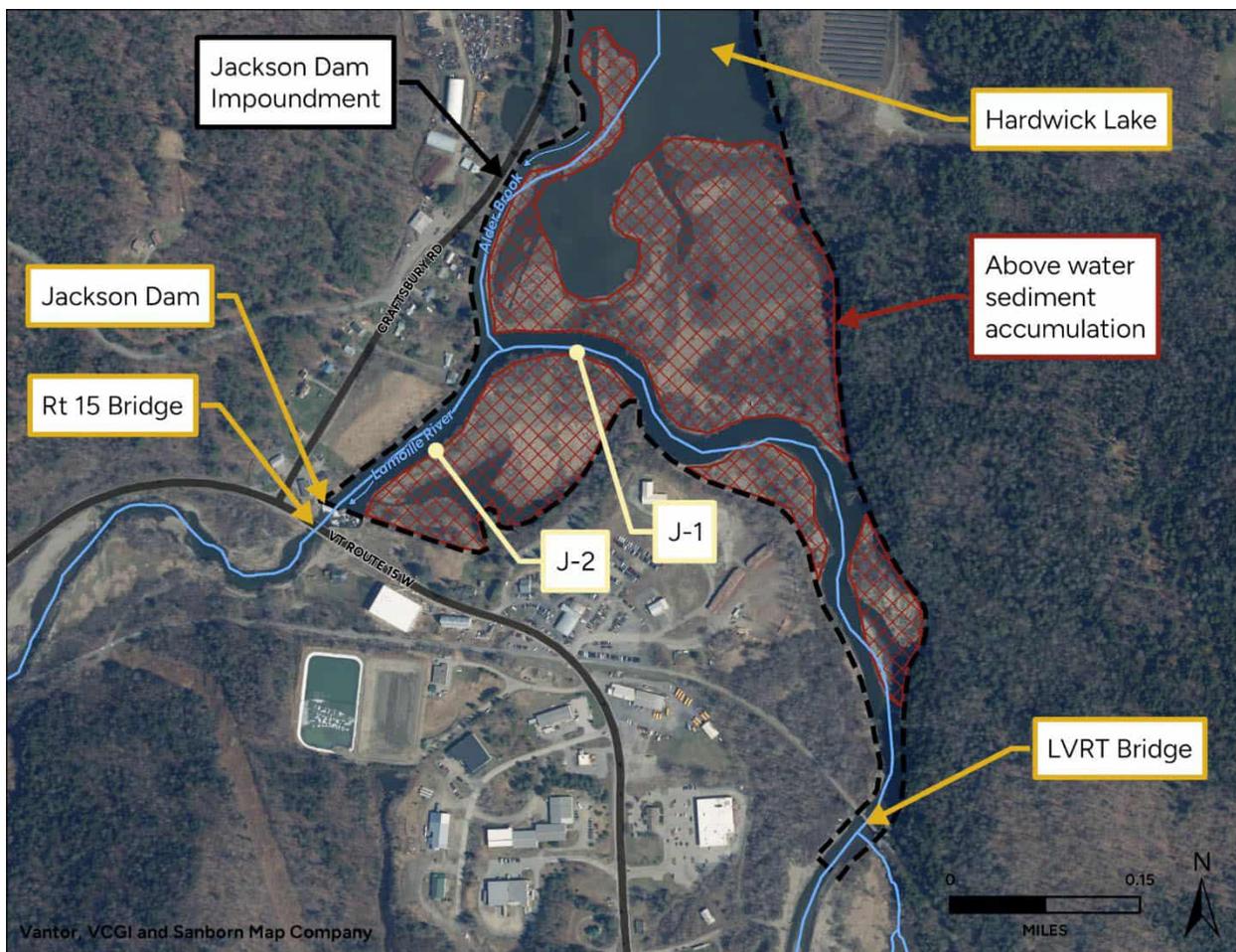


Figure 16: Jackson Dam impoundment area on the Lamoille River, above water sediment deposition, and sediment sampling locations

Jackson Dam impounds approximately 1.8 miles of Alder Brook creating Hardwick Lake. As described above, the southern end of the lake is filled in with sediment, creating a wetland area (Figure 17). Moving north, the lake widens to a maximum width of approximately 0.2 miles before narrowing to about 0.1 miles in the northern section of open water. There is a stable wetland complex with active beaver presence at the northern end of the lake extending 0.4



miles to Smith Farm Road Bridge. The majority of Hardwick Lake is relatively shallow with a maximum depth of approximately 7 feet (Lakes and Ponds Program, 2018). There are six small streams that enter the lake mainly from the eastern slope.

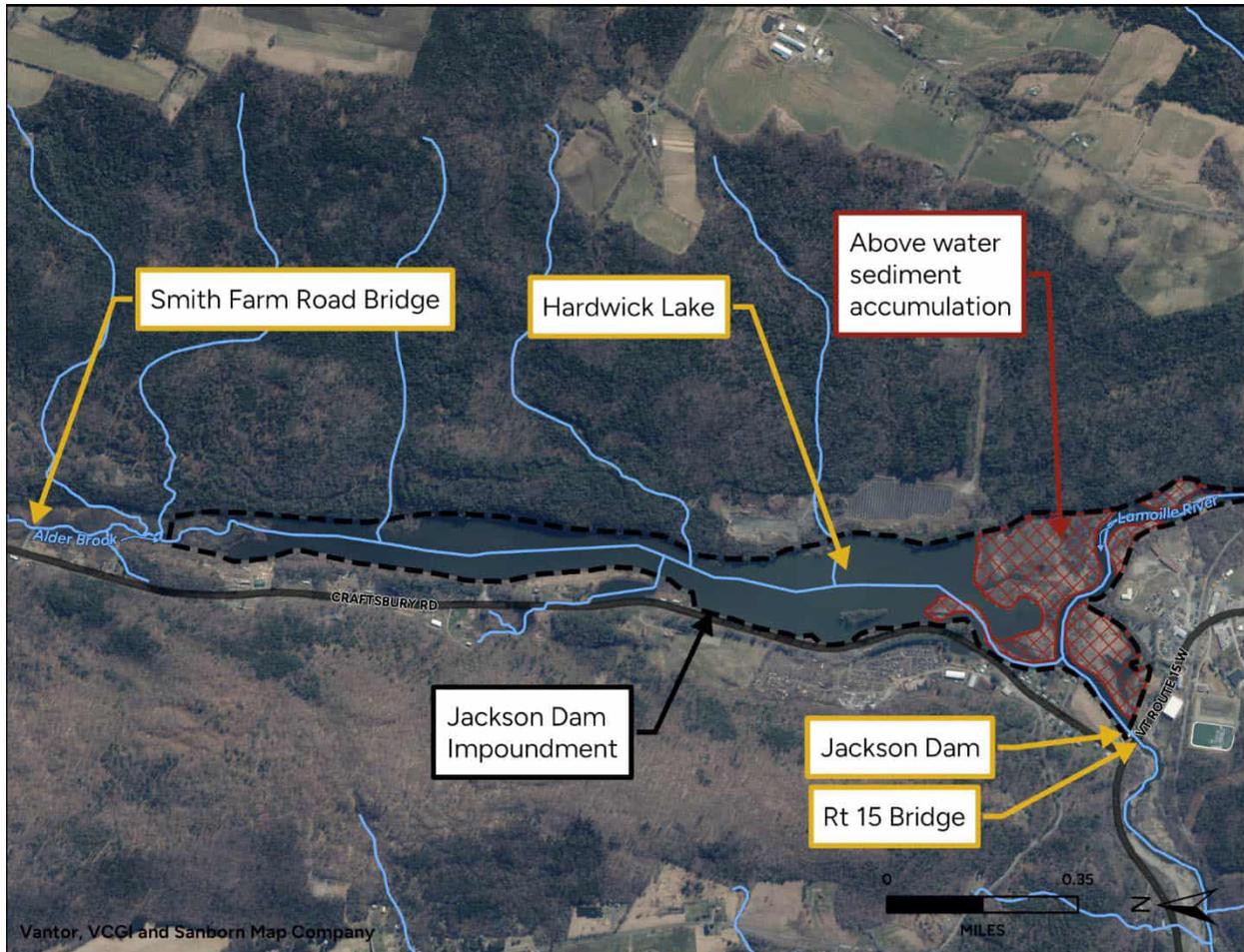


Figure 17: Jackson Dam impoundment area on Alder Brook and above water sediment deposition

Typical channel dimensions were measured in the field and identified in the Phase 2 SGA of the reaches upstream and downstream of the dam (Table 1). The bankfull channel width on the Lamoille River varies from 97 feet upstream of the impoundment to 88 feet downstream of the dam. Upstream of the dam, the Lamoille is highly altered due to the dam, historic straightening along Wolcott Street, and significant armoring as the river flows through the main village center. Downstream of the dam, the Lamoille is confined between Rt 15 to the north and the LVRT to the south.

According to the Vermont hydraulic geometry regression curves (VTDEC, 2006) the bankfull channel width at the dam is estimated to be 106 feet and the bankfull channel depth is estimated to be 4 feet. On Alder Brook, the bankfull width upstream of the impoundment is 33 feet and downstream near the confluence the width is 37 feet. The bankfull depth varies from 1.8 feet upstream of the impoundment to 2 feet downstream.



Table 1: Bankfull Width Channel Measurements

Reach Location	Channel Width (feet)
Upstream of dam and LVRT bridge - R25-B	97
Upstream of dam - R25-A	144*
Downstream of dam - R23-A	88
1,500 feet downstream of dam	90

*Unusually large bankfull width due to impact of dam and impoundment

6.0 Sediment

A large volume of accumulated sediment has built up behind Jackson Dam since it was constructed in 1920. This is evident in the change in USGS topographic maps where Hardwick Lake has more open water in 1938 (see Figure 6) compared with later maps where sediment has accumulated in the southern end of the lake (see Figure 1). In addition, a historic image shows the vast extent of Hardwick Lake (Figure 18) that is significantly different than the current filled in condition of the impoundment.

Sediment management is often a primary driver of method, approach, and cost in a dam removal project. Understanding the volume and characteristics of sediment accumulated behind the dam will provide a basis for estimating how much material may need to be removed in a dam removal. This will also help estimate how much sediment will be naturally transported downstream if left in place. Due to the significant volume of sediment behind Jackson Dam some combination of sediment removal and stabilization in place will likely be required.



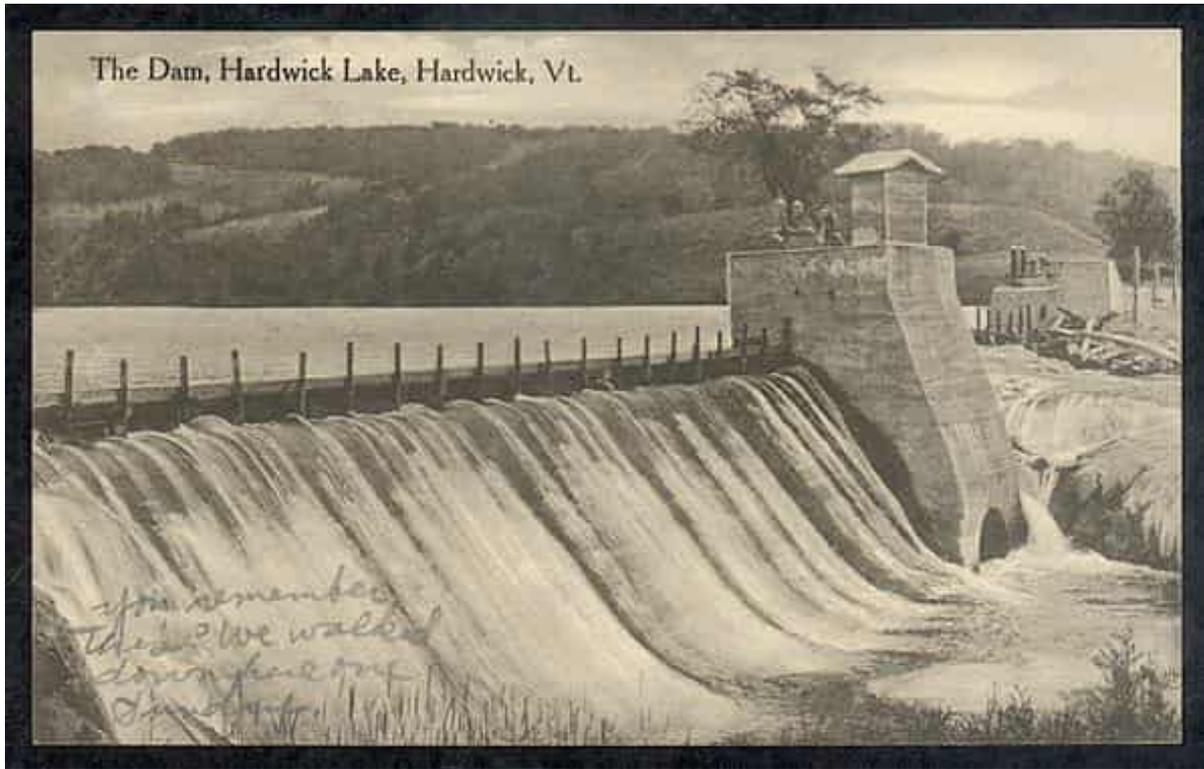


Figure 18: Historic image of Jackson Dam and Hardwick Lake (Hardwick Historic Society, no date)



SLR performed limited sediment probing with a 14-foot rebar rod upstream of the dam. The rod was pushed by hand into the bed until encountering firm, coarse substrate that felt like either bedrock, cobble, or gravel. Closer to the dam, the sediment was either too deep for the 14-foot rod to hit refusal, or the sediment was too consolidated to allow for deeper probing. As a result, measurements that did not hit refusal are potentially underestimating the depth of sediment in the area. Probing was concentrated to the impoundment on the Lamoille River and did not extend upstream through Alder Brook and Hardwick Lake (Figure 19).

The water depth varied from 1 to 8 feet and sediment thickness varied from 2 to 8 feet (Table 3, Appendix B). On the Lamoille, sediment was thickest at the downstream end of the impoundment, closer to the dam. Sediment depths at the dam are around seven feet and taper moving upstream to 2.5 feet deep near the LVRT bridge.

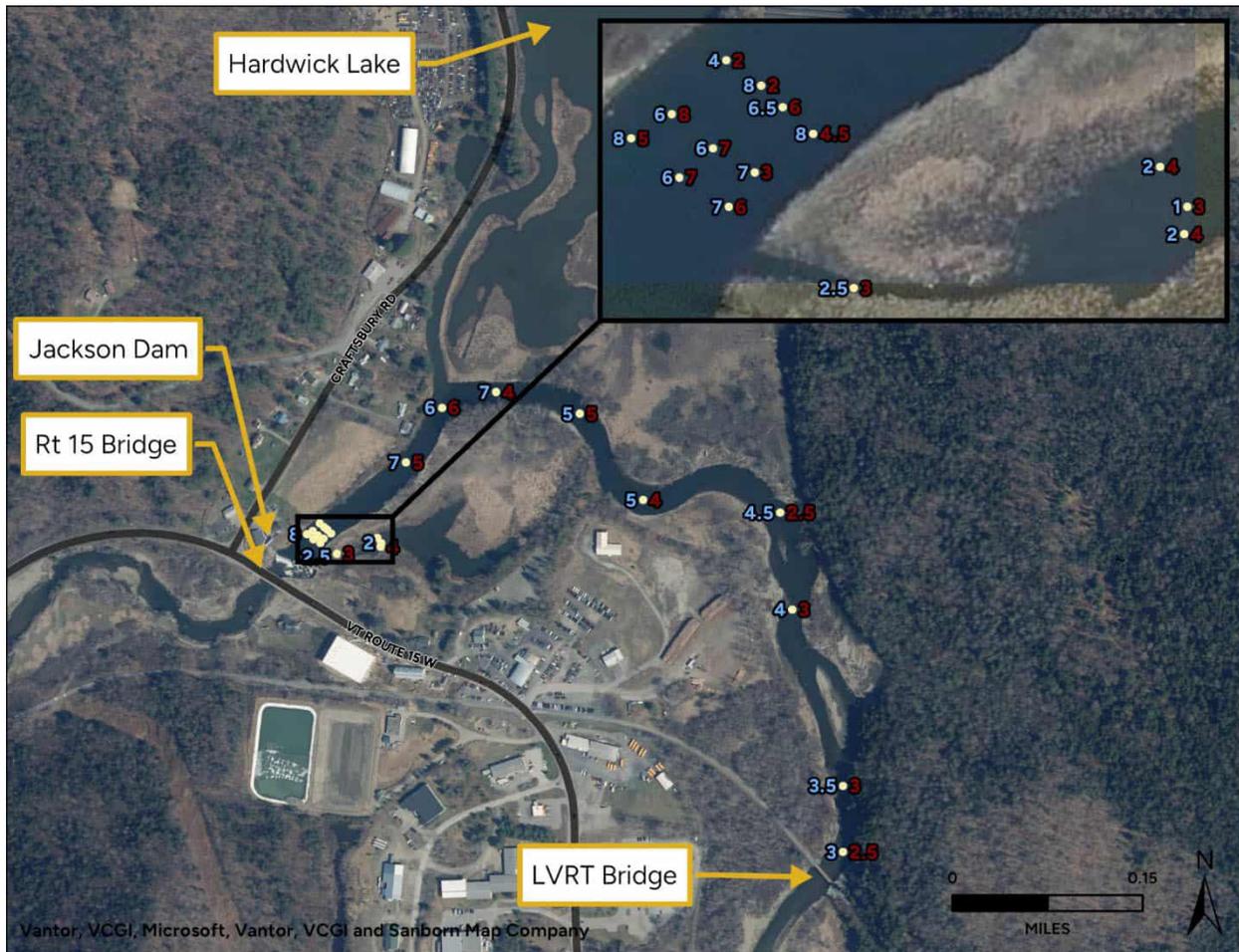


Figure 19: Sediment probing locations on the Lamoille with water (blue, left) and sediment (red, right) depths in feet

An approximate channel profile along the centerline of the Lamoille River includes the normal water surface, top of sediment, and probed channel bottom spanning from the McAllister Farm Road Bridge upstream to the Cottage Street Bridge (Figure 20). The surface water elevation is derived from Vermont 2023 LiDAR data. In the impoundment, sediment and channel elevations were estimated relative to the surveyed water and sediment depths. Upstream and downstream of the impoundment, channel elevations were derived from handheld GPS survey or from the FEMA FIS profile of the Lamoille River.



The channel slope is flat downstream of the dam (0.09%) and is steeper upstream of the impoundment area (0.29%). In the impoundment area, the existing channel bottom has a flat slope (0.10%) and the channel if all the sediment was removed would be steeper (0.23%).

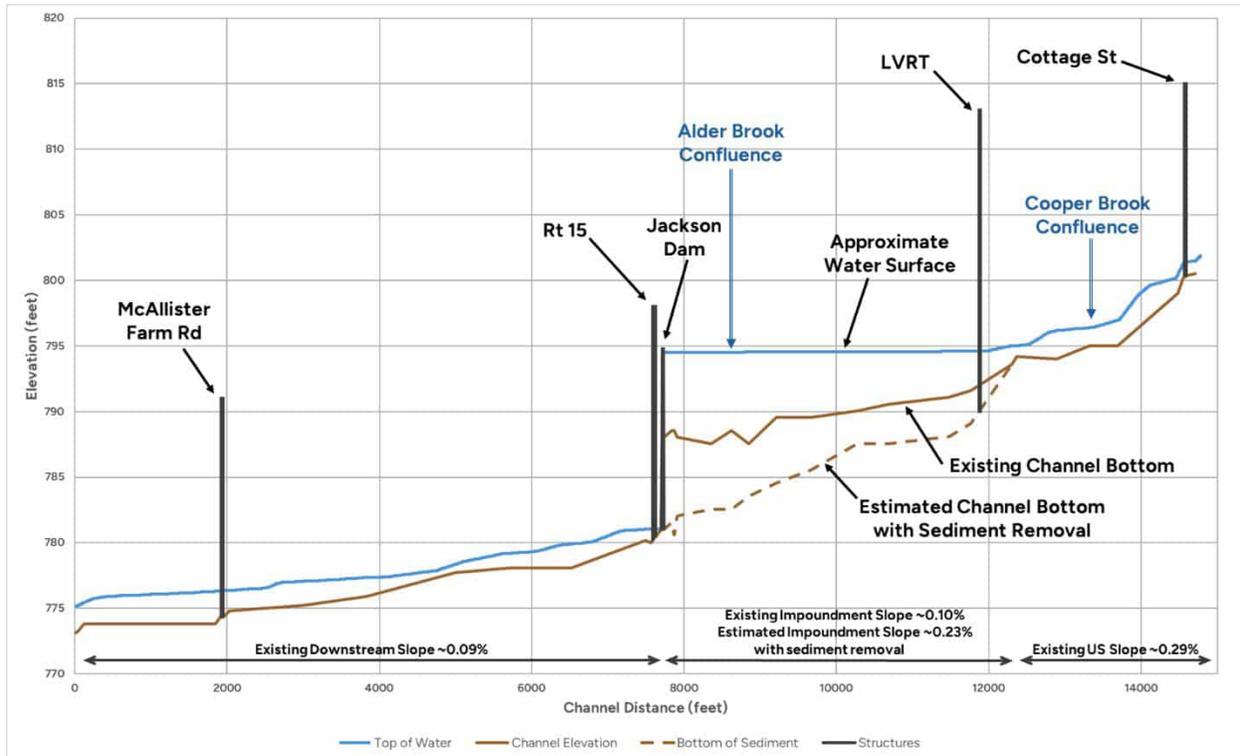


Figure 20: Jackson Dam and Lamoille River Estimated Channel Profile

A channel profile along the approximate centerline of Alder Brook as it flows through Hardwick Lake includes the normal water surface and estimated channel bottom spanning from the Rt 15 Bridge downstream of Jackson Dam to upstream of the Rt 14 Culvert (Figure 21). The surface water elevation is derived from Vermont 2023 LiDAR data. Just upstream of the dam, the sediment and channel elevations were estimated relative to the surveyed water and sediment depths from probing. In Hardwick Lake, the depths were estimated from an existing depth map of the lake from 2018. The depth map represents the surface of the lakebed, and below this there may be additional accumulated sediment within the extent of Hardwick Lake. Upstream of the lake, channel depths were estimated by adjusting the surface LiDAR elevation by 4 feet based on an observed water depth at the Smith Farm Road Culvert. Between the confluence of the Lamoille River and where Alder Brook opens up into Hardwick Lake, the channel and sediment profile in this transition zone is undetermined as sediment probing was not conducted in this area. Further probing in this region will be essential to understanding the transition between Alder Brook and the Lamoille if the dam is removed.

The channel slope on the Lamoille River is shallow downstream of the dam (0.09%), on Alder Brook the slope is unknown in the transition area between the confluence and Hardwick Lake, within Hardwick Lake the slope is shallow (0.07%), and upstream in the wetland complex the slope is moderate (0.22%).



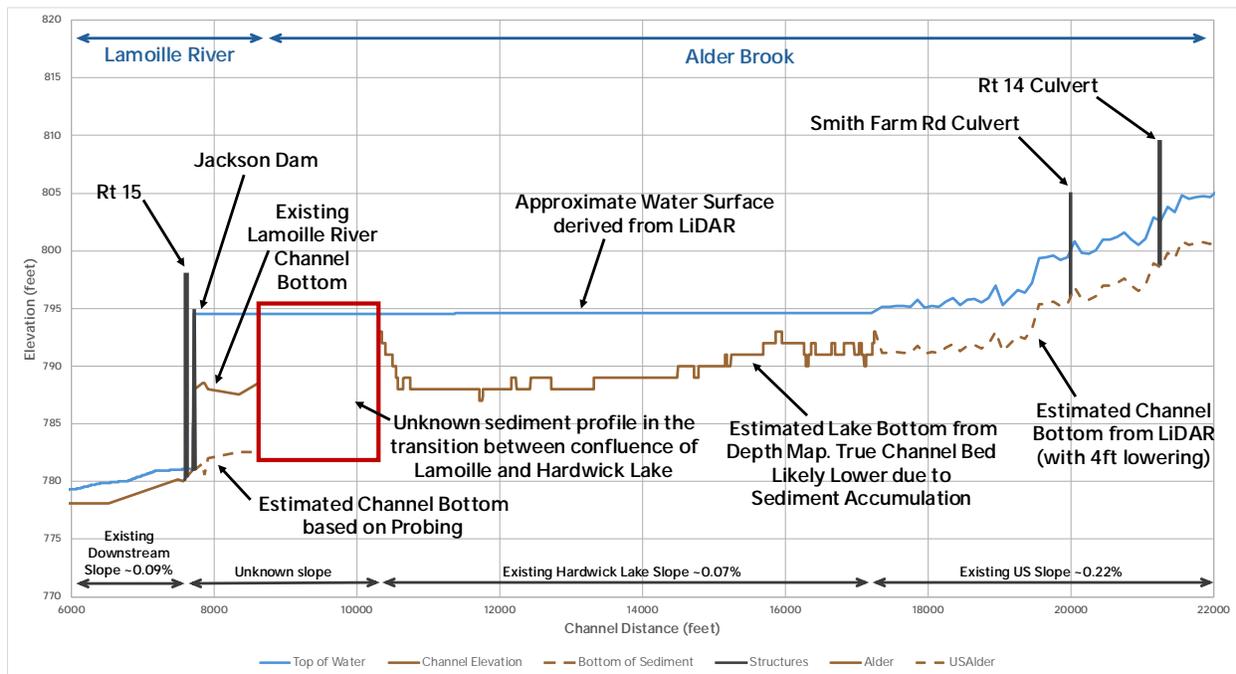


Figure 21: Jackson Dam and Alder Brook Estimated Channel Profile

The estimated volume of impounded sediment was determined from the average probed sediment depth in each impoundment area, as separated by similar attributes (Appendix C). Sediment is trapped upstream of Jackson Dam in the approximate range of 640,000 to 2,520,000 cubic yards.

The upper end of the range was estimated in a report regarding the deteriorating condition of Jackson Dam and diminishing storage within Hardwick Lake in 1949 (Haybrook, 1949). The method for estimating volume of sediment accumulation was not included.

The lower end of the range was determined using sediment depths from probing but may be an underestimation as the large area of Hardwick Lake (Area T) was not included in this calculation. The preliminary sediment estimate needs refinement as the probing performed here did not conclusively identify the depth of sediment directly upstream of the dam, in the areas of accumulated sediment above the water, or the sediment in Hardwick Lake. It is also possible that the impounded sediment extends further upstream on the Lamoille along Wolcott Street where accumulated sediment would be coarser and more difficult to identify by probing.

The sediment within the channel of the Lamoille and the downstream section of Alder Brook was estimated to be 90,000 cubic yards. This is the sediment that is most likely to mobilize in the event of dam failure or dam removal with no sediment excavation. In this case, sediment would flush through the impoundment area and a head cut would travel upstream naturally steepening to the pre-dam channel slope through the reach. This process would cause large pulses of sediment to be released downstream and would likely smother habitat, degrade water quality, and reduce flood conveyance due to channel filling.

The sediment within the river corridor of the Lamoille and estimated river corridor of Alder Brook was estimated to be 370,000 cubic yards. This is the sediment that has accumulated in the floodplain surrounding the main river channel. The sediment in this area is expected to mobilize over a longer time frame during larger storm events as sediment in this area is likely more consolidated and is stabilized by vegetation. Sediment accumulated outside of the river corridor



would be expected to be significantly less likely to erode, as it is outside the geomorphic meander belt and buffer.

The mean annual sediment yield represents background watershed production of sediment and is used to put the amount of sediment upstream of the dam into context (MacBroom, 2011; MacBroom & Schiff, 2013). A mean yield of 50 tons per year per square mile of watershed (range is 25 to 150 tons per square mile) is common based on past measurements throughout New England. Based on a watershed size of 117 square miles at the project site, the annual watershed yield of sediment is roughly 5,850 tons per year incident to the impoundment. At a typical density of 75 pounds per cubic foot for loose fine sediments, each ton of sediment is estimated to occupy a volume of one cubic yard of material. The literature based total sediment volume generated by the watershed and delivered to Jackson Dam is approximately 5,850 cubic yards annually. As the dam has been in place for approximately 106 years, this would estimate the total impounded sediment to 620,000 cubic yards, which is just below our estimate from probing.

It is important to note that beginning in 1975, the winter drawdown of Hardwick Lake has released some sediment downstream. While this annual sediment release has likely reduced some of the accumulated sediment in the impoundment, it has not come close to restoring sediment transport in the reach especially as the annual drawdown mainly mobilizes fine sediment and not coarser material. The “sediment starved” condition of the downstream reach was noted in the geomorphic assessment.

SLR collected sediment samples, J-1 and J-2, at different locations within the Lamoille River section of the impoundment on a site visit in October 2025 (see Figure 16). SLR contracted Endyne Inc. Environmental Laboratories to perform analyses for metals, PAHs, Pesticides, PCBs, and VOCs. The results of this analysis were found that both sediment samples were below the Vermont Human Exposure Thresholds (Appendix D). Additional sampling is recommended once sediment removal areas have been determined.

7.0 Flood Mitigation

The project site is located in a FEMA approximate floodplain (Zone AE) (Appendix E) and the Vermont River Corridor and is thus prone to flood inundation and erosion hazards.

Hardwick has had a long history of ice jam flooding experiencing ten ice related floods between 1960 and 1990 (McKay, 2023). One contributing factor to the prevalence of ice jams in the area is the sharp transition in channel slope when the Lamoille River flows into the impoundment of Jackson Dam (Cahoon, 1996). As a result, in 1975 the USACE Cold Regions Resource and Engineering Laboratory (CRREL) recommended HED lower the dam in the winter to increase the transport capacity of ice through town by smoothing the slope transition of the Lamoille River and moving the tailwater of the impoundment further downstream and away from Wolcott Street homes and businesses (Cahoon, 1996). In addition to this, in 1994 CRREL installed an ice control structure consisting of four granite blocks in the Lamoille River upstream of the Village in order to break up and hold back ice blocks before they entered the downtown area. While these measures are effective in mitigating major ice jam flooding, the Town continues to manage winter ice buildup primarily by using an excavator near the Cottage St Bridge to remove ice from the channel (Brown, 2013). Removing the dam would help mitigate ice jam related flooding in Hardwick.

In addition to ice jam flooding, the Lamoille River in Hardwick has also experienced four significant flood events in the past 15 years (Figure 22; Figure 23). The dam reportedly



overtopped in the 2011 flood and in the July 2023 event, which produced the highest recorded discharge on the Lamoille since the 1927 flood.



Figure 22: Jackson Dam following the July 2023 flood event (AOT, 7/12/2023)



Figure 23: High water on the Lamoille River following the July 2024 flood event (AOT, 7/11/2024)



This section of the Lamoille River in Hardwick was included in a one-dimensional (1D) steady flow hydraulic model that was developed in 2025 by SLR to evaluate flood impacts and mitigation strategies in the Lamoille River and seven tributaries. Selected sections of the report that relate to Jackson Dam are included in Appendix F. One of the flood mitigation alternatives tested in Hardwick was the removal of Jackson Dam. This alternative included removing accumulated sediment in the channel based on depths of preliminary probing and restoring floodplains in the river corridor upstream of the dam by removing accumulated sediment so that the river is not incised and can access its floodplains. The results show significant reduction in water surface elevations extending approximately 3.1 miles upstream of the dam (Figure 24). If the dam is removed, water levels on the Lamoille are expected to decrease in both large and small floods which would provide significant benefits to upstream buildings and infrastructure as they will experience lower flood levels or not be inundated at all. A variation of this alternative was modeled where only the channel was excavated and no sediment was removed from the floodplains, and while this did lower water surface elevations, an additional foot of flood reduction can be achieved with sediment removal on the floodplain.

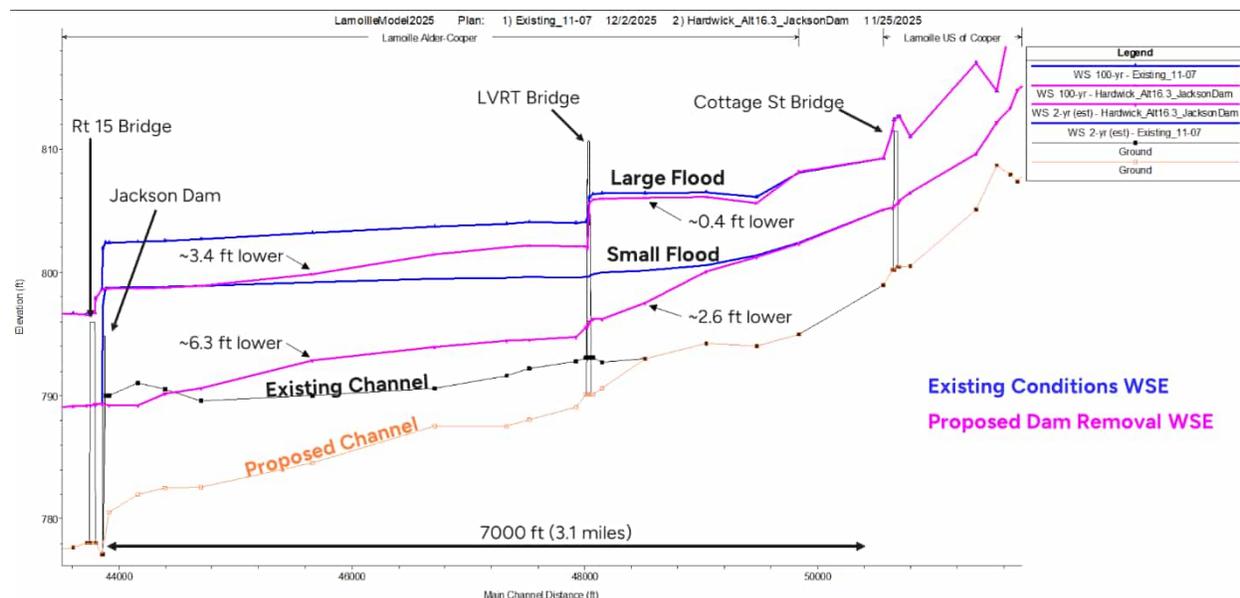


Figure 24: Lamoille River profile of existing conditions and proposed dam removal with channel lowering with WSE of a large, medium, and small flood

Both the existing and proposed conditions modeling show that there are significant constrictions on the Lamoille River at the upstream LVRT Bridge and the downstream Rt 15 Bridge. While dam removal will lower the water surface elevations upstream of the dam, both structures will continue to back up water as they are undersized. Looking at the profile, the LVRT Bridge limits any flood reduction benefits further upstream when the dam is removed. The Rt 15 Bridge will continue to back up water through the impoundment area up to the LVRT bridge. Bridge replacement was identified in the hydraulic study as a flood mitigation project alternative.

With dam removal, channel velocities on the Lamoille River are expected to increase. Currently, water moves slower through the impoundment and ponded area above the dam, and removing the dam would restore the river to its natural slope and velocity. Using the model, channel velocities for the existing conditions and the proposed dam removal and floodplain restoration were compared (Table 2). Results show that channel velocities at the downstream Route 15 Bridge will not change, but velocities will increase in the Lamoille River throughout the current



impoundment area. Upstream of the impoundment where velocities are not changing due to dam removal, velocities on the Lamoille River as it flows through Harwick Village center range between 9 and 20 cfs for both the 10- and 100-year floods, which is larger than the velocities expected in the impoundment area if the dam is removed. With increased velocities, nearby infrastructure would need to be protected to withstand these conditions. The current impoundment area with reconnected floodplains is expected to remain a lower velocity area for sediment or ice to shed.

Table 2: Lamoille River Existing and Proposed Channel Velocities

Location	Cross-Section	Medium Flood (10-year)		Large Flood (100-year)	
		Existing Velocity (ft/s)	Proposed Change (ft/s)	Existing Velocity (ft/s)	Proposed Change (ft/s)
RT 15 Bridge	11.164	5.7	+0.0	7.7	+0.0
Jackson Dam	11.23	3.0	+1.7	3.2	+2.0
500 ft Upstream of Dam	11.19	1.7	+4.5	2.6	+1.6
1500 ft Upstream of Dam	11.21	2.8	+6.6	3.4	+3.1
LVRT Bridge	11.244	6.2	+4.3	6.6	+4.4

Flood storage can help mitigate flooding by allowing the land around rivers to temporarily store water and lower the peak of a flood event. The area behind Jackson Dam currently provides flood storage and would continue to provide flood storage if the dam was removed and adjacent floodplains were restored. Based on existing modeling, it is difficult to quantify how much storage is currently present and what may be lost or gained in the event of dam removal. Based on a recent hydrologic analysis of the Lamoille River Basin, there is flood storage behind Jackson Dam and in Hardwick Lake as peak flows are reduced downstream of the dam (Compass, 2025). But because Jackson Dam is not a flood control dam, any benefit that this storage provides is likely marginal. Operating the dam at low flow permanently or lowering water levels prior to forecasted flooding may provide additional storage. If the dam was removed, the restored floodplains along the Lamoille River and Alder Brook would likely store water and attenuate flow. The current preliminary modeling shows that storage may increase slightly with dam removal. However, more complex modeling would be required to understand the existing storage provided by Jackson Dam and potential storage provided by proposed floodplains if the dam was removed. It is unknown how the storage provided by Jackson Dam or its potential future floodplains would impact downstream communities, but it is likely that any impacts will be limited to the immediate downstream reaches of the Lamoille, and may not extend past the Potterville Dam.

Further modeling would be beneficial to capture the full picture of flood patterns in this area. This section of the Lamoille River has a split flow path where at high flows some water is diverted across Rt 14/15 and re-enters the Lamoille downstream of the dam. The development of a 2D unsteady model in this location may be able to describe the existing flood patterns, storage potential, and assess the impacts of dam removal more accurately. But, based on these preliminary modeling results, dam removal is expected to reduce flood levels upstream of the dam and create a permanent solution to help mitigate ice jam flooding in Hardwick.

8.0 Wildlife

An ecological survey of Hardwick Lake, its shoreline, and two of its tributaries on the east side of the lake was conducted in 2012 by Sterling College students led by Professor Farley Brown. A diverse ecological community of birds, mammals, macroinvertebrates, and plants were



identified and were indicators of a productive habitat (Brown, 2013). In addition to this, a pair of loons nested on an artificial nest platform in 2003, and two loon chicks hatched on Hardwick Lake (Hanson, 2003).

However, it has been widely noted that Jackson Dam and its operation have had a negative impact on the ecosystem of Hardwick Lake and the Lamoille River. The large shallow lake created by the dam increases water temperatures downstream, creating inhabitable environment for trout and other fish species. The dam itself acts as a barrier and removing the dam would reconnect approximately 6 miles of high-quality trout habitat upstream of Jackson Dam to East Hardwick falls and approximately 5 miles downstream to the Pottersville Dam on the Lamoille mainstem and would reconnect significant miles of tributaries (McLean, 2004). The dam interrupts the natural transport of sediment, leaving the downstream reach starved for coarser material and increasing the amount of embedded sediment in the downstream reach. This ultimately reduces the surface area available for macroinvertebrate attachment and reduces their ability to feed (Levey, 1999).

The annual drawdown of Jackson Dam further exacerbates the environmental impact downstream of the dam. When the dam is drawn down it flushes fine sediment downstream smothering habitat. A survey of the reach downstream of Jackson Dam was performed by the VTDEC Department of Fish and Wildlife in November 1999 after the dam was drawn down. It was reported that the river bottom was filled with unconsolidated silt and sand at depths ranging from 0.5 to 2 feet. This sediment buried the existing river channel material that is made up of boulder, cobble, and gravel and likely smothered the macroinvertebrate population. The result of this impairs fish habitat as their macroinvertebrate food source has been effectively eliminated in the area. For brook trout and brown trout in the Lamoille, the winter drawdown occurs just after their normal spawning period, and any fish eggs would be covered and smothered by the sediment (Palmer, 1999).

Upstream in the impoundment the annual water fluctuation creates an unstable aquatic ecosystem that prevents the establishment of a healthy environment for plants and animals (DEC Water Quality Division, 2009).

9.0 Dam Removal Alternatives

Given Jackson Dam's current condition, the "Do Nothing" approach is not advised due to the significant hazard status and poor condition. The repair option was not modeled or analyzed as part of this study, as prior work has identified deficiencies and remediation required along with cost estimates that would need to be recalculated to include current dam safety standards and any additional deficiencies that would need to be addressed as part of a remediation effort. The hydraulics of the repair option would remain as shown in the existing conditions model results. Partial dam removal would require all of the permitting, design, construction, and maintenance costs of a repair. Dam removal is recommended.

Full dam removal is included in each of the considered alternatives to restore the channel profile in the Lamoille River at the dam site. Full dam removal involves the removal of the concrete spillways, outlet works, and all dam pieces. The emergency spillway and training walls may remain to stabilize adjacent land and direct flow through the downstream bridge. The removal would include the full height of the dam down to the original channel bed to naturalize the channel bed for sediment transport and aquatic organism passage.

The main distinction between dam removal alternatives is the sediment management strategy: no sediment removal, full sediment removal, or partial sediment removal with stabilization in



place practices. Dam removal will likely accelerate channel evolution with incision and widening near the dam that could initially reduce channel stability that would eventually increase with sediment consolidation and revegetation. The large area of Hardwick Lake would dewater and many of the existing wetlands will revert to historic floodplain status. Alder Brook will re-establish its channel through the Lake and the surrounding area may have pockets of wetlands as some areas may remain saturated with water. It is anticipated that upland forest plants and trees will establish in dry areas following the permanent dewatering of the lake. Channel stabilization will be needed to control erosion hazards if the dam is removed.

9.1 No Sediment Removal

With no sediment removal, Lamoille River and Alder Brook would be left as incised channels that would downcut through layers of accumulated sediments. The floodplains created by accumulated sediment would not be accessed until large flows, likely increasing channel velocities within a deep channel. Sediment transport through the impoundment area would be significant and fine sediment would be released downstream, similar to what would occur if the dam were to fail. A head cut would form by the location of dam and travel upstream restoring the channel slope to pre-dam conditions over time. The sediment accumulated along the channel and floodplains would also mobilize due to slope failure of the incised channel banks or meandering of the channel in larger flood events. It is likely that regulators will not permit this approach due to the potential downstream environmental degradation associated with large volume of mobilized sediment and potential impact to the storage and operation of the downstream Pottersville Dam. This alternative is not recommended.

9.2 Full Sediment Removal

Full sediment removal for this project would be a significant task due to the large volume of accumulated sediment and the impoundment. With the estimated range of sediment volume in the impoundment between 640,000 to 2,520,000 cubic yards and assuming an approximate cost per cubic yard for removal of \$20, complete sediment removal alone would cost between \$13,000,000 and \$50,000,000 which effectively makes this alternative cost prohibitive and extremely invasive. The current practice of winter drawdown has likely allowed sediment consolidation in the Lake that other dams with full-time impoundments would not have experienced. Large sections of the accumulated sediments have established vegetation in place to jump-start stabilization where excavation and removal may not be necessary. This alternative is not recommended.

9.3 Targeted Sediment Removal and Stabilization in Place

Some sediment is recommended to be removed to prevent significant downstream environmental impacts, but a large portion of the accumulated sediment should be considered for stabilization in place to moderate the cost of excavation. This approach is recommended and is outlined in a concept design with partial sediment removal (Appendix G).

The sediment under the majority of the footprint of Lake Hardwick would be vegetated in place under this alternative, with some areas of the impoundment already having dense vegetated cover where no action may be required. The sediment with the highest priority for removal would be in the channel of the Lamoille River between the LVRT bridge and the dam and in the channel of on Alder Brook upstream of the confluence, estimated at 63,400 cubic yards. In addition, some sediment removal in the river corridor would be recommended to create accessible floodplains, up to 123,500 cubic yards. It is possible that sediment could be removed



from the channel and floodplain and be relocated to another area on the project site outside of the river corridor. This may reduce the costs and impacts associated with removing the sediment from the site. Refining sediment estimates in the impoundment and determining which will be targeted for removal or relocation will be crucial for the next phases of design.

Flood reduction benefits of this alternative are summarized in Appendix F and the above Flood Mitigation section.

This alternative is recommended and additional details are included in the concept design.

10.0 Concept Design

10.1 Dam Removal

Full dam removal would include removal of the concrete spillways, outlet works, and all dam pieces (Appendix G). The emergency spillway and training walls are assumed to remain to stabilize adjacent land and direct flow through the downstream bridge. The non-overflow wall that runs parallel to Wolcott Street/Route 15 blocks a low land area which might allow for more flooding over the road if removed. The concrete volume to be removed is approximately 1,300 cubic yards. The removal would be full depth down to the original channel bed to naturalize the channel bed for sediment transport and aquatic organism passage. Bedrock extends across the channel under the dam and will be the new control on the profile (USACE, 1980).

Impacts to nearby infrastructure will need to be addressed. With dam removal, channel velocities on the Lamoille River are expected to increase within the current impoundment area (See Table 2). As a result, armoring the channel near the LVRT bridge and Rt 15 bridge would need to be evaluated and likely included in the design. Additional channel armoring is assumed to be necessary along the right bank of the river to protect infrastructure and private property and to direct flow through the dam area and through the downstream bridge. As the training wall of the dam is attached to the left abutment of the Rt 15 Bridge, additional assessment of this connection will be necessary to confirm that removing the dam will not impact the bridge.

10.2 Sediment Management and Site Restoration

The sediment under the majority of the footprint of Lake Hardwick would be vegetated in place. The sediment recommended for removal in the channel of the Lamoille River between the LVRT bridge and the dam and in the channel of on Alder Brook upstream of the confluence has an estimated volume of 63,400 CY. In addition, some sediment removal in the river corridor is recommended to create accessible floodplains, up to 123,500 CY. The sediment removal volume in the floodplain was based on lowering areas along the rivers to the 2-year water surface elevation and tying in the floodplain to the existing ground at a 1% slope (Figure 25). This volume could be adjusted based on desired floodplain connectivity – vertically and laterally. It is recommended that the sediment be removed from the channel and floodplain and be relocated to another area on the project site outside of the river corridor against the valley wall.



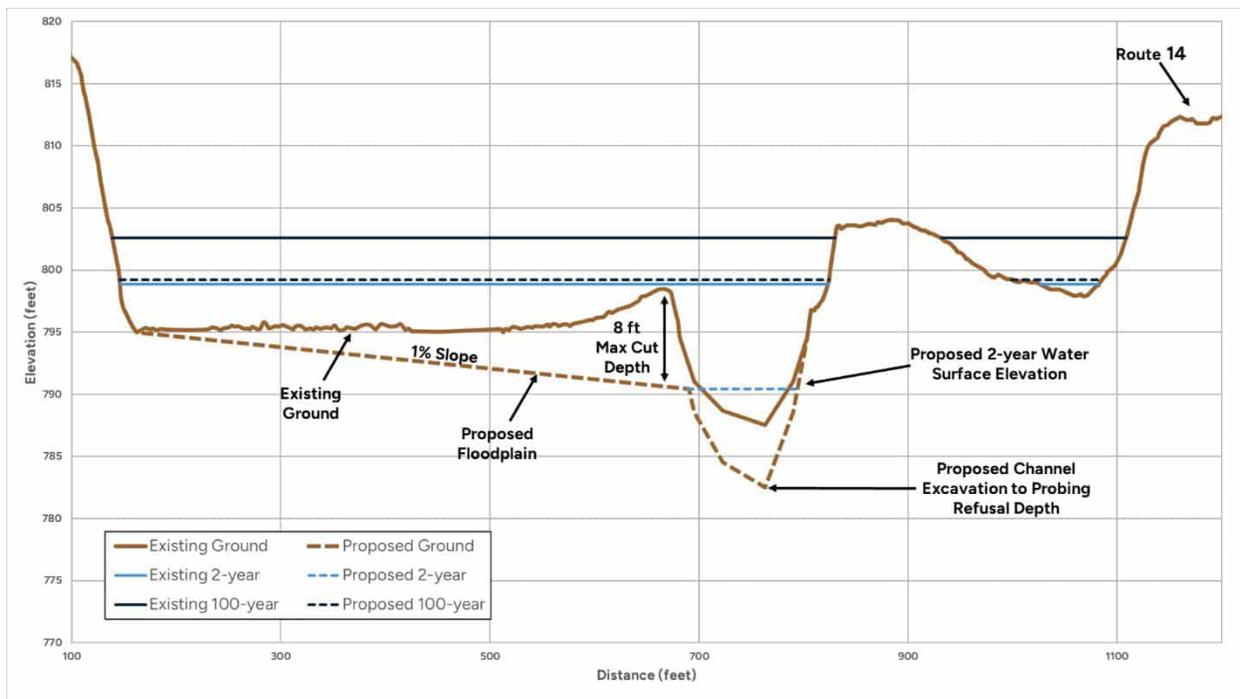


Figure 25: Cross section 500 feet upstream of the dam of Lamoille River and floodplain with existing and proposed conditions (model cross section 11.19)

A phased approach to dam removal is recommended to allow for stabilization of sediment in the current impoundment and establishment of vegetation while the dam remains in place for at least a season. The temporary retention of the dam would help control possible sediment releases in a period when sediments are consolidating and vegetating. After this period, the sediment management and removal design may be reevaluated. It is possible that after a season of revegetation and stabilization a less invasive and more targeted approach for sediment removal could be explored. A season or more of permanent drawdown will help identify areas that may require more aggressive sediment removal or stabilization or that have sufficiently stabilized and revegetated naturally and may be left in place and undisturbed.

Floodplain stabilization is assumed to be a mix of active plantings and passive establishment of vegetation from the present seed bank. In-stream stabilization methods to reduce erosion and meandering or headcutting could include some large wood installations, beaver dam analogs, and post-assisted log jams to stabilize the Alder Brook channel and develop habitat features. Determining the targeted approach to sediment stabilization will need to be addressed in future design stages.

In previous studies exploring the removal Jackson Dam, a benefit for removal included the opportunity to create public river access for fishing, canoeing or other recreational activities. As the Town will have a change in type of recreation on Hardwick Lake, a river access area may be something to explore to enhance recreation opportunities in the Town. While not directly related to removing the dam, the addition of a river access area could be included in this project and would need to be discussed with project partners in future design stages.



10.3 Cost Estimate

The anticipated cost for dam removal construction is between \$4,000,000 and \$9,000,000 depending on a variety of design considerations including sediment removal and site restoration approach. An estimate based on the concept design has been provided for context and scale (Appendix G). The costs for this project fall within the following categories.

- The cost of site preparation including mobilization and demobilization, site access, water and erosion control and traffic control and signage was estimated to be \$200,000.
- The cost of removing the concrete dam and its appurtenances was estimated to be \$400,000.
- Infrastructure protection and stabilization of bridges was estimated to be \$100,000.
- Data collection, engineering design, and permitting could cost in the range of \$200,000.
- Sediment removal costs could range from \$1,500,000 to \$4,500,000 depending on the level of sediment removal and receiving fill location.
- The cost of site restoration depends on the level of active plantings and could range from \$50,000 to \$1,500,000.
- Additional project costs include project management, construction oversight, and construction contingency.

Dam removal costs will need to be refined during future design stages.

10.4 Design Summary

This is a large scale and more complex project than many dam removals undertaken in Vermont and needs a different approach. A phased drawdown allowing for consolidation of sediment and stabilization in place would allow for reevaluation of sediment removal volumes in an adaptive management approach to dam removal.

A proactive approach is highly recommended to avoid a catastrophic dam failure, which would allow for an uncontrolled release of the massive sediment volume identified behind the dam. A wave of sediment and water released in a dam failure could cause damage to downstream infrastructure, as identified by the Significant Hazard status of the dam. The combination of Poor Condition and Significant Hazard points to a dam safety issue in addition to the risk of habitat loss from dam failure.



11.0 Next Steps

The following steps are recommended to move the dam removal project forward.

- Outreach and discussion with owners, partners, and stakeholders
- Site assessment
 - Sediment probing across the impoundment and extended further upstream and into Hardwick Lake
 - Survey of the river profile, cross sections, infrastructure, and private property
 - Wetland delineation
 - Mapping of invasive species to determine if removal or special treatment is needed
- Engineering design - Drawdown phase may include iterations of design and permitting
 - Hydraulic modeling
 - Sediment management alternatives and working with regulators to determine sediment management strategy
 - Channel and floodplain stabilization alternatives analysis
 - Dam removal design
- Permitting – adaptive management or phased approach will be new for all parties
- Bidding
- Construction



12.0 References

- Bear Creek Environmental, 2010, December 15. Lamoille River Corridor Plan, Hardwick to Johnson Lamoille County, Vermont. Lamoille County Planning Commission.
- Bongiovanni, Joe, 2000, July 20. Town of Hardwick Electric Department Hardwick lake Drawdown. Hardwick Electric Department.
- Brown, Farley, 2013. Hardwick Lake Today and Tomorrow. Northern Rivers Land Trust.
- Cahoon, Barry, 1996. Hardwick Lake. Vermont Agency of Natural Resources Department of Environmental Conservation, Stream Alteration Engineer.
- Compass, 2025. Final Results of Hydrology Study Lamoille River Watershed. Prepared by Compass PTS JV for DHS/Federal Emergency Management Agency, FEMA Region I, Arlington, VA.
- Green, Benjamin, McGinnis, Russell, 2024, May 29. Dam Safety Inspection Report – Hardwick Lake Dam. Vermont Agency of Natural Resources Department of Environmental Conservation, Dam Safety Program.
- Haybrook, Stephen, 1949. Report on Hardwick Lake Dam. State of Vermont Public Service Commission.
- Haybrook, Stephen, 1953. Report on the Renovated Hardwick Lake Dam. State of Vermont Public Service Commission.
- Knight, Stephen, 2001, December 7. Site observation of Hardwick Dams at Jackson Harwick Lake, and Caspian Lake. Knight Consulting Engineers, Inc. Williston, VT.
- Lakes and Ponds Program, 2018, November 1. Hardwick Lake, Hardwick, VT. Vermont Agency of Natural Resources Department of Environmental Conservation Watershed Management Division Lakes and Ponds Program.
- McKay, Tim, 2005, December 9. Watch Out for Ice Jams in Vermont’s Spring Floodplain. The North Star Monthly. Features from the Northeast Kingdom of Vermont.
- O’Brien, Kerry, 2009, February. Upper Lamoille River Stream Geomorphic Assessment Phase 2 Report, Greensboro and Hardwick, Vermont. Caledonia County Natural Resources Conservation District.
- Tucker, Jeffrey, 2002, January 30. Jackson Dam: Conceptual Construction Cost. DuBois & King Inc. Randolph, VT.
- USACE, 1980. Phase 1 Inspection Report, Hardwick Lake Dam. National Dam Inspection Program. Department of the Army New England Division, Corps of Engineers, Waltham, MA.
- VTDEC Water Quality Division, 2009. Lamoille River Basin Water Quality Management Plan. Vermont Agency of Natural Resources Department of Environmental Conservation Water Quality Division.
- VTDEC, 2006. Vermont Regional Hydraulic Geometry Curves. Appendix J of the Vermont Stream Geomorphic Assessment Protocol Handbooks: Remote Sensing and Field Surveys Techniques for Conducting Watershed and Reach Level Assessments. Vermont Agency of Natural Resources, Department of Environmental Conservation, Division of Water Quality, River Management Program, Waterbury, VT.



13.0 Appendices

Appendix A

VT DEC Dam Safety Inspection Report 2024





Dam Safety Inspection Report

Dam Safety Program
One National Life Drive
Montpelier, VT 05620-3510
(802) 622-4093
benjamin.green@vermont

Name: **Hardwick Lake Dam**
State ID: **93.01** NID ID: VT00186
Hazard Class: Significant

Town: **Hardwick**
Watershed: Lamoille River
Stream: Lamoille River

Inspection Details

Inspection date: 05/29/2024 08:36

Last inspection date: 7/15/2019

Inspection type: Periodic

Weather: Cloudy, 60F

Inspected by: Benjamin Green, Russell McGinnis

Dam Safety Recommendations

The following recommendations and remedial measures describe the recommended approach to address current deficiencies at the dam. Maintenance level activities can be performed by the Owner, while Studies and Analyses and Remedial Repair Recommendations will require the services of a qualified professional engineer registered in the State of Vermont who is experienced in dam safety engineering design, permitting, and construction. Remedial repairs recommended within this report will likely require obtaining a Dam Order from the Dam Safety Program (DSP).

It is always recommended to communicate with the DSP about any planned repairs to evaluate if the planned work requires obtaining a Dam Order. Additionally, any remedial repairs recommended within this report will likely require obtaining a Dam Order from the Dam Safety Program (DSP) prior to performing the repairs.

Overall dam condition:

Satisfactory Fair Poor Unsatisfactory Not Rated

**See General Information section at the end of report for further details*

Maintenance level recommendations

General	On a regular basis and following the application of unusual or extreme loading conditions, perform monitoring of the dam and its appurtenances. Report any unsafe condition to the Dam Safety Program.
	Establish and maintain vegetation clearing limits a minimum of 15 feet from all portions of the dam. Annually cut and remove grass, weeds, brush, and woody vegetation (but leave stumps) from the dam crest, upstream and downstream walls, spillways, abutments, and downstream areas to near ground surface.
Crest	Monitor the dam crest for signs of settlement, particularly to the left of the principal spillway along the non-overflow weir. Report any change of conditions to the DSP.
Upstream Wall	Monitor the area near the principal spillway structure where the small whirlpool was observed. Determine location of leakage discharge and monitor for changes in flow, turbidity, or size.

Maintenance level recommendations	
<i>Spillways</i>	Continue to maintain the principal and/or auxiliary spillway free of debris to ensure free-flow conditions.
	Monitor and repair minor concrete cracking and deterioration, as well as the condition of the concrete joints.
<i>Low-Level Outlet</i>	Inspect, lubricate, perform maintenance, and test operate the mechanical components on a yearly basis to ensure operability.

Studies and analysis:	
<i>General</i>	Perform necessary analyses to support either the design of repairs to bring the dam into compliance with current dam safety rules and guidelines, or alternately, dam removal.
<i>Hydrology and Hydraulics (H&H)/Hazard Classification</i>	Perform updated hydrologic and hydraulic analyses of the dam to determine hydraulic adequacy and also to confirm the hazard potential classification of the dam.
	Identify alternatives to make the dam hydraulically adequate or capable of being safely overtopped during the Inflow Design Flood (IDF).
	Evaluate the condition of all gate mechanisms and identify repair, maintenance, or replacement alternatives.
<i>Structural</i>	During low flow conditions or winter drawdown, inspect the principal spillway weir for any deficiencies and perform stability analyses.
	Once vegetation is removed from the left non-overflow wall, perform a thorough structural inspection and analyses
	Evaluate the condition of the gate structures and determine repair or replacement requirements.
<i>Emergency Action Planning</i>	Develop an Emergency Action Plan for the dam included updated dam failure analyses and flood inundation maps and provide to the Dam Safety Program.
<i>Operation & Maintenance (O&M)</i>	Develop an Operations and Maintenance Manual for the dam and provide a copy to the Dam Safety Program for record keeping purposes.

Remedial repair recommendations
<p>Based on the studies and analysis recommended above, repair, rehabilitate, or replace the dam to bring it into compliance with current dam safety rules and guidance. Alternatively, consider pursuing dam removal.</p> <p>An alternative to reduce loading and improve hydraulic adequacy of the dam would be to evaluate whether the dam can be operated year-round at the lowered reservoir pool that is currently maintained during winter months. This may provide the dam with more available storage during flooding events and serve as a reasonable risk reduction measure until a permanent solution can be pursued.</p>

Dam Information		
Type: Concrete Purpose: Hydroelectric	Status: In Service Height: 20 ft Length: 523 ft	Construction date: 1920
Owner/Contact/Operator: Hardwick Electric Department <i>email:</i> bessary@hardwickelectric.com <i>phone:</i> (802) 472-5201 <i>Address:</i> PO Box 516 Hardwick, VT 05843		
Normal storage: 900 ac-ft	Max storage: 2,000 ac-ft	
Normal surface area: 180 ac	Drainage area: 78,144 acres	Max surface area: Not determined
Pool elevation during inspection: Slightly above normal	Tailwater elevation during inspection: Within normal ranges	Normal pool elevation: Not determined
Dam has been breached or overtopped. Date: July 11, 2023- Overtopped		
Dam does not have public road on crest.	Dam does not have public bridge.	Dam does not have associated dike.
Inspection history: This dam was last inspected on December 23, 2019, and was rated in POOR condition. After the July 10, 2023, Flooding Event, a Rapid Inspection was performed and it was found the dam had overtopped as a result of the event.		

Access road to dam		
Type: Maintained paved road	Road name: Route 14	Distance from access road to dam: 50 ft
Seasonal access: <input checked="" type="checkbox"/> Plowed winter <input type="checkbox"/> Sanded winter <input type="checkbox"/> Maintained in mud season <input checked="" type="checkbox"/> Passable in all weather conditions <input type="checkbox"/> Need high clearance vehicle		
Access of emergency/construction equipment: Good access for large construction equipment.		
Action required: <input checked="" type="checkbox"/> None <input type="checkbox"/> Monitor <input type="checkbox"/> Maintenance <input type="checkbox"/> Engineer		

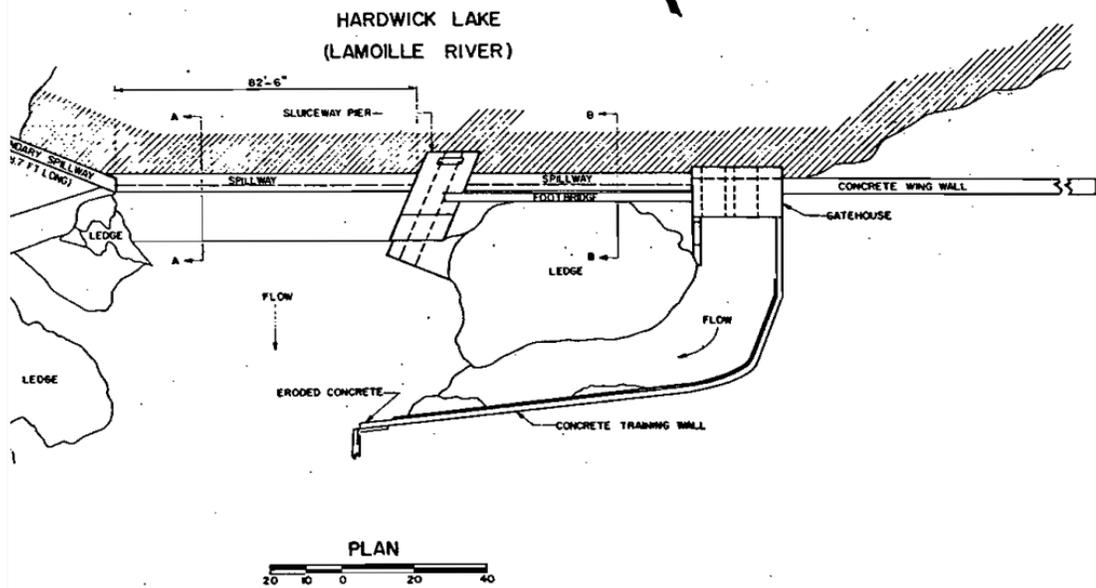
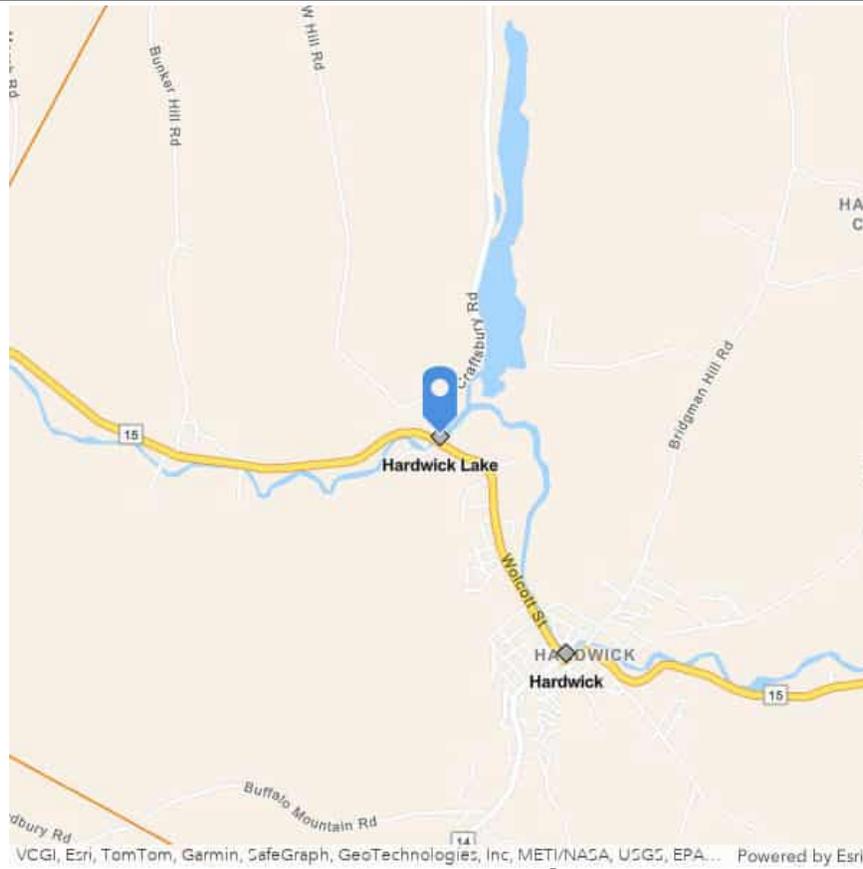
Security
Device type(s): Spillway access bridge secured.
Action required: <input checked="" type="checkbox"/> None <input type="checkbox"/> Monitor <input type="checkbox"/> Maintenance <input type="checkbox"/> Engineer

Public/Inspection team safety at dam	
Confined space entry required: No	Fall protection required: No
Other safety required: No	Public safety consideration: None observed
Action required: <input checked="" type="checkbox"/> None <input type="checkbox"/> Monitor <input type="checkbox"/> Maintenance <input type="checkbox"/> Engineer	

Dam Description/Background

Harwick Lake Dam is a concrete gravity dam with a principal spillway, auxiliary spillway, and outlet works founded on bedrock. The dam is currently classified as a SIGNIFICANT hazard potential. According to our files, the dam has a total length of approximately 523 feet and a structural height of 23 feet. The principal spillway consists of a divided ogee weir with a total length of about 144 feet with a crest at El. 794.8 (all elevations in this report reference the National Geodetic Vertical Datum, NGVD, in feet). The divided ogee weir spillway is fitted with slots and receivers on both sections for flashboards, although no flashboards were installed at the time of our inspection. In the center of the two principal spillway sections is a structure containing a 6-foot diameter, gate operated low-level outlet (LLO) with an invert of El. 780.0. On the right side of the principal spillway is an approximately 40-foot-long, auxiliary spillway at El. 797.3. To the left of the principal spillway is a structure containing two 6-foot diameter gate operated mid-level outlets with inverts at El. 786.0. It is our understanding that the right outlet is plugged and abandoned. To the left of this structure is an approximately 300-foot-long non-overflow concrete wall that extends to the left abutment with a crest at El. 801.0. The upstream and downstream faces of the left abutment structure are vertical. The dam impounds Hardwick Lake, which has a surface area of 180 acres, a drainage area of 78,144 acres, and normal and maximum storage of 900 acre-feet and 2,000 acre-feet, respectively. The dam was constructed in 1920 and reportedly was rebuilt in 1952. The Department of Environmental Conservation was given jurisdiction on this dam from the Public Service Board (now called the Public Utility Commission) circa 2008. The dam was formerly used to store water for hydroelectric production downstream but has not been used for that purpose in many years.

Dam Location



Emergency Action Plan	
EAP on file	EAP date: April 30, 1993
<i>If dam is a SIGNIFICANT or HIGH Hazard dam, an up-to-date EAP with dam failure flood hazard inundation map is highly recommended.</i>	

What issues are present with the EAP?	Action
<input type="checkbox"/> None <input checked="" type="checkbox"/> Revisions required <input type="checkbox"/> Not approved <input type="checkbox"/> No plan available <input type="checkbox"/> Inundation study required <input checked="" type="checkbox"/> Format out of date <input type="checkbox"/> Under review	<input type="checkbox"/> None <input type="checkbox"/> Monitor <input type="checkbox"/> Maintenance <input checked="" type="checkbox"/> Engineer

Operation & Maintenance Manual	
O&M Manual not on file	
Accessibility to outlets or low-level outlet (LLO): Good	Frequency of outlet or LLO discharge: Winter drawdown
Frequency of mowing: Not often.	Seasonal drawdown? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Amount lowered: Partially drained.
Frequency of dam owner surveillance: Unknown. No known monitoring program.	Owner surveillance during storm events: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Operating problems since last inspection: None reported	History of repairs since last inspection: Not known.

What issues are present with the O&M Manual?	Action
<input type="checkbox"/> None <input type="checkbox"/> Revisions required <input type="checkbox"/> Not approved <input checked="" type="checkbox"/> No plan available <input type="checkbox"/> Format out of date <input type="checkbox"/> Under review	<input type="checkbox"/> None <input type="checkbox"/> Monitor <input type="checkbox"/> Maintenance <input checked="" type="checkbox"/> Engineer

Downstream Hazard Classification

Current classification: Significant

The hazard potential classification of the dam informs dam design standards and requirements. There are no records on file indicating how the hazard potential classification of the dam was assigned. Therefore, it is currently unknown if this hazard potential classification is appropriate, and an updated Hazard Classification/Dam Failure Analysis should be performed. It also does not appear that an inundation map was used to determine the hazard potential classification.

A desktop review of the potential downstream impacts was performed and it appears that there could be potential impacts to downstream roads and properties, including 175 McAllister Farm Rd, which appears to be a residential property/commercial farm.

Hydrologic/Hydraulic Data

Since Hardwick Lake dam is currently rated as SIGNIFICANT hazard potential, the Inflow Design Flood (IDF) is the 1,000-yr storm event according to Federal Guidance currently applied in the State of Vermont.

According to State requirements, the dam must provide a minimum of 3.0 feet of freeboard between the normal water level and the dam crest. Based on visual observation this requirement appears to be met. Similarly, the dam is required to provide a minimum of 1.5 feet of freeboard between the peak water surface elevation during the IDF and the dam crest. Based on the dams performance in July 2023, it is unlikely that this condition is met.

Based on file review, there are information and calculations available in the 1980 Phase I Report produced by the USACE. However, these analyses used outdated methods and did not consider the current IDF. Accordingly, the hydraulic adequacy of the dam is considered unknown.

Upstream Wall Face (Left Non-Overflow Wall)

Wall type: Concrete
Length: 300 foot left non-overflow wall

Wall height (exposed): ~5 ft. (left non-overflow wing wall section) **Horizontal wall alignment:** Straight

Unusual wall movement: Yes No

Additional comments: Largely overgrown with brush and trees which prevented a thorough inspection. **Surface condition:** Overall fair with several isolated areas with minor damage.

Upstream Wall Face (Left Non-Overflow Wall)

<p>Joint condition: Where inspectable, appeared fair.</p>	<p>Abutment contact condition: Some undermining and noticeable water flowing around the cavity where the left wall meets the principal spillway section. Additional investigation of this area is recommended.</p>
--	---

Upstream wall issues	Action
<p>Could not inspect, brush covering areas preventing a thorough inspection. Several areas of minor damage.</p>	<p> <input type="checkbox"/> None <input type="checkbox"/> Monitor <input checked="" type="checkbox"/> Maintenance <input type="checkbox"/> Engineer </p>

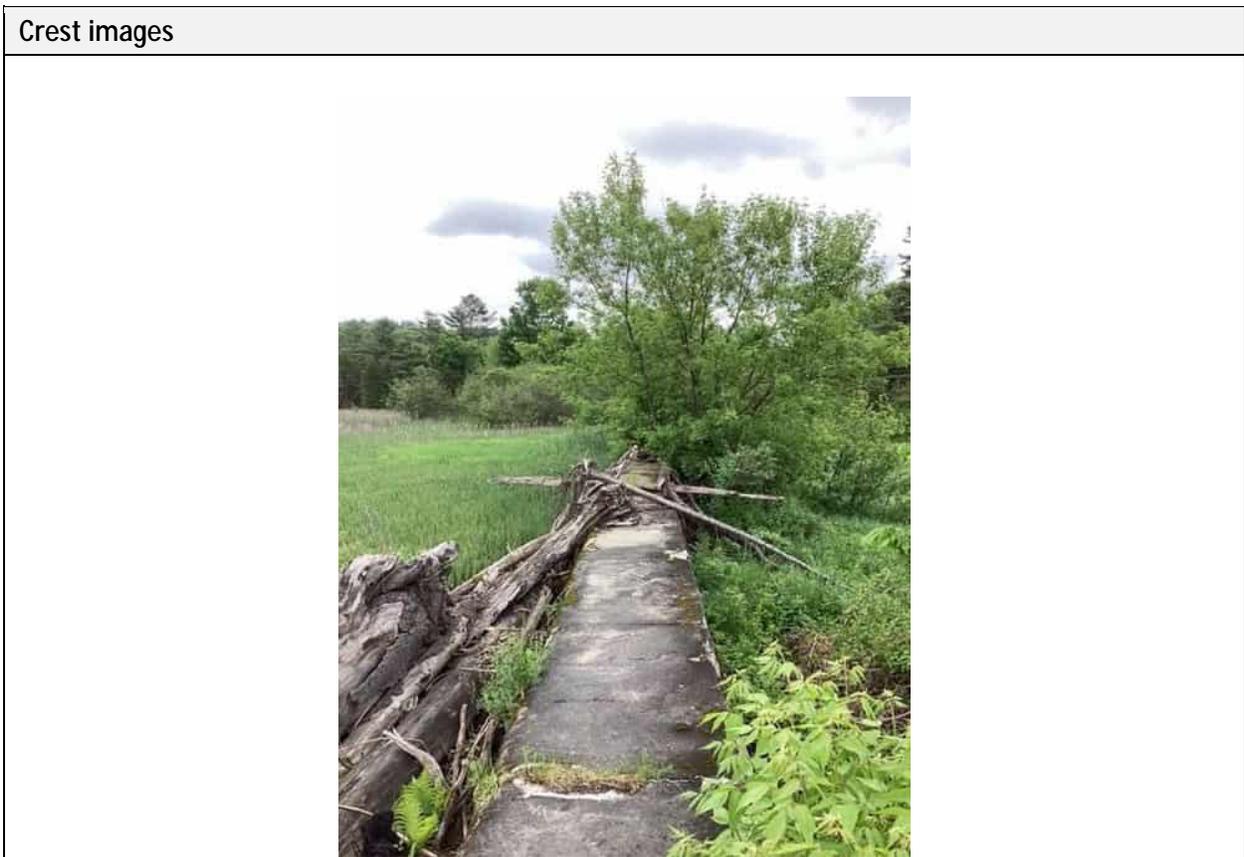
Upstream wall images



Tree growing out of upstream wall about 150 feet down left wall.

Crest (Left Non-Overflow Wall)	
Length: ~300 feet	Width: Approximately 2.5 feet width for the 300-foot-long left non-overflow wall.
Freeboard lengths: There is approximately 6 feet of freeboard between the principal spillway crest/normal water level and the crest of the wall.	
Additional comments: Abutment contact is overgrown and difficult to access which prevented a thorough inspection. Signs of overtopping throughout the entire length of the left downstream wall were observed.	

Crest issues	Action
<ul style="list-style-type: none"> • The crest is covered in brush and debris that prevented a thorough inspection. • An area of deteriorated concrete was observed resulting in a low point in the crest. • Just to the left of the structure that contains the two (2) 6-foot diameter outlet pipes, there was a small whirlpool observed on the upstream side and settlement on the crest be indicative of developing issue in this portion of the dam. 	<input type="checkbox"/> None <input type="checkbox"/> Monitor <input checked="" type="checkbox"/> Maintenance <input checked="" type="checkbox"/> Engineer



Crest images

Debris and tree growth preventing a thorough inspection



Part of left wall showing visible concrete deterioration and vegetation about 150 feet to the left of the principal spillway. Due to concrete deterioration, the crest elevation is lower than the rest of the wall at this location.

Downstream Wall (Left Non-Overflow Wall)	
Wall type: Concrete Length: 300 foot left non-overflow wing wall	
Wall height (exposed): ~5 ft. (left non-overflow wing wall)	Horizontal wall alignment: Straight
Unusual wall movement: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
Additional comments: Largely overgrown with brush and trees which prevented a thorough inspection. Original wall appears to be encased in concrete which is delaminating in areas resulting in material loss on much of the downstream face.	Surface condition: Section loss to a depth of 3 to 5 inches is prevalent.
Joint condition: Fair	Abutment contact condition: Needs investigation where the left non-overflow wing-wall contacts the concrete structure containing the two (2) 6-foot outlets. As previously described in the crest section, this area had observed settlement on the crest, that may be indicative to subsurface damage to the structure. A small whirlpool was observed just upstream of this area, but the outlet of the leakage was not found.

Downstream wall issues	Action
<ul style="list-style-type: none"> • Wall obscured by brush that prevented a thorough inspection. • Concrete section loss observed in large areas of the downstream wall. 	<input type="checkbox"/> None <input type="checkbox"/> Monitor <input checked="" type="checkbox"/> Maintenance <input checked="" type="checkbox"/> Engineer

Downstream wall images



Example of concrete deterioration and delamination on the downstream face.



Vegetation obscuring downstream wall face.

Instrumentation
<i>No instrumentation found</i>

Principal Spillway	
Spillway type: Weir	Primary material: Concrete Weir: Ogee
Spillway location: Spills the full length of the channel. One weir section on right side of gate structure and one on left side.	Gate: Low-Level slide gate in structure between spillway sections, see below for more information.
Water level measured against principal spillway crest: Approximately 3 inches flowing over	Erosion control structures: None
Spillway components:	
<input type="checkbox"/> Anti-vortex plate	<input type="checkbox"/> Filter Diaphragm <input checked="" type="checkbox"/> Training Walls
<input type="checkbox"/> Flashboard	<input type="checkbox"/> Trashrack <input type="checkbox"/> Other:
Additional comments: During the July 2023 Storm the spillway experienced heavy flows and debris. Flow over the spillway on day of inspection prevented thorough inspection. It is recommended to inspect the spillway during low flows or winter drawdown conditions.	

Principal spillway issues	Action
Deteriorating concrete	
Issues:	
<input type="checkbox"/> Bug holes	<input type="checkbox"/> None
<input checked="" type="checkbox"/> Hairline crack	<input type="checkbox"/> Monitor
<input checked="" type="checkbox"/> Efflorescence	<input checked="" type="checkbox"/> Maintenance
<input type="checkbox"/> Spalling	<input checked="" type="checkbox"/> Engineer
Impacted area: Throughout	
Location: Entire Surface	

Principal spillway images



Ogee weir section on right side of dam.



Weir section on left side.

Principal spillway images



Effervescence and cracks above the two (2) 6-foot-diameter principal spillway outlet structure.



Bulging of the training wall on the left side of where the two (2) 6-foot-diameter principal spillway outlet barrels discharge.

Outlet Structures
Total number of outlet structures: 2

LLO Gate in Center of Principal Spillway	
Elevation: El. 780.0 (feet)	Location: Center of the divided ogee spillway, accessible by the suspension bridge
Drain size and configuration: Slide gate. Electric motor operated.	Access: Access is only possible if the suspension bridge is intact and well maintained.
Additional comments: Outlet was not test operated during inspection. Reportedly in working condition.	
LLO Gate Issues	Action
Description: Condition is Poor. Described as still operable, but the condition of the steel is in a deteriorating state that requires some maintenance. There were some observed cracks in the steel at mounting points for the mechanisms. The condition of the gate itself could not be determined.	<input type="checkbox"/> None <input type="checkbox"/> Monitor <input checked="" type="checkbox"/> Maintenance <input checked="" type="checkbox"/> Engineer

Main Principal Outlet Structure	
Elevation: El. 786.0 (feet)	Location: Left side of principal spillway.
Drain size and configuration: Two (2) 6-foot-diameter outlet barrels with a manually operated gate. Left of the two outlet pipes is nonfunctional and reportedly abandoned.	Access: Good.
Additional comments: Outlet was not operated during inspection. The lake is reportedly lowered using this outlet works in the winter. Leakage through this gate was observable.	
Main Principal Outlet Structure Issues	Action
The mechanism and visible condition of the gate operator appears poor. The condition of the gate itself could not be determined.	<input type="checkbox"/> None <input type="checkbox"/> Monitor <input checked="" type="checkbox"/> Maintenance <input checked="" type="checkbox"/> Engineer

Outlet images



Gate across wooden spillway cable bridge.



On left gate at the entrance of the spillway. Both gates are closed but are heavily leaking.

Outlet images



Inside of the housing where the gate operator is located for the left main gate.

Outlet images



Crack observed in gate support.

Auxiliary Spillway	
Spillway type: Broad Crested Weir with concrete splash pad.	Primary material: Concrete
Spillway location: Right abutment	
Auxiliary Spillway Freeboard: Approximately 2.5 feet above the principal spillway crest.	Erosion control structures: None
Spillway components:	
<input type="checkbox"/> Anti-vortex plate	<input type="checkbox"/> Filter Diaphragm
<input type="checkbox"/> Flashboard	<input type="checkbox"/> Trashrack
	<input checked="" type="checkbox"/> Training Walls
	<input type="checkbox"/> Other:
Additional comments: Underdrain present under auxiliary. 2 pipes 4" in diameter observed.	Number of auxiliary spillways: 1

Auxiliary spillway issues	Action
Debris and vegetation buildup was observed in the approach to the auxiliary spillway.	<input type="checkbox"/> None <input checked="" type="checkbox"/> Monitor <input checked="" type="checkbox"/> Maintenance <input type="checkbox"/> Engineer

Auxiliary Spillway Drains	Number
<i>Two (2) 4" auxiliary spillway underdrains were present.</i>	2

Auxiliary spillway images



Auxiliary spillway at the right abutment.



Broad crested auxiliary spillway weir from right abutment.

Auxiliary spillway images



Auxiliary Spillway discharges onto a splash pad that appears to be founded on bedrock.

GENERAL INFORMATION

Website: <https://dec.vermont.gov/water-investment/dam-safety>

The Dam Safety Program conducts periodic safety inspections of non-federal, non-power dams to determine their condition and the extent to which they pose a potential or actual threat to life, property, and the environment. The condition rating reported herein was based on available data and visual inspection. Detailed investigations/analyses were beyond the scope of this report. It should be realized that the reported condition was based on observations of field conditions at the time of inspection, along with data available to the inspection team. The condition of the dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the reported condition of the dam will continue to represent the condition of the dam in the future. Only through continued care and inspection can there be any chance that unsafe conditions are detected.

Hazard Potential Classifications:

HIGH: Dams where failure or mis-operation will probably cause loss of human life.

SIGNIFICANT: Dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

LOW: Dams where failure or mis-operation results in no probable loss of human life and low economic and environmental losses.

MINIMAL: A dam that meets the LOW hazard definition, above, but is only capable of impounding less than 500,000 cubic feet.

Condition Ratings:

SATISFACTORY: No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.

FAIR: No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.

POOR: A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. POOR may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.

UNSATISFACTORY: A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.

NOT RATED: The dam has not been inspected, is not under state jurisdiction, or has been inspected but, for whatever reason, has not been rated.

Definitions:

Upstream: The side of the dam that borders the impoundment located up gradient of the dam.

Downstream: The side of the dam opposite the upstream side, located down gradient of the dam.

Right: The area to the right when looking in the downstream direction (also known as "river right").

Left: The area to the left when looking in the downstream direction (also known as "river left").

Structural Height-of-Dam: The vertical distance from the lowest point in the stream bed or native ground surface at the downstream toe of the dam to the elevation of the lowest non-overflow section of the dam crest.

Embankment: An artificially constructed feature usually consisting of earth and rock with sloping sides and a flat crest, intended to provide a permanent barrier that impounds or is capable of impounding water.

Dam Crest: The top of the non-overflow portion of the dam.

Abutment: The part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed at the interface with a concrete gravity section.

Normal Pool: The water elevation, reservoir surface area, and reservoir storage capacity that is prevalent at the site or typical under normal, non-storm conditions. Typically, this level is controlled by the principal spillway.

Maximum Pool: The highest water elevation, reservoir surface area, and reservoir storage capacity that could be impounded by the dam, including accumulated sediments, with the water or liquid level at the top of the lowest non-overflow part of the structure or dam crest.

Principal spillway: A structure that maintains normal pool conditions and over which daily non-storm related and flood flows are discharged. Also called a primary or service spillway.

Auxiliary Spillway: The secondary spillway not in use under normal conditions but used when needed to pass flood flows that exceed the capacity of the principal spillway.

Low-level outlet or "LLO": An installed pipe and operable gate or valve typically located in or near the foundation of a dam that can be used to alter water levels, drain the reservoir, or otherwise meet operational or safety needs. Also called a pond drain.

Inflow Design Flood or "IDF": The storm event which the hydraulic capacity of the spillway structure and dam is designed and required to safely pass. Dam safety rules under development are considering the following prescriptive IDF's, Low and Minimal = 100-year Storm, Significant = 1,000-year storm, High = PMF. The use of incremental consequence analysis or risk-informed decision making to evaluate the potential of selecting a smaller/site specific IDF is permitted.

Emergency Action Plan (EAP): A written plan that identifies the area that would likely be inundated by the failure of a dam and identifies the actions that should be taken by the Owner to protect life, property, lifelines, and the environment in the event of a dam failure or threatening condition at the dam. The plan is usually implemented in cooperation with the local, regional, and state emergency personnel.

Operation and Maintenance Plan or "O&M": A plan that provides guidelines for the necessary, regular operation and maintenance activities at a dam.

Complete list of definitions from the Vermont Dam Safety Rule:

<https://anrweb.vt.gov/DEC/IronPIG/DownloadFile.aspx?DID=185352&DVID=0>

Appendix B

Sediment Measurements

Table 3: Sediment and Water Depth Measurements in the Lamoille River Impoundment

Distance Upstream of Dam (feet)	Measured Point	Water Depth (feet)	Sediment Depth (feet)	Refusal?
100	1	8	5	n
	2	6	7	n
	3	7	6	n
	4	2.5	3	n
130	5	6	8	n
	6	6	7	y
	7	7	3	n
170	8	2	4	n
	9	1	3	n
	10	2	4	n
200	11	4	2	y
	12	8	2	y
	13	6.5	6	y
	14	8	4.5	y
630	15	7	5	y
900	16	6	6	y
1140	17	7	4	y
1520	18	5	5	y
1975	19	5	4	y
2605	20	4.5	2.5	y
3010	21	4	3	y
3795	22	3.5	3	y
4075	23	3	2.5	y



Appendix C

Sediment Volume Estimate

Table 4: Estimated Sediment Volume Calculations Upstream of Jackson Dam

Impoundment ID	Approximate Sediment Depth (feet)	Area (feet ²)	Volume (feet ³)	Volume (cy)
A	6	17,000	102,000	3,800
B	6	4,000	24,000	900
C	3.6	28,000	100,800	3,700
D	5	41,000	205,000	7,600
E	6	34,000	204,000	7,600
F	4	33,000	132,000	4,900
G	5	44,000	220,000	8,100
H	4	66,000	264,000	9,800
I	2.5	72,000	180,000	6,700
J	3	98,000	294,000	10,900
K	3	52,000	156,000	5,800
L	2.5	61,000	152,500	5,600
M	8.5	469,000	3,986,500	147,600
N	7.5	115,000	862,500	31,900
O	5.5	92,000	506,000	18,700
P	2.5	24,000	60,000	2,200
Q	6.5	689,000	4,478,500	165,900
R	4	108,000	432,000	16,000
S	6.5	741,000	4,816,500	178,400
T	~	4,600,000	~	~
Total			17,180,000	640,000
Total in river corridor (M, N, O, P, Q)			9,894,000	370,000
Total in channel (A, B, C, D, E, F, G, H, I, J, K, L, R)			2,466,000	90,000



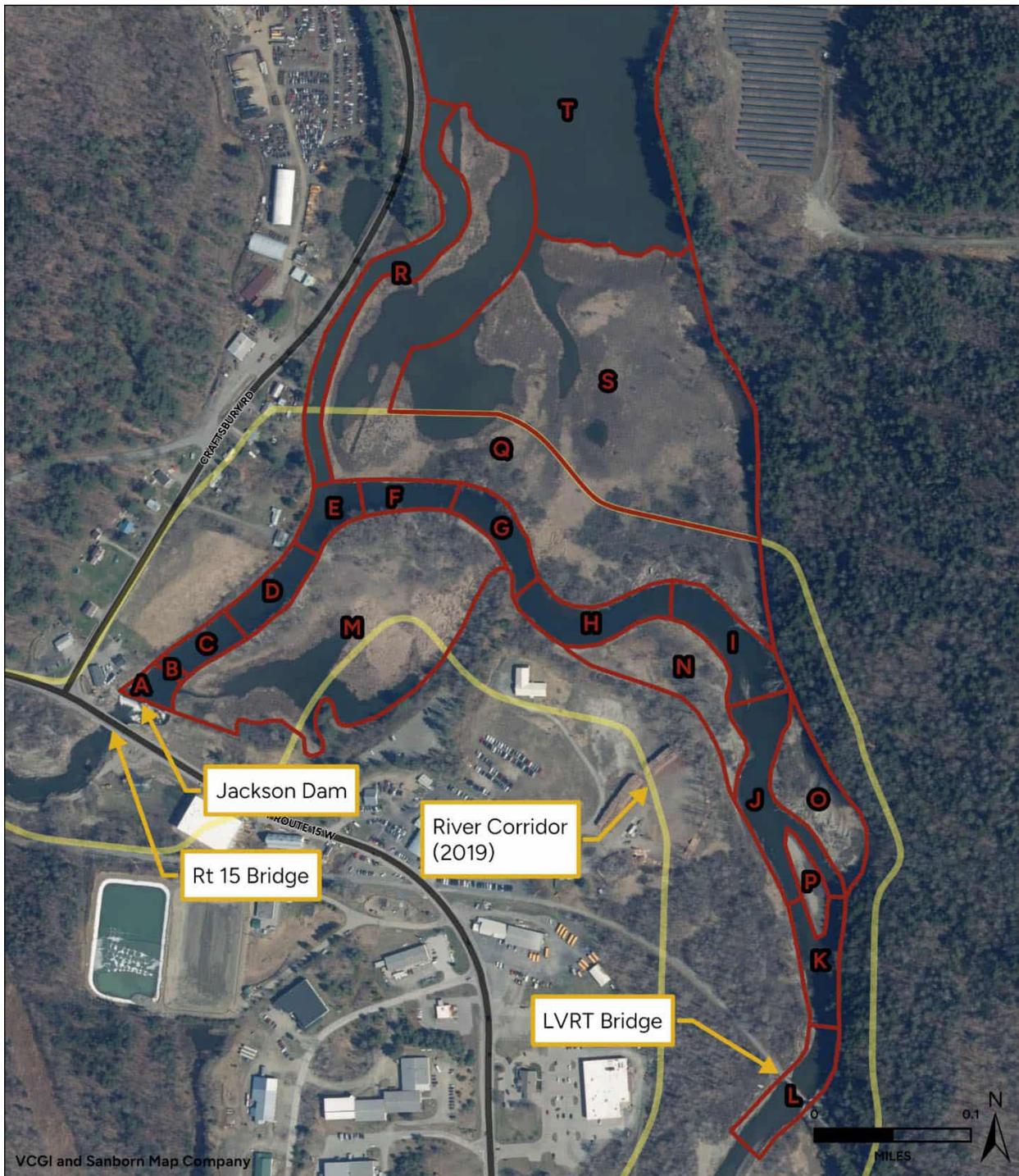


Figure 26: Impoundment areas with similar attributes used to estimate sediment volume



Appendix D

Sediment Sample Results



SLR International Corporation
1 South Main Street 101249
Waterbury, VT 05676
Atten: Roy Schiff

PROJECT: Jackson Dam
WORK ORDER: **2510-37426**
DATE RECEIVED: October 23, 2025
DATE REPORTED: November 07, 2025
SAMPLER: Jessica L.

Laboratory Report

Enclosed please find the results of the analyses performed for the samples referenced on the attached chain of custody. All required method quality control elements including instrument calibration were performed in accordance with method requirements and determined to be acceptable unless otherwise noted.

The column labeled Lab/Tech in the accompanying report denotes the laboratory facility where the testing was performed and the technician who conducted the assay. A "W" designates the Williston, VT lab under NELAC certification ELAP 11263; "R" designates the Lebanon, NH facility under certification NH 2037 and "N" the Plattsburgh, NY lab under certification ELAP 11892. "Sub" indicates the testing was performed by a subcontracted laboratory. The accreditation status of the subcontracted lab is referenced in the corresponding NELAC and Qual fields. The Williston, VT facility is also ISO/IEC 17025:2017 accredited for Total Coliform and E coli by SM9223B.

The NELAC column also denotes the accreditation status of each laboratory for each reported parameter. "A" indicates the referenced laboratory is NELAC accredited for the parameter reported. "N" indicates the laboratory is not accredited. "U" indicates that NELAC does not offer accreditation for that parameter in that specific matrix. Test results denoted with an "A" meet all National Environmental Laboratory Accreditation Program requirements except where denoted by pertinent data qualifiers. Test results are representative of the samples as they were received at the laboratory

Endyne, Inc. warrants, to the best of its knowledge and belief, the accuracy of the analytical test results contained in this report, but makes no other warranty, expressed or implied, especially no warranties of merchantability or fitness for a particular purpose.

Reviewed by:



Harry B. Locker, Ph.D.
Laboratory Director

Laboratory Report

DATE REPORTED: 11/07/2025

CLIENT: SLR International Corporation
PROJECT: Jackson DamWORK ORDER: 2510-37426
DATE RECEIVED: 10/23/2025

001 Site: Jackson 1 Date Sampled: 10/22/25 Time: 16:30

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Carbon, Total Organic (TOC)	27500	mg/Kg	L. Kahn	11/3/25	SWSUB	U	SBP
Phosphorus, Total	520	mg/Kg, dry	EPA 365.1, mod	10/29/25	N WEP	U	
Solids, Total	62.5	%	SM 2540 G.-15	10/27/25	W JSS	U	
Mercury Digestion	Digested		EPA 7471B	11/7/25	W RSB	A	
Metals Solids Digestion	Digested		EPA 3050B	10/28/25	W MLR	A	
Arsenic, Total	2.2	mg/Kg Dry	EPA 6010C	10/30/25	0:57 W MLR	A	
Barium, Total	39	mg/Kg Dry	EPA 6010C	10/30/25	0:45 W MLR	A	
Cadmium, Total	< 0.13	mg/Kg Dry	EPA 6010C	10/30/25	0:57 W MLR	A	
Chromium, Total	24	mg/Kg Dry	EPA 6010C	10/30/25	0:45 W MLR	A	
Lead, Total	8.6	mg/Kg Dry	EPA 6010C	10/30/25	0:51 W MLR	A	
Mercury, Total	< 0.025	mg/Kg, dry	EPA 7471B	11/7/25	W RSB	A	
Selenium, Total	< 1.3	mg/Kg Dry	EPA 6010C	10/30/25	0:57 W MLR	A	
Silver, Total	< 0.63	mg/Kg Dry	EPA 6010C	10/30/25	0:57 W MLR	A	
Volatile Organic Compounds							
Prep EPA 5035A	Complete		EPA 5035A-H	10/27/25	W TRP	A	
Dichlorodifluoromethane	< 1,080	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Chloromethane	< 1,080	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Vinyl chloride	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Bromomethane	< 1,080	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Chloroethane	< 1,080	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Trichlorofluoromethane	< 1,080	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Diethyl ether	< 1,080	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
1,1-Dichloroethene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Acetone	4,490	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Carbon disulfide	< 1,080	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Methylene chloride	< 1,080	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
t-Butanol	< 5,400	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Methyl-t-butyl ether (MTBE)	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
trans-1,2-Dichloroethene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Di-isopropyl ether (DIPE)	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	U	
1,1-Dichloroethane	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Ethyl-t-butyl ether (ETBE)	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	U	
2-Butanone	< 2,160	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
2,2-Dichloropropane	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
cis-1,2-Dichloroethene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Bromochloromethane	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Chloroform	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Tetrahydrofuran	< 2,160	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	U	
1,1,1-Trichloroethane	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Carbon tetrachloride	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,1-Dichloropropene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Benzene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
t-Amylmethyl ether (TAME)	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	U	
1,2-Dichloroethane	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Trichloroethene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2-Dichloropropane	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	

Laboratory Report

DATE REPORTED: 11/07/2025

CLIENT: SLR International Corporation
PROJECT: Jackson DamWORK ORDER: 2510-37426
DATE RECEIVED: 10/23/2025

001 Site: Jackson 1

Date Sampled: 10/22/25 Time: 16:30

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Dibromomethane	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Bromodichloromethane	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
cis-1,3-Dichloropropene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
4-Methyl-2-pentanone (MIBK)	< 2,160	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Toluene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
trans-1,3-Dichloropropene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,1,2-Trichloroethane	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Tetrachloroethene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,3-Dichloropropane	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
2-Hexanone	< 2,160	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Dibromochloromethane	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2-Dibromoethane	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Chlorobenzene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Ethylbenzene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,1,1,2-Tetrachloroethane	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Xylenes, Total	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Styrene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Bromoform	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Isopropylbenzene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,1,2,2-Tetrachloroethane	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Bromobenzene	< 216	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
n-Propylbenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2,3-Trichloropropane	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
2-Chlorotoluene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
1,3,5-Trimethylbenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
4-Chlorotoluene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
t-Butylbenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2,4-Trimethylbenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
s-Butylbenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
4-Isopropyltoluene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,3-Dichlorobenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,4-Dichlorobenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2,3-Trimethylbenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
n-Butylbenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2-Dichlorobenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2-Dibromo-3-Chloropropane	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
1,2,4-Trichlorobenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
1,3,5-Trichlorobenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Hexachlorobutadiene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Naphthalene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2,3-Trichlorobenzene	< 432	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Surr. 1 (Dibromofluoromethane)	100	%	EPA 8260C	10/27/25	W TRP	U	
Surr. 2 (Toluene d8)	100	%	EPA 8260C	10/27/25	W TRP	U	
Surr. 3 (4-Bromofluorobenzene)	101	%	EPA 8260C	10/27/25	W TRP	U	
Unidentified Peaks	>10		EPA 8260C	10/27/25	W TRP	U	
Priority Pollutant Pesticides							

Laboratory Report

DATE REPORTED: 11/07/2025

CLIENT: SLR International Corporation
PROJECT: Jackson DamWORK ORDER: 2510-37426
DATE RECEIVED: 10/23/2025

001 Site: Jackson 1

Date Sampled: 10/22/25 Time: 16:30

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Extraction	Completed		EPA 3545A	10/31/25	W JCM	A	
alpha-BHC	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
gamma-BHC (Lindane)	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
beta-BHC	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
delta-BHC	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Heptachlor	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Aldrin	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Heptachlor Epoxide	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
4,4'-DDE	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Endosulfan I	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Dieldrin	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Endrin	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
4,4'-DDD	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Endosulfan II	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
4,4'-DDT	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	AN1
Endrin Aldehyde	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Endosulfan Sulfate	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Methoxychlor	< 10.4	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	AN1
Chlordane	< 52.0	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Toxaphene	< 52.0	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Surrogate-TCMX	72	%	EPA 8081B	11/6/25	W DPD	A	
Surrogate-DCB	38	%	EPA 8081B	11/6/25	W DPD	A	
Poly-Chlorinated Biphenyls							
Extraction	Completed		EPA 3545A	10/31/25	W JCM	A	
Aroclor 1016 (PCB-1016)	< 20.8	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1221 (PCB-1221)	< 20.8	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1232 (PCB-1232)	< 20.8	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1242 (PCB-1242)	< 20.8	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1248 (PCB-1248)	< 20.8	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1254 (PCB-1254)	< 20.8	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1260 (PCB-1260)	< 20.8	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Surrogate-TCMX	75	%	EPA 8082A	11/5/25	W DPD	A	
Surrogate-DCB	42	%	EPA 8082A	11/5/25	W DPD	A	
Poly-Aromatic Hydrocarbons							
Extraction	Completed		EPA 3550C	10/28/25	W JCM	A	
Naphthalene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
2-Methylnaphthalene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
1-Methylnaphthalene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	U	
Acenaphthylene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Acenaphthene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Fluorene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Phenanthrene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Anthracene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Fluoranthene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Pyrene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Benzo(a)anthracene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	

Laboratory Report

DATE REPORTED: 11/07/2025

CLIENT: SLR International Corporation
PROJECT: Jackson DamWORK ORDER: 2510-37426
DATE RECEIVED: 10/23/2025

001 Site: Jackson 1 Date Sampled: 10/22/25 Time: 16:30

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Chrysene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Benzo(b)fluoranthene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Benzo(k)fluoranthene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Benzo(a)pyrene	< 15.9	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Indeno(1,2,3-cd)pyrene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Dibenzo(a,h)anthracene	< 15.9	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Benzo(g,h,i)perylene	< 31.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
BaP Toxic Equiv. Quotient	< 20.8	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	U	
B/N Surr.1 Nitrobenzene-d5	53	%	EPA 8270D	10/30/25	W EEP	U	
B/N Surr.2 2-Fluorobiphenyl	51	%	EPA 8270D	10/30/25	W EEP	U	
B/N Surr.3 Terphenyl-d14	74	%	EPA 8270D	10/30/25	W EEP	U	
Unidentified Peaks	>10		EPA 8270D	10/30/25	W EEP	U	

002 Site: Jackson 2 Date Sampled: 10/22/25 Time: 16:50

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Carbon, Total Organic (TOC)	12500	mg/Kg	L. Kahn	11/3/25	SWSUB	U	SBP
Phosphorus, Total	570	mg/Kg, dry	EPA 365.1, mod	10/29/25	N WEP	U	
Solids, Total	67.8	%	SM 2540 G.-15	10/27/25	W JSS	U	
Mercury Digestion	Digested		EPA 7471B	11/7/25	W RSB	A	
Metals Solids Digestion	Digested		EPA 3050B	10/28/25	W MLR	A	
Arsenic, Total	2.0	mg/Kg Dry	EPA 6010C	10/30/25	1:14 W MLR	A	
Barium, Total	31	mg/Kg Dry	EPA 6010C	10/30/25	1:08 W MLR	A	
Cadmium, Total	< 0.12	mg/Kg Dry	EPA 6010C	10/30/25	1:14 W MLR	A	
Chromium, Total	21	mg/Kg Dry	EPA 6010C	10/30/25	1:08 W MLR	A	
Lead, Total	12	mg/Kg Dry	EPA 6010C	10/30/25	1:08 W MLR	A	
Mercury, Total	0.041	mg/Kg, dry	EPA 7471B	11/7/25	W RSB	A	
Selenium, Total	< 1.2	mg/Kg Dry	EPA 6010C	10/30/25	1:14 W MLR	A	
Silver, Total	< 0.60	mg/Kg Dry	EPA 6010C	10/30/25	1:14 W MLR	A	
Volatile Organic Compounds							
Prep EPA 5035A	Complete		EPA 5035A-H	10/27/25	W TRP	A	
Dichlorodifluoromethane	< 550	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Chloromethane	< 550	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Vinyl chloride	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Bromomethane	< 550	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Chloroethane	< 550	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Trichlorofluoromethane	< 550	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Diethyl ether	< 550	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
1,1-Dichloroethene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Acetone	< 1,100	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Carbon disulfide	< 550	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Methylene chloride	< 550	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
t-Butanol	< 2,750	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Methyl-t-butyl ether (MTBE)	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
trans-1,2-Dichloroethene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Di-isopropyl ether (DIPE)	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	U	

Laboratory Report

DATE REPORTED: 11/07/2025

CLIENT: SLR International Corporation
PROJECT: Jackson DamWORK ORDER: 2510-37426
DATE RECEIVED: 10/23/2025

002 Site: Jackson 2

Date Sampled: 10/22/25 Time: 16:50

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
1,1-Dichloroethane	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Ethyl-t-butyl ether (ETBE)	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	U	
2-Butanone	< 1,100	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
2,2-Dichloropropane	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
cis-1,2-Dichloroethene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Bromochloromethane	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Chloroform	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Tetrahydrofuran	< 1,100	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	U	
1,1,1-Trichloroethane	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Carbon tetrachloride	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,1-Dichloropropene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Benzene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
t-Amylmethyl ether (TAME)	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	U	
1,2-Dichloroethane	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Trichloroethene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2-Dichloropropane	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Dibromomethane	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Bromodichloromethane	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
cis-1,3-Dichloropropene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
4-Methyl-2-pentanone (MIBK)	< 1,100	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Toluene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
trans-1,3-Dichloropropene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,1,2-Trichloroethane	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Tetrachloroethene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,3-Dichloropropane	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
2-Hexanone	< 1,100	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Dibromochloromethane	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2-Dibromoethane	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Chlorobenzene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Ethylbenzene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,1,1,2-Tetrachloroethane	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Xylenes, Total	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Styrene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Bromoform	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Isopropylbenzene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,1,2,2-Tetrachloroethane	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
Bromobenzene	< 110	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
n-Propylbenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2,3-Trichloropropane	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
2-Chlorotoluene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
1,3,5-Trimethylbenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
4-Chlorotoluene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
t-Butylbenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2,4-Trimethylbenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
s-Butylbenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
4-Isopropyltoluene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	

Laboratory Report

DATE REPORTED: 11/07/2025

CLIENT: SLR International Corporation
PROJECT: Jackson DamWORK ORDER: 2510-37426
DATE RECEIVED: 10/23/2025

002 Site: Jackson 2

Date Sampled: 10/22/25 Time: 16:50

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
1,3-Dichlorobenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,4-Dichlorobenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2,3-Trimethylbenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
n-Butylbenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2-Dichlorobenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2-Dibromo-3-Chloropropane	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
1,2,4-Trichlorobenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
1,3,5-Trichlorobenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Hexachlorobutadiene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Naphthalene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	A	
1,2,3-Trichlorobenzene	< 220	ug/Kg, Dry	EPA 8260C	10/27/25	W TRP	N	
Surr. 1 (Dibromofluoromethane)	98	%	EPA 8260C	10/27/25	W TRP	U	
Surr. 2 (Toluene d8)	99	%	EPA 8260C	10/27/25	W TRP	U	
Surr. 3 (4-Bromofluorobenzene)	100	%	EPA 8260C	10/27/25	W TRP	U	
Unidentified Peaks	0		EPA 8260C	10/27/25	W TRP	U	
Priority Pollutant Pesticides							
Extraction	Completed		EPA 3545A	10/31/25	W JCM	A	
alpha-BHC	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
gamma-BHC (Lindane)	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
beta-BHC	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
delta-BHC	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Heptachlor	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Aldrin	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Heptachlor Epoxide	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
4,4'-DDE	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Endosulfan I	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Dieldrin	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Endrin	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
4,4'-DDD	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Endosulfan II	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
4,4'-DDT	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	AN1
Endrin Aldehyde	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Endosulfan Sulfate	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Methoxychlor	< 9.8	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	AN1
Chlordane	< 49.1	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Toxaphene	< 49.1	ug/Kg, dry	EPA 8081B	11/6/25	W DPD	A	
Surrogate-TCMX	64	%	EPA 8081B	11/6/25	W DPD	A	
Surrogate-DCB	35	%	EPA 8081B	11/6/25	W DPD	A	
Poly-Chlorinated Biphenyls							
Extraction	Completed		EPA 3545A	10/31/25	W JCM	A	
Aroclor 1016 (PCB-1016)	< 19.7	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1221 (PCB-1221)	< 19.7	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1232 (PCB-1232)	< 19.7	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1242 (PCB-1242)	< 19.7	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1248 (PCB-1248)	< 19.7	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Aroclor 1254 (PCB-1254)	< 19.7	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	

Laboratory Report

DATE REPORTED: 11/07/2025

CLIENT: SLR International Corporation
PROJECT: Jackson DamWORK ORDER: 2510-37426
DATE RECEIVED: 10/23/2025

002 Site: Jackson 2

Date Sampled: 10/22/25 Time: 16:50

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Aroclor 1260 (PCB-1260)	< 19.7	ug/Kg, dry	EPA 8082A	11/5/25	W DPD	A	
Surrogate-TCMX	67	%	EPA 8082A	11/5/25	W DPD	A	
Surrogate-DCB	42	%	EPA 8082A	11/5/25	W DPD	A	
Poly-Aromatic Hydrocarbons							
Extraction	Completed		EPA 3550C	10/28/25	W JCM	A	
Naphthalene	< 29.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
2-Methylnaphthalene	< 29.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
1-Methylnaphthalene	< 29.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	U	
Acenaphthylene	< 29.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Acenaphthene	< 29.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Fluorene	< 29.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Phenanthrene	40.5	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Anthracene	< 29.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Fluoranthene	79.8	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Pyrene	76.2	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Benzo(a)anthracene	49.8	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Chrysene	46.9	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Benzo(b)fluoranthene	49.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Benzo(k)fluoranthene	< 29.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Benzo(a)pyrene	38.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Indeno(1,2,3-cd)pyrene	< 29.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Dibenzo(a,h)anthracene	< 14.7	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
Benzo(g,h,i)perylene	< 29.3	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	A	
BaP Toxic Equiv. Quotient	57.6	ug/Kg, dry	EPA 8270D	10/30/25	W EEP	U	
B/N Surr.1 Nitrobenzene-d5	65	%	EPA 8270D	10/30/25	W EEP	U	
B/N Surr.2 2-Fluorobiphenyl	68	%	EPA 8270D	10/30/25	W EEP	U	
B/N Surr.3 Terphenyl-d14	83	%	EPA 8270D	10/30/25	W EEP	U	
Unidentified Peaks	>10		EPA 8270D	10/30/25	W EEP	U	

Report Summary of Qualifiers and Notes

VOC results below 200 ug/Kg may be biased low due to sample preparation by 5035A High method.

AN1: Due to the nature of the sample matrix, the closing calibration check standard was Low bias for 4,4-DDT and Methoxychlor. Associated results may be biased low.

SBP: Analysis performed by subcontracted laboratory, Phoenix Environmental Laboratories, ELAP#11301. The complete subcontracted report has been appended to this report.



Monday, November 03, 2025

Attn: Eileen Toomey
Endyne, Inc.
160 James Brown Dr.
Williston, VT 05495

Project ID: 2510-37426-W
SDG ID: GCU60026
Sample ID#s: CU60026 - CU60027

This laboratory is in compliance with the NELAC requirements of procedures used except where indicated.

This report contains results for the parameters tested, under the sampling conditions described on the Chain Of Custody, as received by the laboratory. This report is incomplete unless all pages indicated in the pagination at the bottom of the page are included.

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

A scanned version of the COC form accompanies the analytical report and is an exact duplicate of the original.

The contents of this report cannot be discussed with anyone other than the client listed above without their written consent.

Sincerely yours,

A handwritten signature in cursive script that reads "Phyllis Shiller".

Phyllis Shiller

Laboratory Director

NELAC - #NY11301
CT Lab Registration #PH-0618
MA Lab Registration #M-CT007
ME Lab Registration #CT-007
NH Lab Registration #213693-A,B

NJ Lab Registration #CT-003
NY Lab Registration #11301
PA Lab Registration #68-03530
RI Lab Registration #63
VT Lab Registration #VT11301



Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102 Fax (860) 645-0823

Sample Id Cross Reference

November 03, 2025

SDG I.D.: GCU60026

Project ID: 2510-37426-W

Client Id	Lab Id	Matrix	Col Date
2510-37426-001	CU60026	SOIL	10/22/25 16:30
2510-37426-002	CU60027	SOIL	10/22/25 16:50



Environmental Laboratories, Inc.

587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102

Analysis Report

November 03, 2025

FOR: Attn: Eileen Toomey
Endyne, Inc.
160 James Brown Dr.
Williston, VT 05495

Sample Information

Matrix: SOIL
Location Code: END-WIL
Rush Request: Standard
P.O.#:

Custody Information

Collected by:
Received by: SR1
Analyzed by: see "By" below

Date

Time

10/22/25 16:30
10/28/25 11:00

Laboratory Data

SDG ID: GCU60026
Phoenix ID: CU60026

Project ID: 2510-37426-W
Client ID: 2510-37426-001

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
Percent Solid	54		%		10/28/25 23:20	CV	SW846-%Solid
Tot.Org.Carbon	27500	100	mg/kg	1	11/03/25 12:26	EG	L. Kahn
Tot.Org.Carbon Preparation	Completed				10/29/25 02:10	BS	

RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

Comments:

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.
If you are the client above and have any questions concerning this testing, please do not hesitate to contact Phoenix Client Services at ext.200.
The contents of this report cannot be discussed with anyone other than the client listed above without their written consent.

Phyllis Shiller, Laboratory Director

November 03, 2025

Reviewed and Released by: Helen Geoghegan, Project Manager



Environmental Laboratories, Inc.

587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102

Analysis Report

November 03, 2025

FOR: Attn: Eileen Toomey
Endyne, Inc.
160 James Brown Dr.
Williston, VT 05495

Sample Information

Matrix: SOIL
Location Code: END-WIL
Rush Request: Standard
P.O.#:

Custody Information

Collected by:
Received by: SR1
Analyzed by: see "By" below

Date

Time

10/22/25 16:50
10/28/25 11:00

Laboratory Data

SDG ID: GCU60026
Phoenix ID: CU60027

Project ID: 2510-37426-W
Client ID: 2510-37426-002

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
Percent Solid	64		%		10/28/25 23:20	CV	SW846-%Solid
Tot.Org.Carbon	12500	100	mg/kg	1	11/03/25 12:26	EG	L. Kahn
Tot.Org.Carbon Preparation	Completed				10/29/25 02:10	BS	

RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

Comments:

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.
If you are the client above and have any questions concerning this testing, please do not hesitate to contact Phoenix Client Services at ext.200.
The contents of this report cannot be discussed with anyone other than the client listed above without their written consent.

Phyllis Shiller, Laboratory Director

November 03, 2025

Reviewed and Released by: Helen Geoghegan, Project Manager



Environmental Laboratories, Inc.
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
 Tel. (860) 645-1102

QA/QC Report

November 03, 2025

QA/QC Data

SDG I.D.: GCU60026

Parameter	Blank	Blk RL	Sample Result	Dup Result	Dup RPD	LCS %	LCSD %	LCS RPD	MS %	MSD %	MS RPD	% Rec Limits	% RPD Limits
QA/QC Batch 811893 (mg/kg), QC Sample No: CU60027 (CU60026, CU60027)													
Tot.Org.Carbon	BRL	100	12500	12500	0	105						75 - 125	30
Comment: Additional criteria matrix spike acceptance range is 75-125%.													

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

- RPD - Relative Percent Difference
- LCS - Laboratory Control Sample
- LCSD - Laboratory Control Sample Duplicate
- MS - Matrix Spike
- MS Dup - Matrix Spike Duplicate
- NC - No Criteria
- Intf - Interference
- (ISO) - Isotope Dilution


 Phyllis Shiller, Laboratory Director
 November 03, 2025

Monday, November 03, 2025

Criteria: None

State: VT

Sample Criteria Exceedances Report

GCU60026 - END-WIL

SampNo	Acode	Phoenix Analyte	Criteria	Result	RL	Criteria	RL	Criteria	Analysis Units
--------	-------	-----------------	----------	--------	----	----------	----	----------	----------------

*** No Data to Display ***

Phoenix Laboratories does not assume responsibility for the data contained in this exceedance report. It is provided as an additional tool to identify requested criteria exceedances. All efforts are made to ensure the accuracy of the data (obtained from appropriate agencies). A lack of exceedance information does not necessarily suggest conformance to the criteria. It is ultimately the site professional's responsibility to determine appropriate compliance.



Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102 Fax (860) 645-0823



Analysis Comments

November 03, 2025

SDG I.D.: GCU60026

The following analysis comments are made regarding exceptions to criteria not already noted in the Analysis Report or QA/QC Report: None.

14.1000
15

10/23/25

Chain of Custody



ENDYNE INC

Phoenix Environmental Laboratc
 567 East Middle Turnpike
 Manchester CT
 06040
 860-645-8726
 Customer: Eileen Toomey
 Endyne, Inc.
 160 James Brown Drive
 Williston VT 05495
 Etoomey@endynelabs.com
 802-879-4333

State of Sample origin: VERMONT

The analysis requested requires the Testing Lab have and maintain TNI/NELAC accreditation. If you do not currently maintain TNI/NELAC accreditation for the parameter/matrix requested in the above referenced State, please Contact Endyne immediately at (802) 879-4333.

Thank you.

Turn Around Time: _____

Special Instructions:

SS-TOC-W	GENERAL	TOC in Soil			2510-37426-W		
Sample		Btl #	Btl Typ	Btl Desc	Pres.	Matrix	Sampled
60026 2510-37426-001	Jackson 1	007	STC	125ml Amber Glass	<6C	SOIL	10/22/25 16:30
60027 2510-37426-002	Jackson 2	007	STC	125ml Amber Glass	<6C	SOIL	10/22/25 16:50

Relinquished by: (Sign, Date, Time) Tyler Roque

Relinquished by: (Sign, Date, Time) LPS

Relinquished by: (Sign, Date, Time) _____

Received by: (Sign, Date, Time) _____

Received by: (Sign, Date, Time) Maura J. Fokern 10/28/25
lla

Received by: (Sign, Date, Time) _____

Do Not use this form for WSID Samples or Residential Drinking Water Samples



160 James Brown Dr. Williston, VT 05495
Ph 802-979-4333

Chain-of-Custody-Record

*Required Fields

PO# _____ *EMAIL: jlajois@slrconsulting.com

*Project Name: JACKSON DAM

*State of Origin: VT NY NH Other

*Company Name: SLR

*Phone #: 802 882 8335

*Mailing Address: 1 South Main St Waterbury VT

*Sampler Name: JESSICA Lajois

*Phone #: 802 882 8335

*Billing Address: " "

*Sample Location	Please Print Clearly	*Matrix	GRAB	COMP	*Date/Time Sampled	Container Volume, Ex. 16oz, 1/2 gal.	Sample Preservation	*Analysis Required: Enter Number from Choices Below	Field Results/Remarks
JACKSON 1		S	X		10/26/05 4:30		ICE	See Below	TESTS APPROVED: TOTAL PHOSPHORUS TOTAL SULFUR RUBB & METALS ANALYSE
JACKSON 2		S	X		10/26/05 4:50		ICE	" "	TOTAL SULFUR RUBB & METALS ANALYSE CHECK WATER SW TESTS RUBB, SOIL

2510-37426

2510-37426

SLR International Corporation
Jackson Dam

*Relinquished By: <u>Michael Randos</u>		Date/Time	Received By:	Date/Time	Received By:	Date/Time
1. pH	6.7	(11) Total Solids		21. F.O.G		34. PP13 Metals
2. Chloride	1.1	12. TSS		22. 8015 GRO		32. Total RCRA 8 Metals
3. Ammonia N	0.0	13. TDS		23. 8015 DRO		RCRA 8 Metals
4. Nitrate N	0.0	14. Turbidity		24. Full 8260 NH60-W		33. Corrosivity
5. Nitrite N	0.0	15. Conductivity		25. Full 8270 827-W		34. Ignitability
6. TN	0.0	16. Sulfate		26. 8270 B/N only 827B-W		35. Reactivity
7. TP	0.0	17. E. coli		27. 8270 Acid only 827A-W		
8. TDP	0.0	18. COD		28. 8270 PAH Only 827P		
9. BOD	0.0	19. VOC 8021B		29. 9081 Pest		
10. Alkalinity	0.0	20. 8260		30. 8082 PCB		
11. Halocarbons		21. 8260				

36. Metals Total or Diss. Ag Al As B Ba Be Ca Cd Co Cr Cu Fe Hg K Mg Mn Mo Na Ni Pb Sb Se Sn TI U V Zn (circle)

37. TCLP (circle) Metals, Volatiles, Semi-volatiles, Pesticides, Herbicides

38. PFAS (circle) Drinking Water Non-potable

39. Other: TAC in Solid

Standard Sediment Analyses for Vermont

Projects (adjust if due diligence suggests additional pollutant risks)

VT Human Exposure Thresholds (upland/floodplain)

"Background" Value

Parameters	Units	VT Human Exposure Thresholds (upland/floodplain)				"Background" Value		
		Resident	Non-Resident	Urban Background	Non-Urban Background	Sample 1 S1	Sample 2 S2	
Metals, Total								
Total Organic Carbon	mg/kg (ppm)	N/A	N/A	N/A	N/A	N/A	27500	#N/A
Phosphorous	mg/kg (ppm)	N/A	N/A	N/A	N/A	N/A	520	570
Arsenic	mg/kg (ppm)	N/A	N/A	16	16	1.1	2.2	2
Barium	mg/kg (ppm)	11,247	127,382	N/A	N/A	0.7	39	31
Cadmium	mg/kg (ppm)	6.90	87	N/A	N/A	0.1 - 0.3	< 0.13	< 0.12
Chromium	mg/kg (ppm)	N/A	N	N/A	N/A	7 - 13	24	21
Chromium III	mg/kg (ppm)	40,223	360,223	N/A	N/A	N/A	#N/A	#N/A
Chromium VI (Hexavalent)	mg/kg (ppm)	0.09	1.7	N/A	N/A	N/A	#N/A	#N/A
Lead	mg/kg (ppm)	N/A	N/A	111	41	4 - 17	8.6	12
Mercury	mg/kg (ppm)	3.1	3.1	N/A	N/A	0.004 - 0.051	< 0.025	0.041
Selenium	mg/kg (ppm)	366	4,900	N/A	N/A	0.29	< 1.3	< 1.2
Silver	mg/kg (ppm)	237	2,483	N/A	N/A	< 0.5	< 0.63	< 0.60
Copper, Total	mg/kg (ppm)	10,407	139,231	N/A	N/A	10 - 25	#N/A	#N/A
Nickel, Total	mg/kg (ppm)	940	9,707	N/A	N/A	9.9	#N/A	#N/A
Zinc, Total	mg/kg (ppm)	21,986	294,150	N/A	N/A	7 - 38	#N/A	#N/A

Key
Exceeds Non-Resident Threshold
Exceeds Urban Background Threshold
Exceeds Resident or Non-Urban Background Threshold
Below All Thresholds
Detection Limit is Less Than Threshold
Below Detection Limit and/or No Threshold Available

PAHs

2-Methylnaphthalene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	< 29.3
Acenaphthylene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	< 29.3
Fluorene	ug/kg (ppb)	2,301,000	26,371,000	N/A	N/A	N/A	< 31.7	< 29.3
Anthracene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	< 29.3
Pyrene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	76.2
Chrysene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	46.9
Benzo[k]fluoranthene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	< 29.3
Indeno[1,2,3-cd]pyrene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	< 29.3
Benzo[g,h,i]perylene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	< 29.3
Naphthalene	ug/kg (ppb)	1,200	7,200	N/A	N/A	N/A	< 31.7	< 29.3
1-Methylnaphthalene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	< 29.3
Acenaphthene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	< 29.3
Phenanthrene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	40.5
Fluoranthene	ug/kg (ppb)	2,301,000	26,371,000	N/A	N/A	N/A	< 31.7	79.8
Benzo[a]anthracene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	49.8
Benzo[b]fluoranthene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 31.7	49.3
Benzo[a]pyrene	ug/kg (ppb)	70	1,540	580	N/A	N/A	< 15.9	38.7
Dibenz[a,h]anthracene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 15.9	< 14.7
BaP Toxic Equiv. Quotient (Lab Calculated)	ug/kg (ppb)	70	1,540	580	N/A	N/A	< 20.8	57.6
BaP Toxic Equiv. Quotient (SLR Calculated)	ug/kg (ppb)	70	1,540	580	N/A	N/A	20.8	57.6

Pesticides

gamma-BHC (Lindane)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
delta-BHC	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Aldrin	ug/kg (ppb)	20	100	N/A	N/A	N/A	< 10.4	< 9.8
4,4'-DDE	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Dieldrin	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
4,4'-DDD	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
4,4'-DDT	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Endosulfan Sulfate	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Chlordane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 52.0	< 49.1
alpha-BHC	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
beta-BHC	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Heptachlor	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Heptachlor epoxide	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Endosulfan I	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Endrin	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Endosulfan II	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Endrin Aldehyde	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Methoxychlor	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 10.4	< 9.8
Toxaphene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 52.0	< 49.1

PCB

Aroclor 1221 (PCB-1221)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 20.8	< 19.7
Aroclor 1242 (PCB-1242)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 20.8	< 19.7
Aroclor 1254 (PCB-1254)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 20.8	< 19.7
Aroclor 1016 (PCB-1016)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 20.8	< 19.7
Aroclor 1232 (PCB-1232)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 20.8	< 19.7
Aroclor 1248 (PCB-1248)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 20.8	< 19.7
Aroclor 1260 (PCB-1260)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 20.8	< 19.7
Sum of PCBs	ug/kg (ppb)	110	680	N/A	N/A	N/A	< 20.8	< 19.7

Volatile Organic Compounds (VOCs)

Chloroethane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 1,080	< 550
Bromomethane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 1,080	< 550
Trichlorofluoromethane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 1,080	< 550
1,1-Dichloroethene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110

Standard Sediment Analyses for Vermont

Projects (adjust if due diligence suggests additional pollutant risks)

VT Human Exposure Thresholds (upland/floodplain)

"Background" Value

Parameters	Units	VT Human Exposure Thresholds (upland/floodplain)				"Background" Value		
		Resident	Non-Resident	Urban Background	Non-Urban Background	Sample 1 S1	Sample 2 S2	
Carbon Disulfide	ug/kg (ppb)	608,000	661,000	N/A	N/A	N/A	< 1,080	< 550
t-Butanol	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 5,400	< 2,750
trans-1,2-Dichloroethene	ug/kg (ppb)	108,000	296,000	N/A	N/A	N/A	< 216	< 110
1,1-Dichloroethane	ug/kg (ppb)	2,100	13,000	N/A	N/A	N/A	< 216	< 110
2-Butanone	ug/kg (ppb)	16,952,000	26,991,000	N/A	N/A	N/A	< 2,160	< 1,100
cis-1,2-Dichloroethene	ug/kg (ppb)	77,000	352,000	N/A	N/A	N/A	< 216	< 110
Chloroform	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
1,1,1-Trichloroethane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
1,1-Dichloropropene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
t-Amyl methyl ether (TAME)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
Trichloroethene	ug/kg (ppb)	2,400	14,000	N/A	N/A	N/A	< 216	< 110
Dibromomethane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
cis-1,3-Dichloropropene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
Toluene	ug/kg (ppb)	705,000	798,000	N/A	N/A	N/A	< 216	< 110
1,1,2-Trichloroethane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
1,3-Dichloropropane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
Dibromochloromethane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
Chlorobenzene	ug/kg (ppb)	267,000	676,000	N/A	N/A	N/A	< 216	< 110
1,1,1,2-Tetrachloroethane	ug/kg (ppb)	1,300	7,910	N/A	N/A	N/A	< 432	< 220
Styrene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
Isopropylbenzene	ug/kg (ppb)	256,000	264,000	N/A	N/A	N/A	< 216	< 110
Bromobenzene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
1,2,3-Trichloropropane	ug/kg (ppb)	3	70	N/A	N/A	N/A	< 432	< 220
t-Butylbenzene	ug/kg (ppb)	7,009,000	90,685,000	N/A	N/A	N/A	< 432	< 220
s-Butylbenzene	ug/kg (ppb)	7,009,000	90,685,000	N/A	N/A	N/A	< 432	< 220
1,3-Dichlorobenzene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
1,2-Dichlorobenzene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
1,2,4-Trichlorobenzene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
Hexachlorobutadiene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
1,2,3-Trichlorobenzene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
Dichlorodifluoromethane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 1,080	< 550
Vinyl chloride	ug/kg (ppb)	100	590	N/A	N/A	N/A	< 432	< 220
Chloroethane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 1,080	< 550
Diethyl ether	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 1,080	< 550
Acetone	ug/kg (ppb)	63,079,000	816,169,000	N/A	N/A	N/A	4490	< 1,100
Methylene chloride	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 1,080	< 550
Methyl-t-butyl ether (MTBE)	ug/kg (ppb)	27,000	165,000	N/A	N/A	N/A	< 432	< 220
Di-isopropyl ether (DIPE)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
Ethyl-t-butyl ether (ETBE)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
2,2-Dichloropropane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
Bromochloromethane	ug/kg (ppb)	193,000	597,000	N/A	N/A	N/A	< 432	< 220
Tetrahydrofuran	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 2,160	< 1,100
Carbon tetrachloride	ug/kg (ppb)	370	2,200	N/A	N/A	N/A	< 216	< 110
Benzene	ug/kg (ppb)	700	4,200	N/A	N/A	N/A	< 216	< 110
1,2-Dichloroethane	ug/kg (ppb)	290	1,700	N/A	N/A	N/A	< 216	< 110
1,2-Dichloropropane	ug/kg (ppb)	1,500	9,100	N/A	N/A	N/A	< 432	< 220
Bromodichloromethane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
4-Methyl-2-pentanone (MIBK)	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 2,160	< 1,100
trans-1,3-Dichloropropene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 216	< 110
Tetrachloroethene	ug/kg (ppb)	2,400	14,000	N/A	N/A	N/A	< 216	< 110
2-Hexanone	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 2,160	< 1,100
1,2-Dibromoethane	ug/kg (ppb)	20	140	N/A	N/A	N/A	< 432	< 220
Ethylbenzene	ug/kg (ppb)	3,700	22,000	N/A	N/A	N/A	< 216	< 110
Xylenes, Total	ug/kg (ppb)	252,000	257,000	N/A	N/A	N/A	< 432	< 220
Bromoform	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
1,1,2,2-Tetrachloroethane	ug/kg (ppb)	1,300	7,910	N/A	N/A	N/A	< 432	< 220
n-Propylbenzene	ug/kg (ppb)	253,000	261,000	N/A	N/A	N/A	< 432	< 220
2-Chlorotoluene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
4-Chlorotoluene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
4-Isopropyltoluene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
1,4-Dichlorobenzene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
n-Butylbenzene	ug/kg (ppb)	3,504,000	45,343,000	N/A	N/A	N/A	< 432	< 220
1,2-Dibromo-3-Chloropropane	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
1,3,5-Trichlorobenzene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
Naphthalene	ug/kg (ppb)	1,200	7,200	N/A	N/A	N/A	< 432	< 220
1,3,5-Trimethylbenzene	ug/kg (ppb)	144,000	177,000	N/A	N/A	N/A	< 432	< 220
1,2,3-Trimethylbenzene	ug/kg (ppb)	N/A	N/A	N/A	N/A	N/A	< 432	< 220
1,2,4-Trimethylbenzene	ug/kg (ppb)	144,000	177,000	N/A	N/A	N/A	< 432	< 220
Sum of Trimethylbenzenes	ug/kg (ppb)	144,000	177,000	N/A	N/A	N/A	< 432	< 220

Key
Exceeds Non-Resident Threshold
Exceeds Urban Background Threshold
Exceeds Resident or Non-Urban Background Threshold
Below All Thresholds
Detection Limit is Less Than Threshold
Below Detection Limit and/or No Threshold Available

Appendix E

FEMA Flood Insurance Rate Map



ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION IN FT. (NGVD) ¹	DESCRIPTION OF LOCATION
RM 4	794.30	Chiseled square on northeast bridge abutment of Tom Road 41 over the Lamoille River approximately 300 feet south of State Route 15W.
RM 5	792.02	Chiseled square on granite block on southwest end of McAllister Farm Road bridge abutment over the Lamoille River approximately 60 feet south of State Route 15W.
RM 6	797.31	Chiseled square on west end of Lake Hardwick Dam approximately 150 feet southeast of intersection of Craftsbury Road and State Route 15W.
RM 7	811.70	USCGAS disk on northeast end of Lamoille Valley Railroad bridge over the Lamoille River.
RM 8	811.38	Chiseled square on southeast concrete rail of Wolcott Street over Cooper Brook.
RM 9	831.29	Chiseled square on southeast corner footbridge over the Lamoille River.
RM 10	866.88	USCGAS disk in concrete post approximately 275 feet southeast of railroad station in Village of Hardwick approximately 60 feet west of Maple Street.

¹National Geodetic Vertical Datum of 1929

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATE BY 100-YEAR FLOOD

- ZONE A** No base flood elevations determined.
- ZONE AE** Base flood elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE A99** To be protected from 100-year flood by Federal flood protection system under construction; no base flood elevations determined.
- ZONE V** Coastal flood with velocity hazard (wave action); no base flood elevations determined.
- ZONE VE** Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

- ZONE X** Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage area less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

- ZONE X** Areas determined to be outside 500-year floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.

UNDEVELOPED COASTAL BARRIERS*

- Identified 1983
- Identified 1990 or Later
- Otherwise Protected Area Identified 1991 or Later

*Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

BOUNDARIES

- Floodplain Boundary
- Floodway Boundary
- Zone D Boundary
- Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

BASE FLOOD ELEVATION LINE BEATION IN FEET**

CROSS SECTION LINE

TRANSVERSE LINE

(EL. 987)
RM7 x
Elevation Reference Mark

● M1.5
River Mile

**Referenced to the National Geodetic Vertical Datum of 1929

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local change sources of small size, or all planimetric features outside Special Flood Hazard Areas. The community map repository should be consulted for possible updated flood hazard information prior to use of this map for property purchase or construction purposes.

Coastal base flood elevations apply only to landward of 0.7 National Geodetic Vertical Datum of 1929 (NGVD), and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Areas of special flood hazard (100-year flood) include Zones A, AE, AH, AO, A99, V, and VE.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency. Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

For adjoining map panels see separately printed Map Index.

NOTE: The coordinate system used for the production of this Flood Insurance Rate Map (FIRM) is Universal Transverse Mercator (UTM), North American Datum of 1983 (NAD83), UTM Zone 18N. Differences in the datum and spherical used in the production of FIRMs for adjacent communities may result in slight positional differences in map features at the community boundaries. These differences do not affect the accuracy of the information shown on the FIRM.

ATTENTION: Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structures and ground elevations referenced to the same datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, contact the National Geodetic Survey at the following address:
Vertical Network Branch, 14223
National Geodetic Survey, NGA
Silver Spring, Maryland Center 3
305 East-West Highway
Silver Spring, Maryland 20910
(301) 732-3200

BASE MAP SOURCE: Planimetric base map files were provided in digital format by the Town of Hardwick Office of the Zoning Administrator. These files were compiled at scales of 1:5,000 and 1:20,000. Additional information was also provided in digital format by the Vermont Center for Geographic Information. These files were compiled at scales of 1:5,000 and 1:24,000. Information may have been derived from other sources. Users of the FIRM should be aware that minor adjustments may have been made to specific base map features.

MAP REPOSITORY

Hardwick Town Hall, 20 Church Street, Hardwick, Vermont 05843 (Maps available for reference only, not for distribution.)

INITIAL IDENTIFICATION:
JUNE 28, 1974

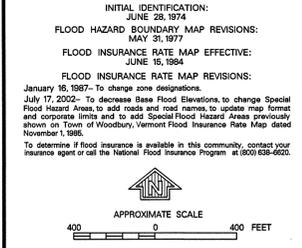
FLOOD HAZARD BOUNDARY MAP REVISIONS:
MAY 31, 1977

FLOOD INSURANCE RATE MAP EFFECTIVE:
JUNE 15, 1984

FLOOD INSURANCE RATE MAP REVISIONS:
January 16, 1987 - To change zone designations.
July 17, 2002 - To decrease Base Flood Elevations to change Special Flood Hazard Areas to add roads and road names, to update map format and corporate limits and to add Special Flood Hazard Areas previously shown on Town of Woodbury Vermont Flood Insurance Rate Map, dated November 1, 1986.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE



NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
TOWN AND VILLAGE OF
HARDWICK,
VERMONT
CALEDONIA COUNTY

PANEL 12 OF 21
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY - PANEL NUMBER
500027 0012 D

MAP REVISED:
JULY 17, 2002



Appendix F

Lamoille River Hydraulic Modeling – Jackson Dam Excerpt





Lamoille River Hydraulic Modeling

Lamoille River Basin

Lamoille County Planning Commission

54 Portland Street, 2nd Floor, Morrisville, VT 05661

Prepared by:

SLR International Corporation

1 South Main Street, Waterbury, Vermont, 05676

SLR Project No.: 146.12911.00016

December 17, 2025

EXCERPT ONLY

SEE FULL REPORT FOR ADDITIONAL
DETAILS ON THE STUDY

1.0 Introduction

1.1 Purpose

The Lamoille River watershed has experienced periodic flood damage on both the Lamoille River mainstem and tributaries. The flooding in 2023 and 2024, which caused erosion and inundation damage throughout the basin, emphasized the need for flood mitigation activities and changes to historic land use patterns. This project extends the existing hydraulic model of the Lamoille River to create a watershed-scale understanding of existing flood patterns and how they could be changed to reduce impacts of future floods. This model aims to provide communities, towns, and Regional Planning Commissions (RPCs) with the information to understand current flood dynamics and prioritize the most impactful mitigation strategies.



Figure 1: Lamoille River in Hardwick, Vermont

1.2 Project Location

This hydraulic modeling project studies the mainstem of the Lamoille River and seven tributaries within the Lamoille River watershed (Figure 2). The existing model included the Lamoille mainstem through Cambridge Village, Jeffersonville, Johnson, and Wolcott and the tributaries of the Brewster and Wild Branch Rivers. The model was expanded to include the Lamoille mainstem through Hardwick, Fairfax, and Georgia and tributaries including Cooper Brook, Gihon River, Seymour River, Mill Brook, and Stones Brook. Through this project, certain areas within the existing model were refined with the most accurate data available.



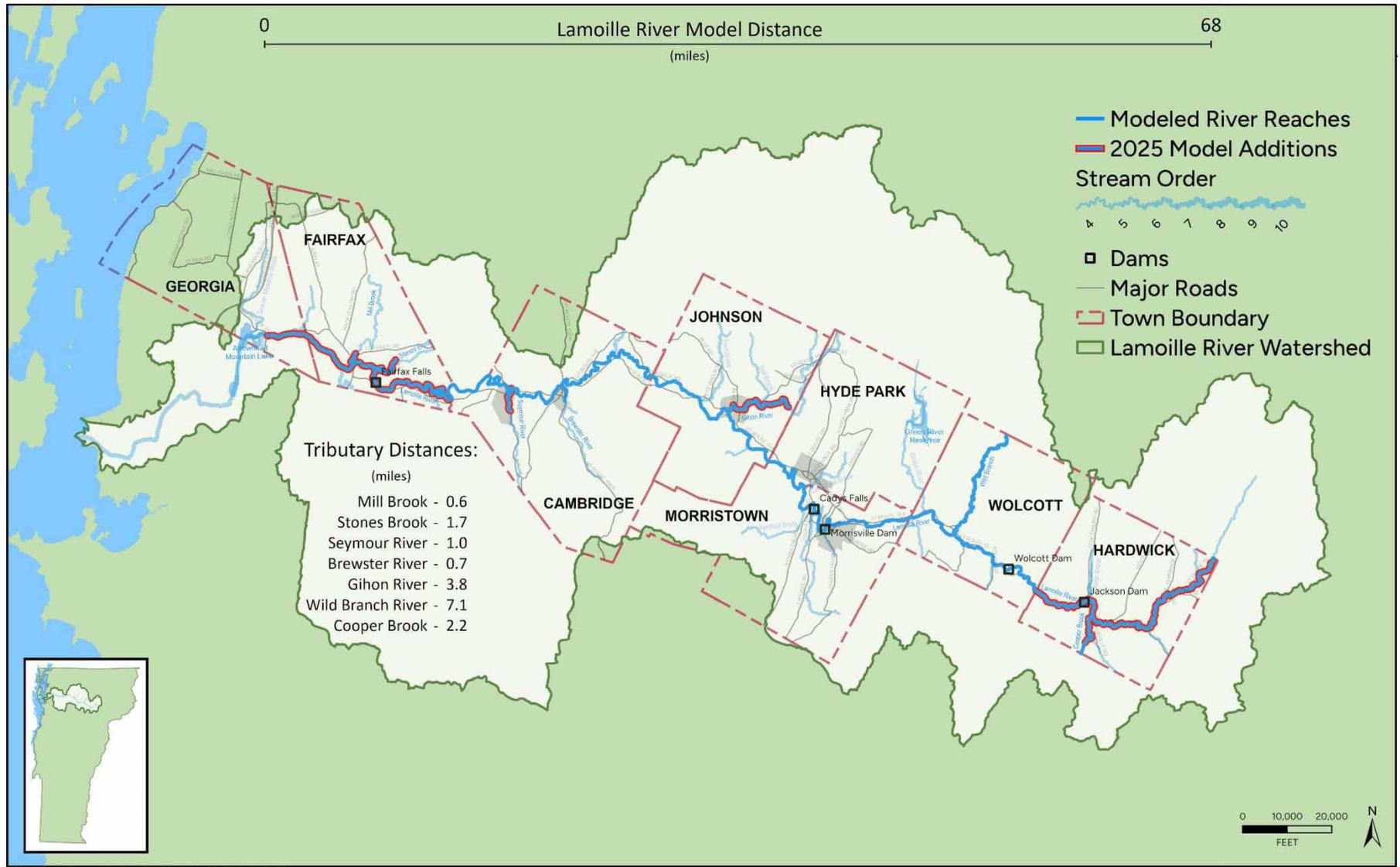


Figure 2: Map of Lamoille Watershed Model extent



1.3 Scope of Work

The scope of work for this study includes the follow tasks.

- Data Collection
 - Coordination and communication with project partners including periodic meetings
 - Data collection and review, including past studies, flood damage, modeling data, LiDAR and other topography, bridge plans
 - Creation of a GIS basemap with existing and collected data
 - Field visits to review flood patterns
 - Measurement of data for input to the hydraulic model including survey and channel and structure measurements
- Existing Conditions Hydraulic Modeling
 - Updates to the existing hydraulic model including extension into new areas upstream, downstream, and select tributaries
 - Validation/calibration based on past flooding
 - Inundation and depth maps
- Flood Mitigation Alternatives Analysis
 - Prepare a draft list of alternatives with input from the project team, field observations, and review of existing conditions modeling
 - Meetings with the project team to review existing conditions and list of alternatives
 - Field visits to selected alternatives analysis locations
 - Data collection at alternatives locations to possibly include survey, measurements, or existing data
 - Test alternatives in the hydraulic model
 - Summarize model results with maps, tables, or profile views
- Reporting and Presentations
 - Project report summarizing results
 - Presentations at multiple public and targeted stakeholder groups by community



2.0 Lamoille Watershed

2.1 Lamoille River Mainstem

The Lamoille River is approximately 82 miles long and flows west across northern Vermont from Greensboro to Lake Champlain. Its watershed is approximately 721 square miles, spanning 7.5% of the state of Vermont. This project studied approximately 68 miles of the Lamoille River from Hardwick to Arrowhead Mountain Lake (Figure 3). There are 44 bridges and 5 dams modeled along the mainstem of the Lamoille. The headwaters of the Lamoille River are characterized by its upper valley setting with steeper slope and riffle pool channel. As the river flows downstream, its slope decreases, and the channel becomes more sinuous surrounded by broad floodplains.

The Lamoille River supports a variety of uses including watersports, fishing, irrigation, and recreation along its banks on the Lamoille Valley Rail Trail. The dams along the mainstem are used primarily for hydropower. Additionally, the river supports a diverse abundance of aquatic and terrestrial wildlife providing habitat and clean water.

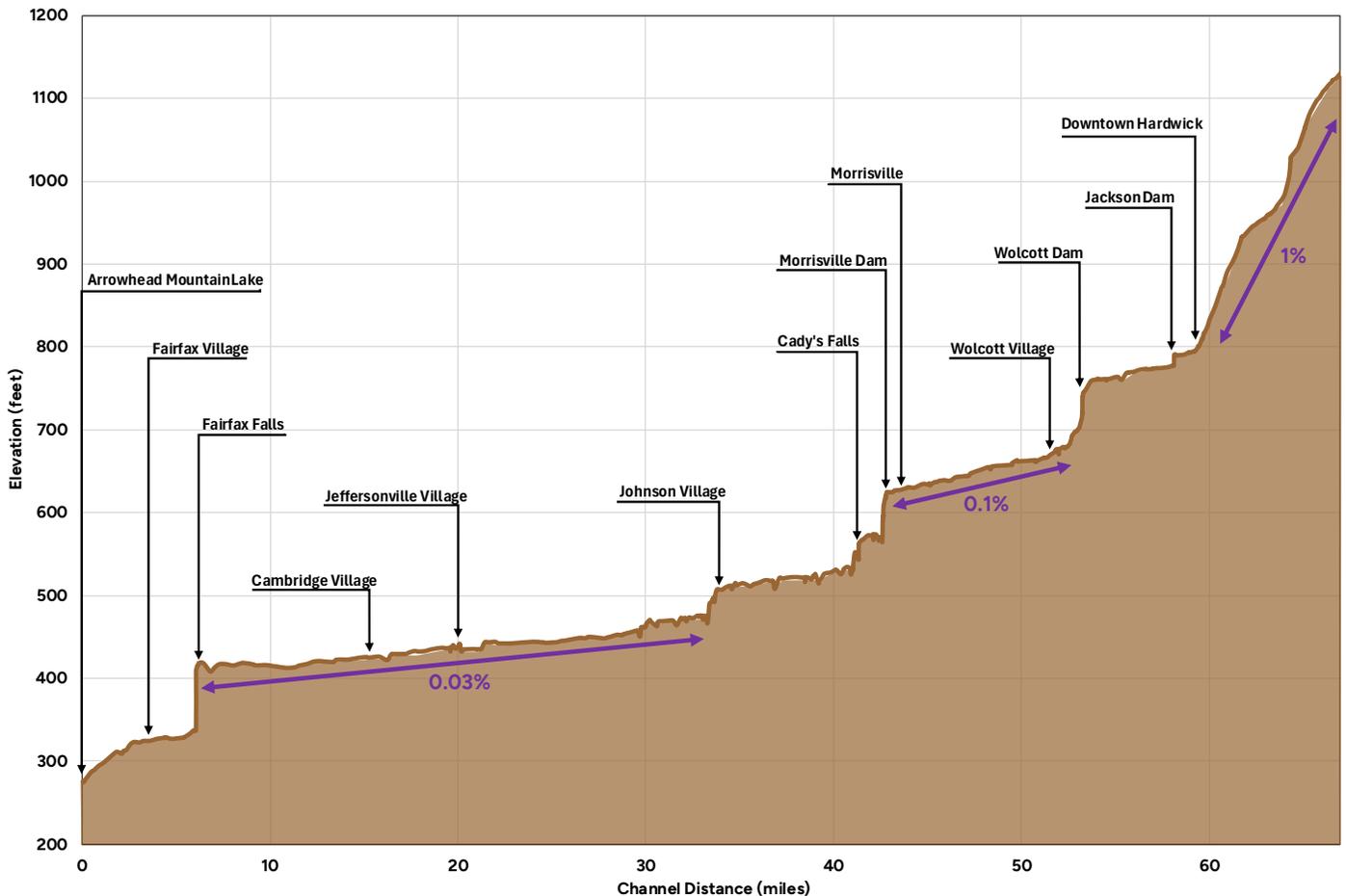


Figure 3: Long profile of the Lamoille River from Hardwick to Arrowhead Mountain Lake in Georgia



3.0 Hydrology

3.1 Introduction

The hydraulic model requires input of peak flood flow estimates to evaluate flood characteristics. A 2025 hydrology study completed for FEMA updated peak flood flow estimates for the Lamoille River and select tributaries (Compass, 2025). Flows were calculated for the 2-, 10-, 25-, 50-, 100-, and 500-year flood events. The locations of all hydraulic model flow input and flow changes is shown below (Figure 11).

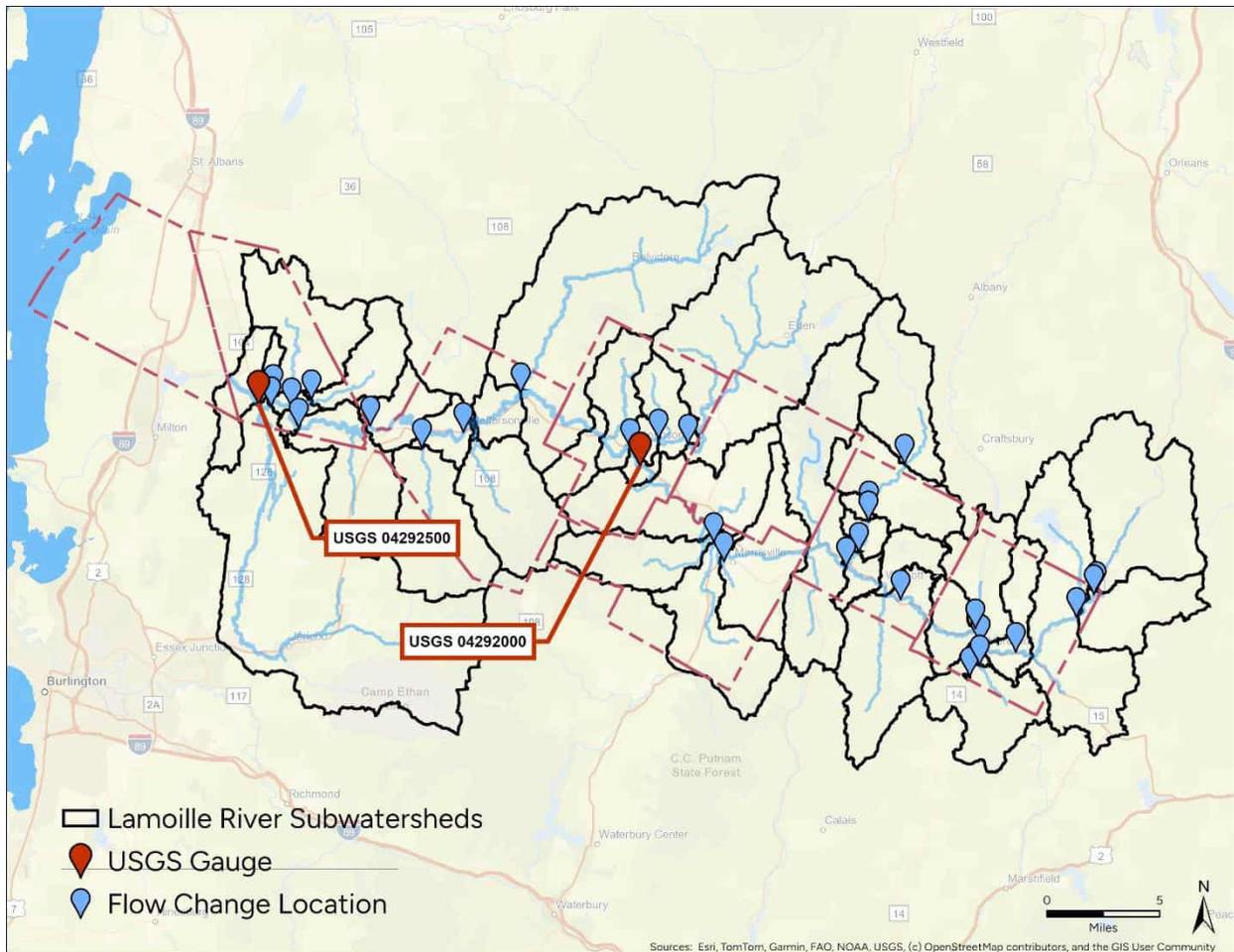


Figure 11: Flow in locations in the Lamoille model and their sub-watersheds

For model flow input locations where calculation points existed, the updated FEMA flows were inserted into the model. For locations where a calculation point did not exist, relationships between the revised FEMA flows and drainage area were developed for the mainstem Lamoille River and tributaries to estimate peak flood flows in the model (Appendix A).

3.2 Review of Peak Flood Flows

The updated FEMA peak flood flows were compared to the peak flows at the two long-term USGS gages on the Lamoille River in Johnson and East Georgia. A gage analysis (USGS,



1982) was completed for both gages and found that the updated FEMA flood flows agree with the gage data. Measured peak flows for the July 2023 flood were compared to the estimated FEMA peak flood flows (Figure 12). The observed July 2023 flood falls between the FEMA-estimated 100- and 500-year flood at each gage.

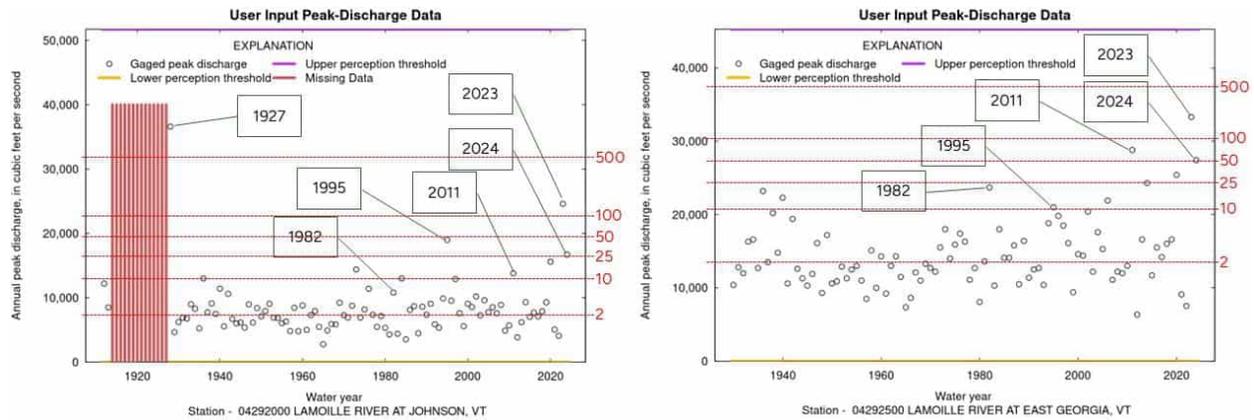


Figure 12: Peak annual flow data with flood flow estimates at the Lamoille River USGS gages in Johnson (left) and East Georgia (right)

The updated FEMA flood flows have changed the flow magnitudes evaluated in the hydraulic model. Peak flood flow estimates increased 20% in Johnson with the 100-year flow increasing from 18,900 cfs to 22,786 cfs (Table 1). Flood flows estimates unexpectedly decrease in the East Georgia (Table 2). The gage analysis found that peak flood flow estimates have increased at both gages since the 1980 FEMA study.

Table 1: FEMA Flood Flow Comparison in Johnson

Recurrence Interval (years)	Updated 2025 FEMA Flows (cfs)	1980 FEMA FIS Flows (cfs)
10	10,890	10,800
25	15,430	n/a
50	19,546	16,050
100	22,786	18,900
500	30,717	27,200



Table 2: FEMA Flood Flow Comparison in East Georgia

Recurrence Interval (years)	Updated 2025 FEMA Flows (cfs)	1980 FEMA FIS Flows (cfs)
10	14,956	19,100
25	20,553	n/a
50	26,168	28,300
100	31,286	33,310
500	41,448	48,330

3.3 Uncertainty in Estimating Peak Flows

Estimating peak flood flows comes with uncertainty. Only two USGS gages exist in the Lamoille River Basin with long-term flow data. Flood flows in all other areas of the watershed are calculated with hydrologic modeling that relies on variables including precipitation estimates, land cover data, soil characteristics, and storage area estimates.

In locations with long-term USGS gages peak flood flows are calculated with more certainty; however, periods of record are typically 100 years or less. The gages on the Lamoille River show that most of the largest recorded floods have occurred since 1980 (Figure 13). Comparing the estimated peak flood flows using data from pre-1980 to peak flood flows using the whole period of record reveals that estimated peak flood flows have increased. The measured 100-year flood at the Johnson gage has increased 10% in 45 years from 20,630 cfs to 22,786 cfs. In East Georgia the 100-year flow has increased 29% in 45 years from 24,280 cfs to 31,286 cfs.

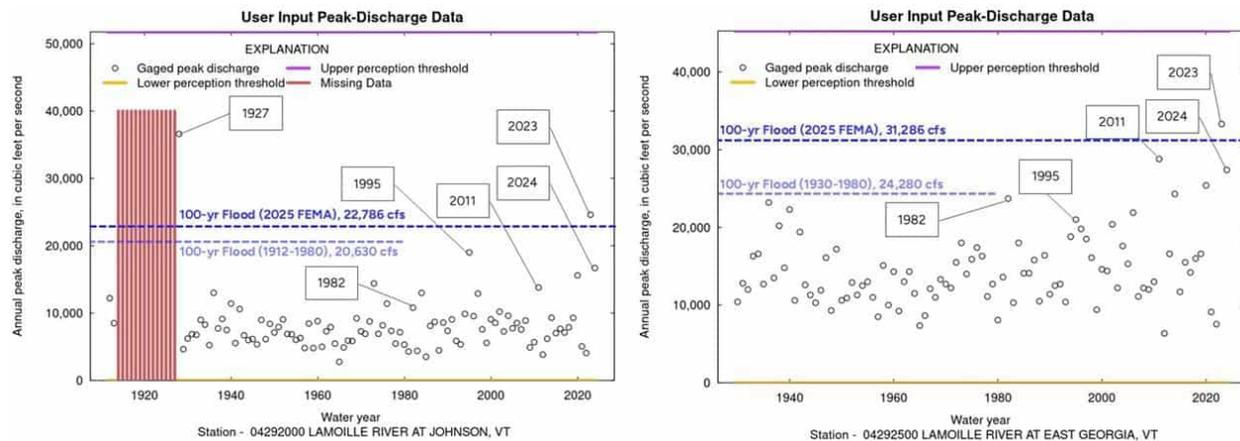


Figure 13: Peak annual flow data with historic and present 100-year flood flow estimates at the Lamoille River USGS gages in Johnson (left) and East Georgia (right)

This modeling effort uses the most up to date flood flow estimates that considers the large floods measured in the Lamoille River Basin in the past 15 years.



4.0 Hydraulic Analysis

4.1 Introduction

A one-dimensional (1D) steady flow hydraulic model was developed to evaluate the Lamoille River and seven tributaries using the United States Army Corps of Engineers Hydrologic Engineering Center River Analysis System (HEC-RAS) software (USACE, 2024). Water surface elevations, flow depths, and velocities are computed at each cross section. Model results including water surface elevations, flow velocities, and shear stress are predicted at each cross section and are used to evaluate existing conditions within the study area and to test flood mitigation alternatives.

4.2 Existing Conditions Model

4.2.1 Model Setup

This project built upon an existing hydraulic model of the Lamoille River and incorporated data from numerous sources.

The previous model which covered a smaller region, included terrain data derived from Vermont 2018 Light Detection and Ranging (LiDAR) data, HEC-2 microfiche scans, and field survey. Through this project, the model was extended, and certain areas were refined and updated to more accurately represent current conditions. The model extension and alternative refinement areas were created with the following data inputs.

The model terrain used Vermont 2023 QL1 LiDAR (0.35m) (VCGI) to establish the cross section geometry along the banks and the floodplains of the rivers. As LiDAR does not penetrate water, additional information was required to determine the geometry of the channel below water level. Channel geometries were estimated using FEMA profiles to establish the thalweg elevation. Some sections were further refined using available survey either from a high accuracy GPS or professional survey from Grenier Engineering or Horizons Engineering. Channel geometry without FEMA data or survey were estimated using nearby FEMA or surveyed sections as reference.

There are seventy bridges and five dams in the Lamoille Model. Bridge and dam geometries were identified using existing plans, state inspection reports, and survey.

Buildings were modeled as obstructions and were created using the Vermont Base Land Cover 2021/2022.

Frictional energy losses are computed based on expansion or contraction coefficients at bridges and Manning's roughness coefficients (n) (Chow, 1959; Arcement and Schneider, 2006) (Table 3). Model n -values were initially designated using Vermont Base Land Cover 2021/2022. The n -values were updated with field observations, FEMA HEC-2 data, and FEMA FIS information when available.



Table 3: Manning's Roughness Coefficients

Land Cover	Roughness Coefficient (n)
Water	0.03 – 0.04
Tree Canopy	0.12
Grass/Shrubs	0.05
Buildings	10
Railroads	0.02
Roads	0.013
Other Impervious	0.013
Bare Soil	0.02

4.2.2 Model Validation

The hydraulic model was validated using documentation of recent flood events. The primary validation events were the July and December 2023 floods.

Certain areas of the model were validated using photos from flood events as well as conversations with residents documenting their past flood experiences. Meeting with communities to provide an overview of the results of the existing conditions model created a valuable opportunity to discuss results compared to observed conditions. Community members marked up maps of the initial modeled inundation extent. This outline of the experienced flood impacts would illustrate where the model was representing flood patterns and where more work was required to refine the model to better match flood conditions.

In addition, photos of flood events were shared and high water marks (HWM) were documented to compare with the existing conditions model results. For example, in Hardwick, we met with members of the Granite Street Historic District and walked through their community while they pointed out impacts from the flooding. We recorded pictures and measured HWMs (Figure 14). We compared the elevation of the measured HWM with the water surface elevation from the model (Figure 15). This documentation of past flood events provides effective information to understand model accuracy.





Figure 14: Lamoille River High Water Mark Measurement in the Granite Street Historic District in Hardwick



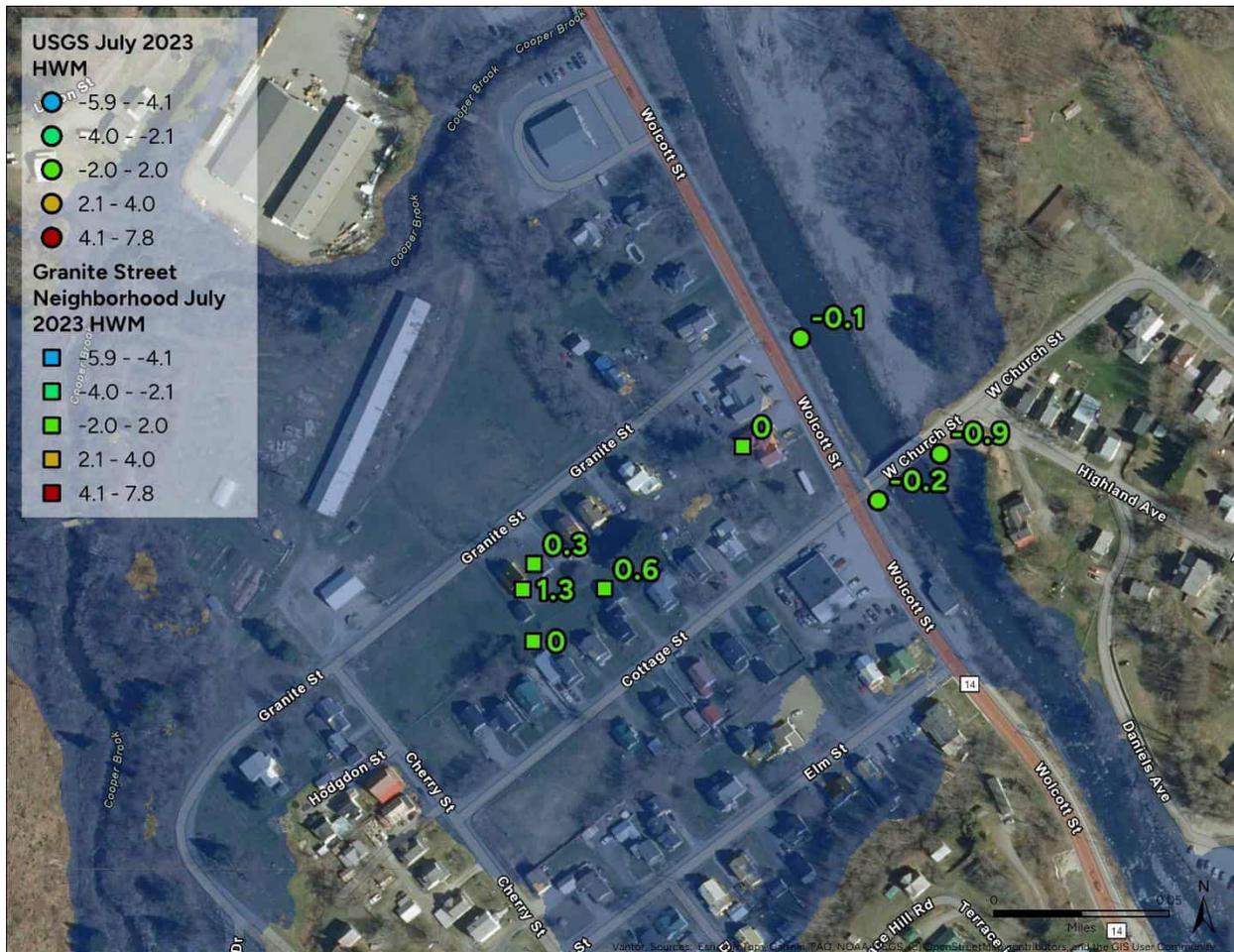


Figure 15: Comparison between Measured High Water Marks and Modeled Flood Levels in the Granite Street Historic District in Hardwick

We compared the model results with the USGS HWM for July 2023 (Figure 15, Figure 16). Using the peak flows recorded at the USGS gage in Johnson and East Georgia, we estimated the July 2023 flow to be approximately 7% greater than the 100-year flow. We scaled all flow inputs to the model by 7% to approximate the conditions of this flood. The model results for the water surface elevation were then compared to the HWM elevations throughout the Lamoille River watershed. A total of 91 HWM were used to validate the model results.

In addition, the model results were compared to USGS HWM for December 2023 (Figure 16). This flood had spatially variable impacts across the watershed as the gage in Johnson recorded a peak flow that was greater than the 25-year flow while the East Georgia gage recorded a peak flow greater than the 50-year flow. To approximate the conditions of the December 2023 flood, the flows inputs to the model were scaled based on the average flow variation between the gages and the 50-year flood which likely overestimated flow in the upstream watershed and underestimated flow in the downstream watershed. A total of 22 HWM were used to validate the water surface elevations in the Lamoille River model.



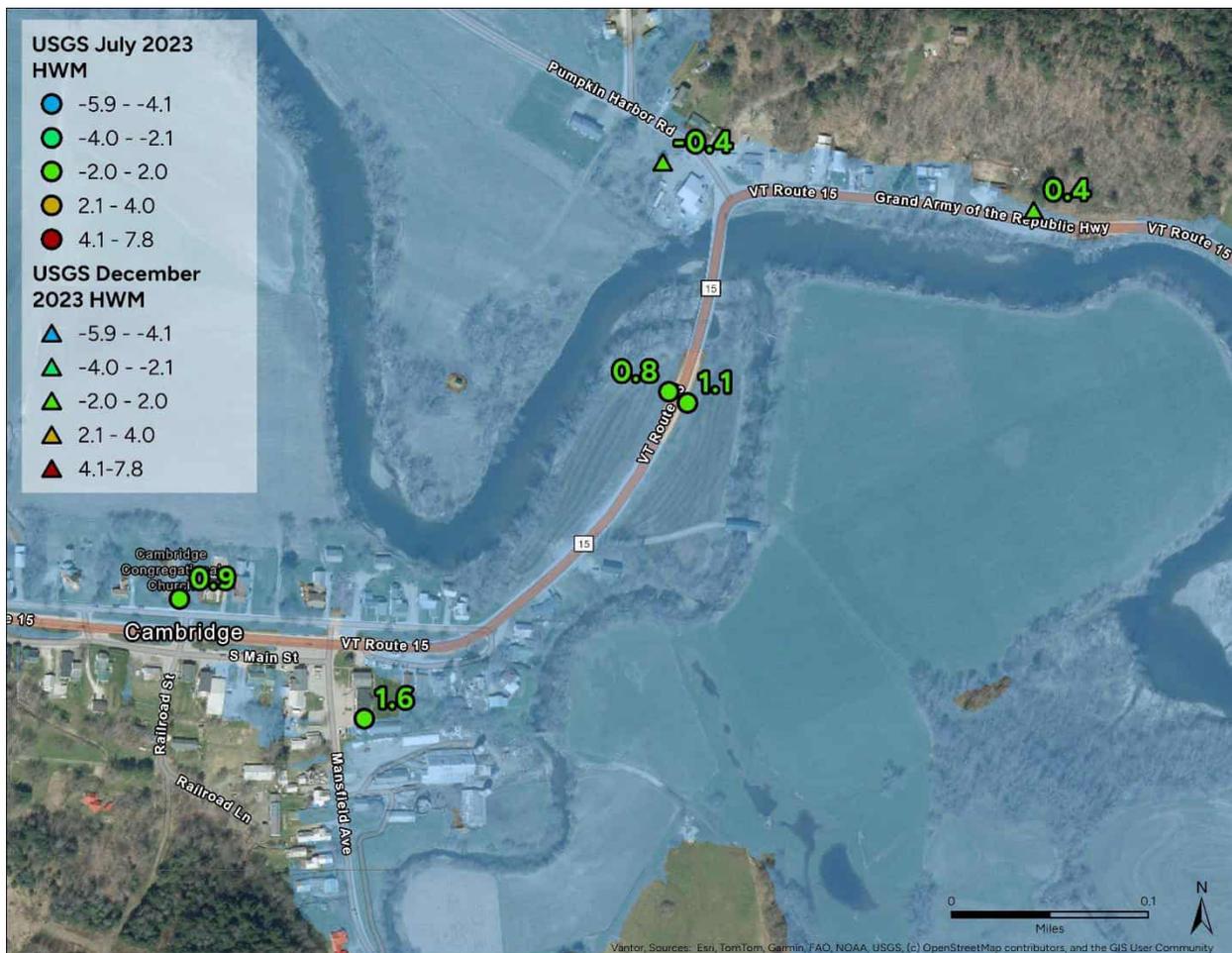


Figure 16: July and December 2023 USGS HWM in Cambridge

The model was calibrated in multiple locations by adjusting cross section locations and shape, n-values, and bridge geometry. The flood patterns that have been observed in recent large floods are well represented by the existing conditions results. **Modeled water surface elevations are generally within 1 foot of observations** and most larger differences can be explained with understanding of the conditions during flooding, such as debris blocking a structure.

The validation step indicates that the hydraulic model functions well for evaluation of flood mitigation alternatives. With the 1-foot accuracy, the comparison between existing and proposed conditions is expected to be a good representation of flood mitigation benefits.

4.3 Existing Conditions Model Results

Existing conditions depths, water surface elevations, and velocities were calculated at each model cross section along the project length. Results can be viewed in a table view within the model at each cross section. HEC-RAS interpolates results between cross sections and maps across the terrain to create polygons of inundation extent and raster images of hydraulic variables such as water depth, water surface elevation, and velocity.



Model results were reviewed to help inform possible mitigation projects. In profile, where water surface elevations had a quick rise or step, conditions were reviewed to understand what was causing the back up of water (i.e., backwatering) and if there was a constriction that could be removed to create less backwatering. The identification of these constrictions led to alternatives to increase flow through larger crossing structures, by removing fill, or by reconnecting floodplains. Where inundation occurs over neighborhoods or other critical infrastructure, possible mitigation projects were identified to decrease flood depths and shrink the width of the floodplain.

Existing conditions flood depth maps have been created by Town for the 10-year, 100-year, and 500-year floods (Appendix B). An existing conditions flood velocity map has been created for the estimated 100-year flood (Appendix C). Note that some unexpected results can be displayed in the plan view results mapping due to the interpolation process used for a 1D hydraulic model while displaying results in 2-dimensions.



5.0 Alternatives Analysis

5.1 Hardwick

Ten locations in Hardwick were selected as potential flood mitigation alternatives (Figure 17). Some of these locations were identified by the town and regional planning commission as areas with repeat damage from flooding while others were selected in a review of the existing condition model results. Most of these alternatives are floodplain restoration projects. In addition, we explored alternatives widening bridges, lowering an embankment, and removing a dam. A summary of each of the alternatives in Hardwick and an overview of the existing and proposed model results are discussed in the next sections.

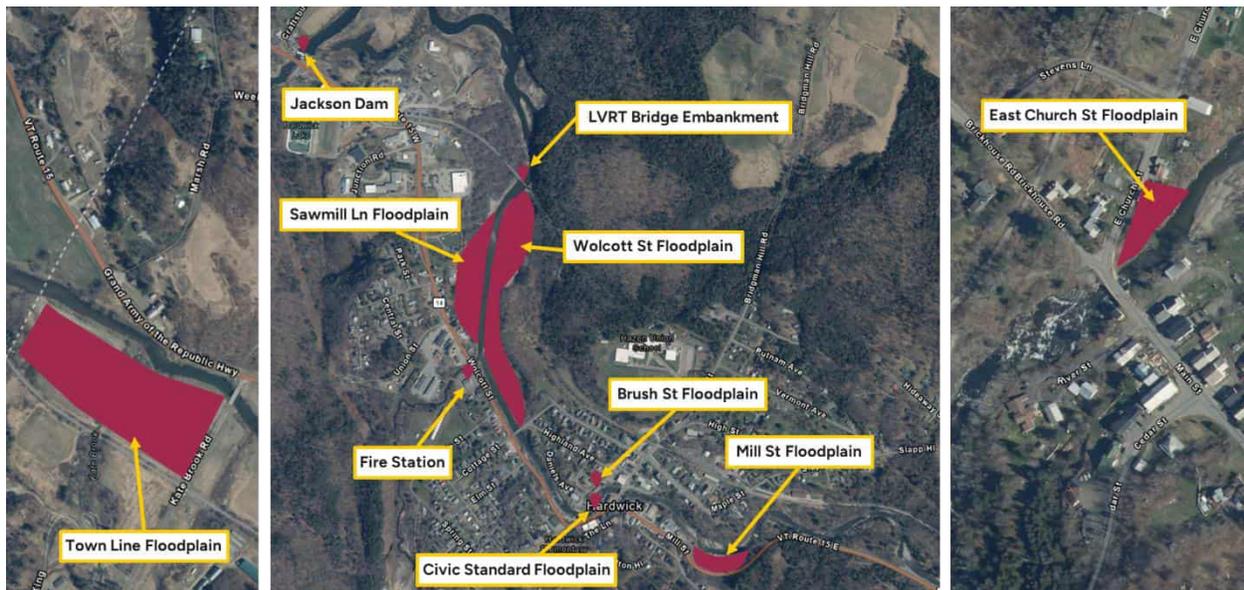


Figure 17: Map of flood mitigation alternatives in Hardwick

Public meetings were held to provide an overview of the model results and review possible alternatives on December 3, 2025 (am and pm sessions, and recorded on HCTV) and December 4, 2025 at the Selectboard meeting (Appendix D).



5.1.8 Jackson Dam

Jackson Dam on the Lamoille River is just north of the Route 14/15 Bridge and forms Hardwick Lake to the north (Figure 43). Jackson Dam is currently being studied in a dam removal feasibility assessment. The alternative tested here explores if a dam removal would reduce flooding in Hardwick.



Figure 43: Location map of Jackson Dam (left) and Jackson Dam looking upstream (right)

This alternative involves removing the dam and excavating sediment built up behind the dam up through the LVRT Bridge (Figure 44). In addition, floodplains next to the river would be lowered so the river is not incised and can access the floodplains. The flood reduction benefits extend 3.1 miles upstream of the dam. Large flood water surface elevations are lowered 3.4 feet just upstream of the dam and 0.4 feet upstream of the LVRT Bridge. Small flood water surface elevations are lowered 6.3 feet just upstream of the dam and 2.6 feet upstream of the LVRT Bridge.



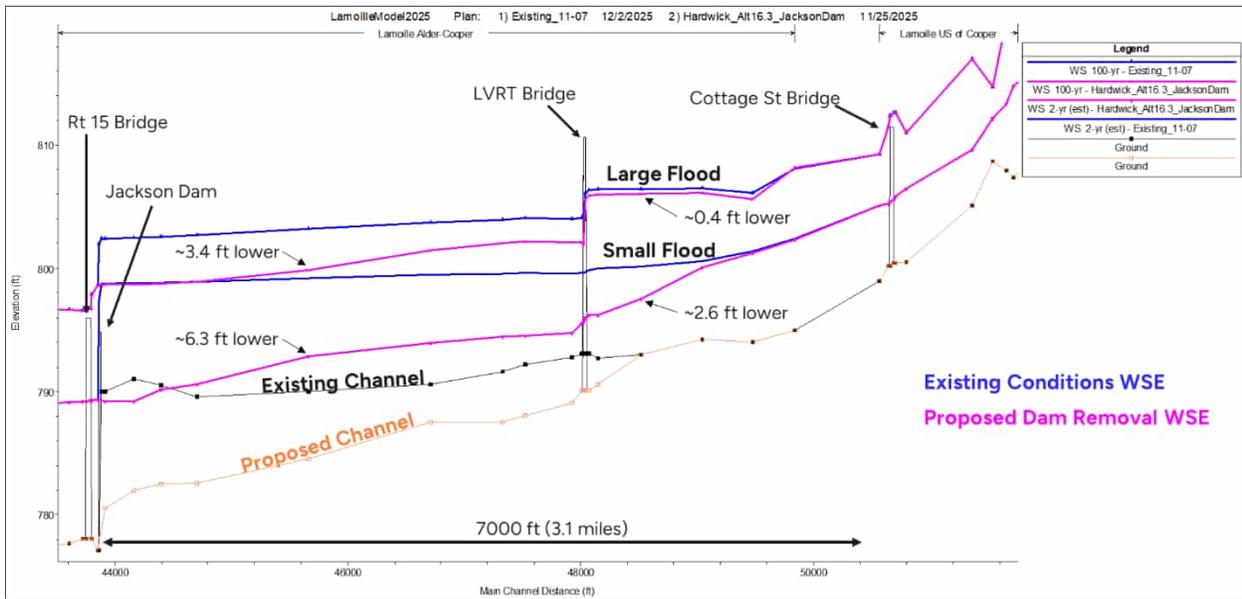


Figure 44: Profile of existing conditions and proposed dam removal with channel lowering with WSE of a large, medium, and small flood

Mapping of the existing and proposed flood depths for the 100-year flood show flood reduction benefits from removing Jackson Dam (Figure 45, Figure 46). These results highlight how run-of-river dam removal would reduce inundation extent across Route 14/15 and reduce impacts to nearby businesses.



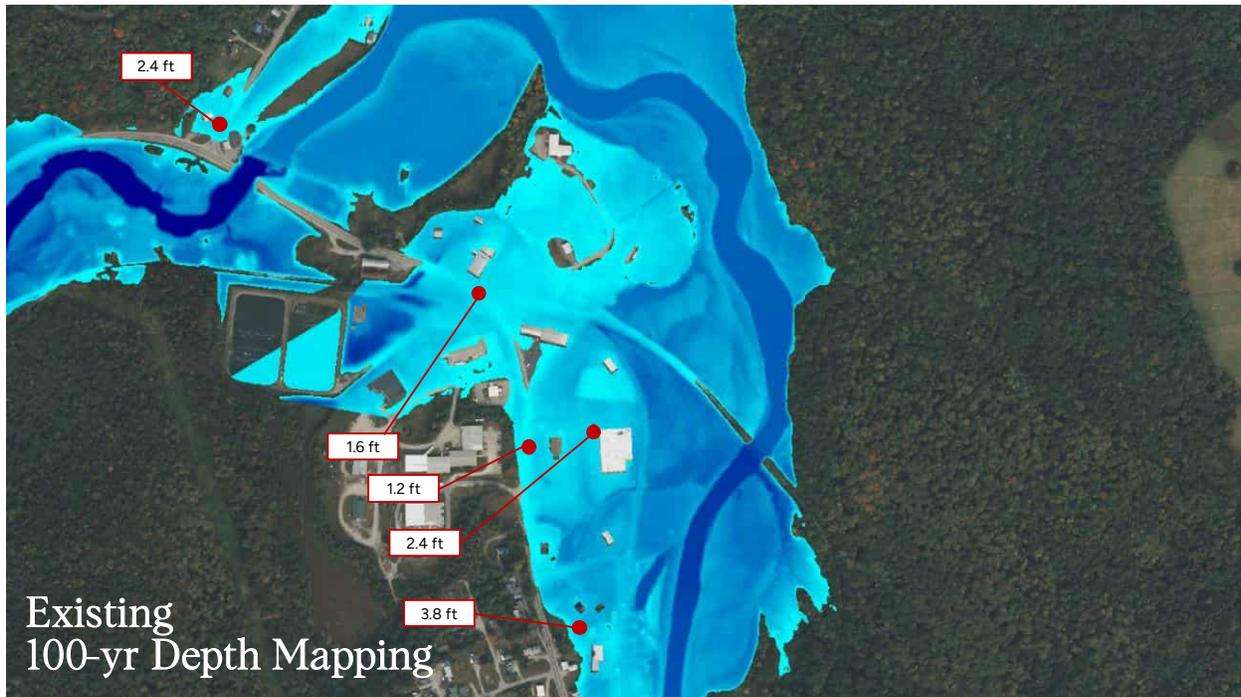


Figure 45: Depth mapping of existing conditions for a large flood

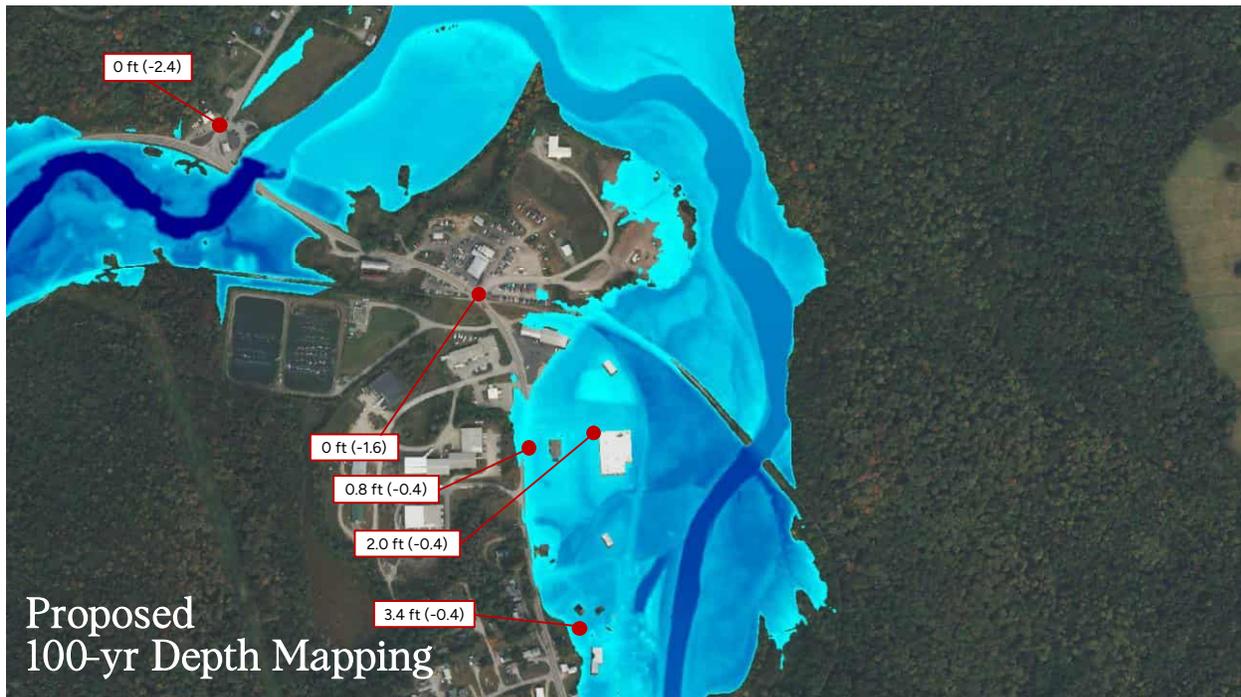


Figure 46: Depth mapping of proposed dam removal for a large flood



Appendix G

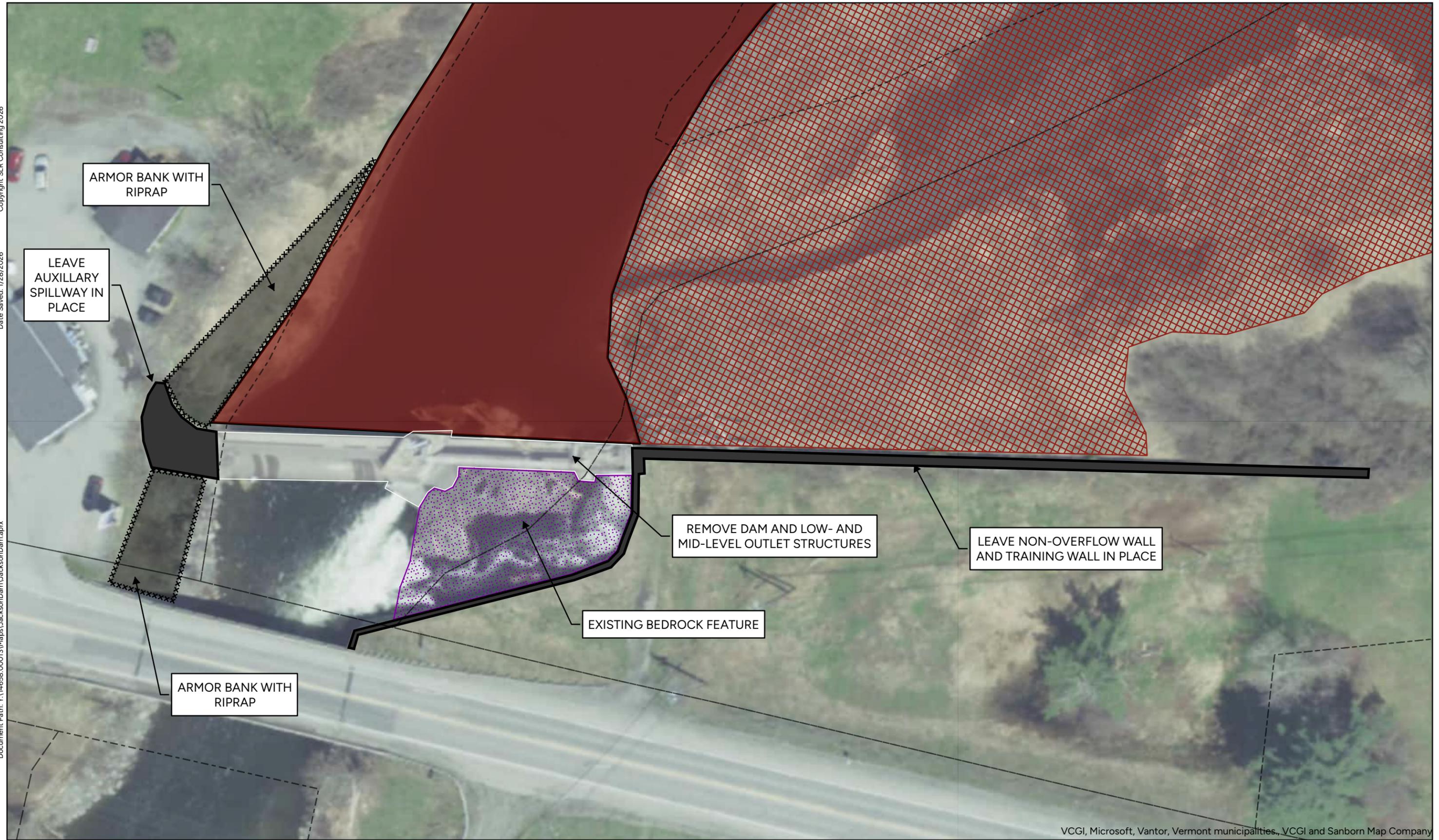
Jackson Dam Concept Design



Copyright SLR Consulting 2026

Date Saved: 1/28/2026

Document Path: Y:\14658.00013\Maps\JacksonDam\JacksonDam.aprx



VCGI, Microsoft, Vantor, Vermont municipalities, VCGI and Sanborn Map Company

Jackson Dam Removal Concept Design - Dam

Jackson Dam Removal Feasibility Analysis
Caledonia County Natural Resources Conservation District

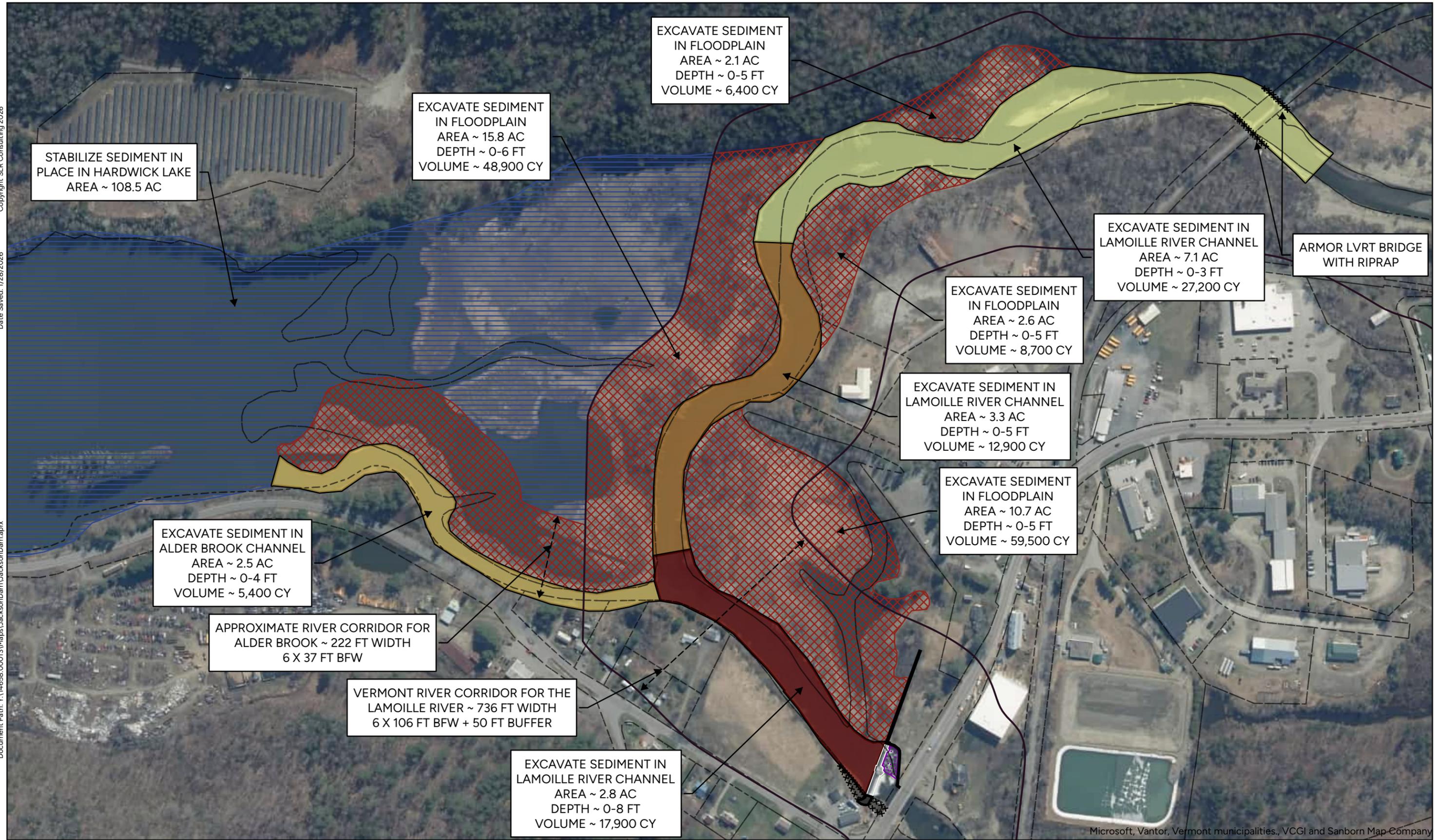
Channel Sediment Removal Depth (ft)	Floodplain Sediment Removal
0-3	Sediment to Stabilize in Place
0-4	Proposed Riprap
0-5	Existing Bedrock
0-8	Vermont Parcels



Copyright SLR Consulting 2026

Date Saved: 1/28/2026

Document Path: Y:\14658.00013\Maps\JacksonDam\JacksonDam.aprx

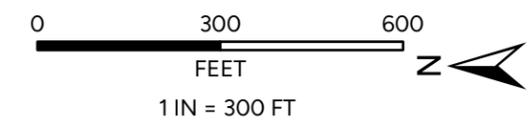


Microsoft, Vantor, Vermont municipalities, VCGI and Sanborn Map Company

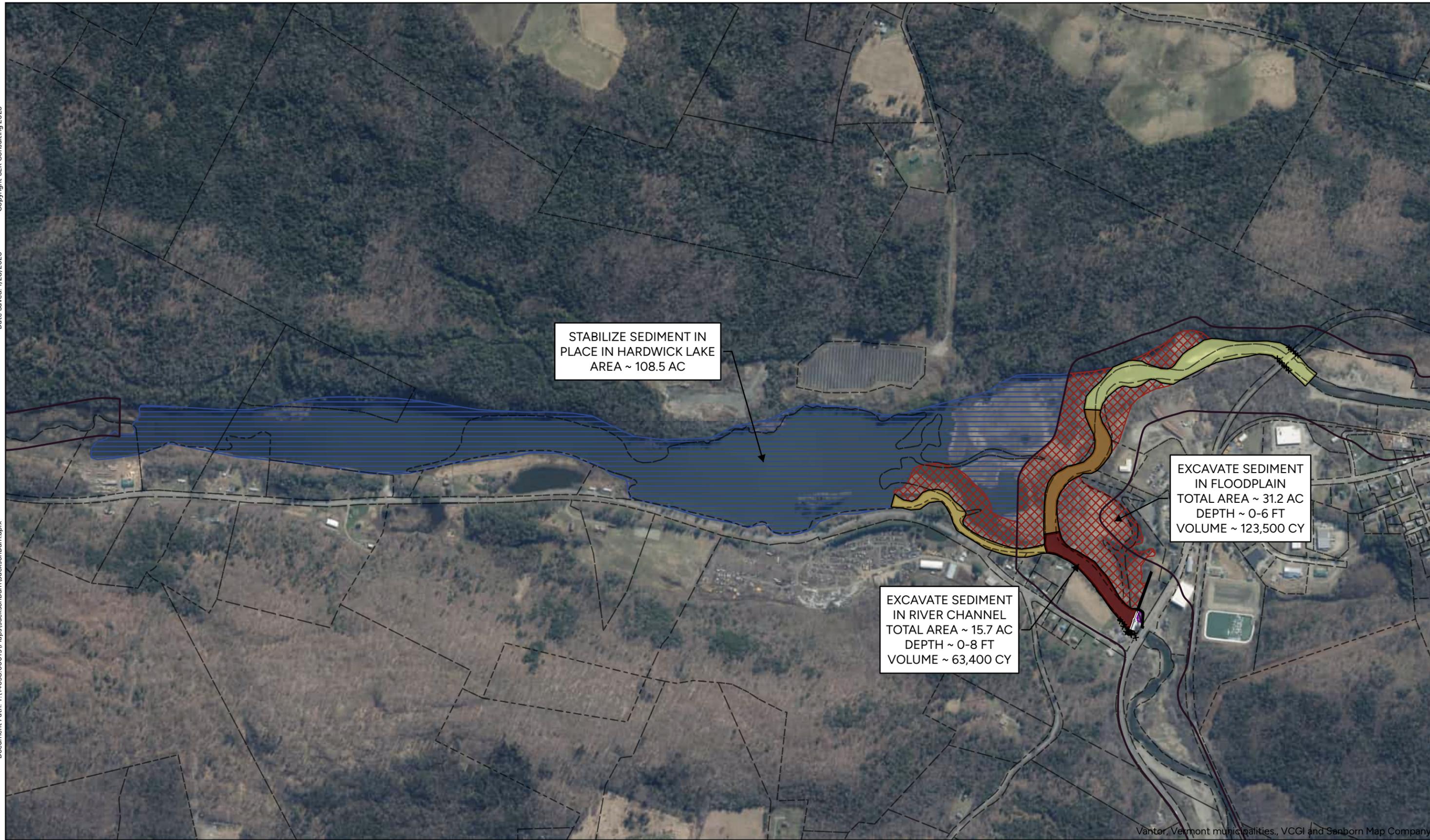
Jackson Dam Removal Concept Design - Sediment

Jackson Dam Removal Feasibility Analysis
Caledonia County Natural Resources Conservation District

Channel Sediment Removal Depth (ft)	▨ Floodplain Sediment Removal
0-3	▨ Sediment to Stabilize in Place
0-4	▨ Proposed Riprap
0-5	▨ Existing Bedrock
0-8	▨ Vermont Parcels



1 SOUTH MAIN STREET
WATERBURY VT, 05676



Vantor, Vermont municipalities, VCGI and Sanborn Map Company

Jackson Dam Removal Concept Design - Hardwick Lake

Jackson Dam Removal Feasibility Analysis

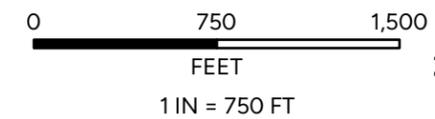
Caledonia County Natural Resources Conservation District

Channel Sediment Removal Depth (ft)

- 0-3
- 0-4
- 0-5
- 0-8

Floodplain Sediment Removal

- Sediment to Stabilize in Place
- Proposed Riprap
- Existing Bedrock
- Vermont Parcels



1 SOUTH MAIN STREET
WATERBURY VT, 05676

CONCEPT DESIGN PROBABLE CONSTRUCTION COST

JACKSON DAM REMOVAL - CONCEPT STAGE

Hardwick, Vermont

SLR #14658.00013

February 12, 2026



Item	ITEM/DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
SITE PREPARATION					
	Mobilization & Demobilization	LS	1	\$50,000	\$50,000
	Site Access	LS	1	\$80,000	\$80,000
	Water Control	LS	1	\$40,000	\$40,000
	Erosion Control	LS	1	\$20,000	\$20,000
	Traffic Control and Signage	LS	1	\$5,000	\$5,000
DAM REMOVAL					
	Concrete Dam	CY	1,300	\$300	\$390,000
	Dam Appertenances	LS	1	\$15,000	\$15,000
FLOODPLAIN RESTORATION					
	Excavation & haul to restore channel	CY	63,400	\$20	\$1,268,000
	Excavation & haul to restore floodplain	CY	123,500	\$20	\$2,470,000
	Excavation & haul - Alder Brook (TBD)	CY	0	\$20	\$0
	Restoration of Disturbed Areas	LS	1	\$50,000	\$50,000
	Riparian Native Seed and Mulch	AC	140	\$6,000	\$840,000
	Woody Buffer Planting (400 stem/acre)	EA	60,000	\$10	\$600,000
INFRASTRUCTURE PROTECTION					
	Stabilization along River Bank	CY	450	\$70	\$31,500
	Stabilization at Bridges	CY	700	\$70	\$49,000
	Repairs to wall	LS	1	\$25,000	\$25,000
	Construction Subtotal				\$5,828,000
	Construction Contingency (15%)				\$874,000
	Data Collection				\$40,000
	Final Design				\$80,000
	Permitting				\$40,000
	Bid Phase				\$10,000
	Drawdown Phase				\$45,000
	Construction Oversight				\$120,000
	Project Management, CCNRCD				\$20,000
	TOTAL (round)				\$7,060,000

Appendix H

Additional Photos

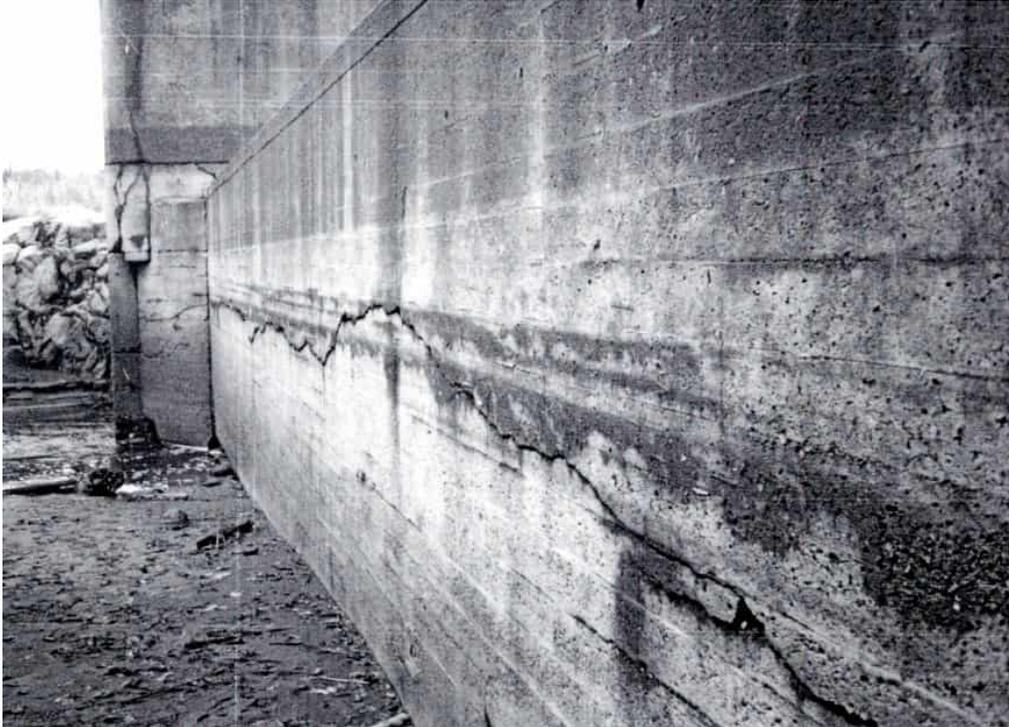


Figure 27: Jackson Dam upstream face during winter draw down (Knight, 2001)



Figure 28: Jackson Dam cracking on upstream face (Knight, 2001)





Figure 29: Jackson Dam during winter draw down (Knight, 2001)



Figure 30: Jackson Covered Bridge (Hardwick Historical Society)



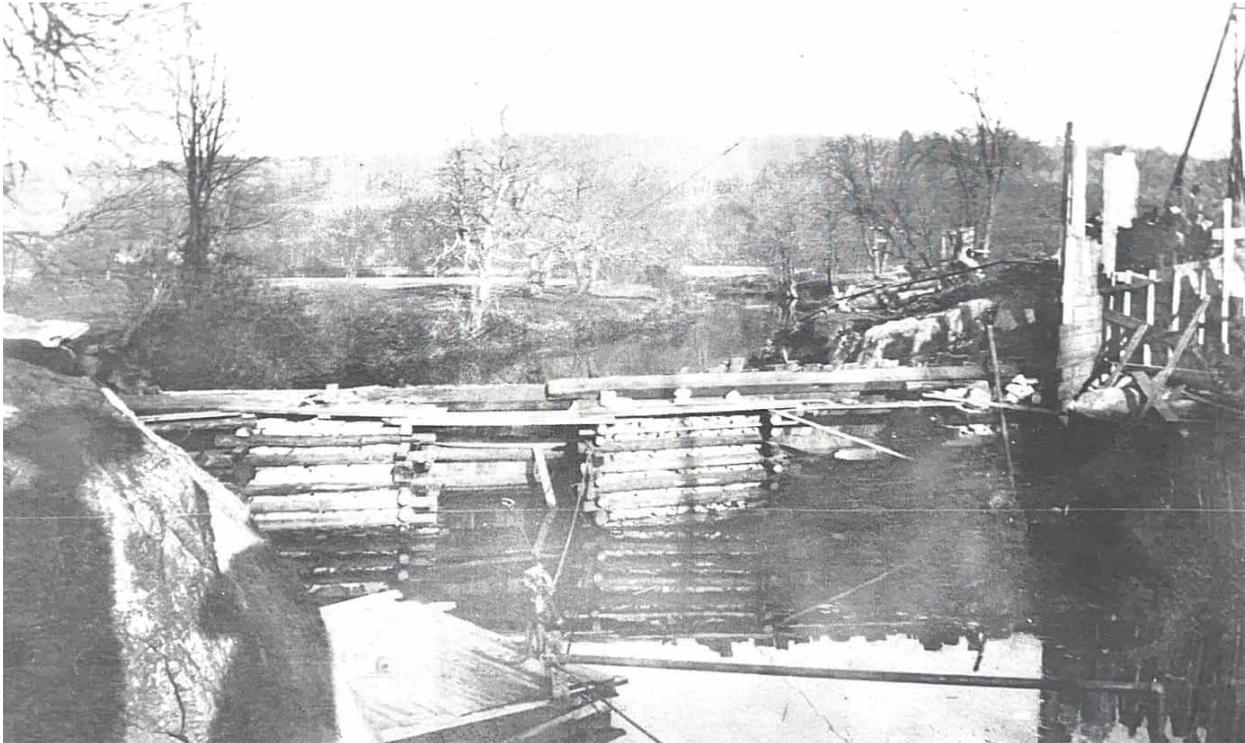


Figure 31: Jackson Dam during construction (Hardwick Historical Society, 1912)

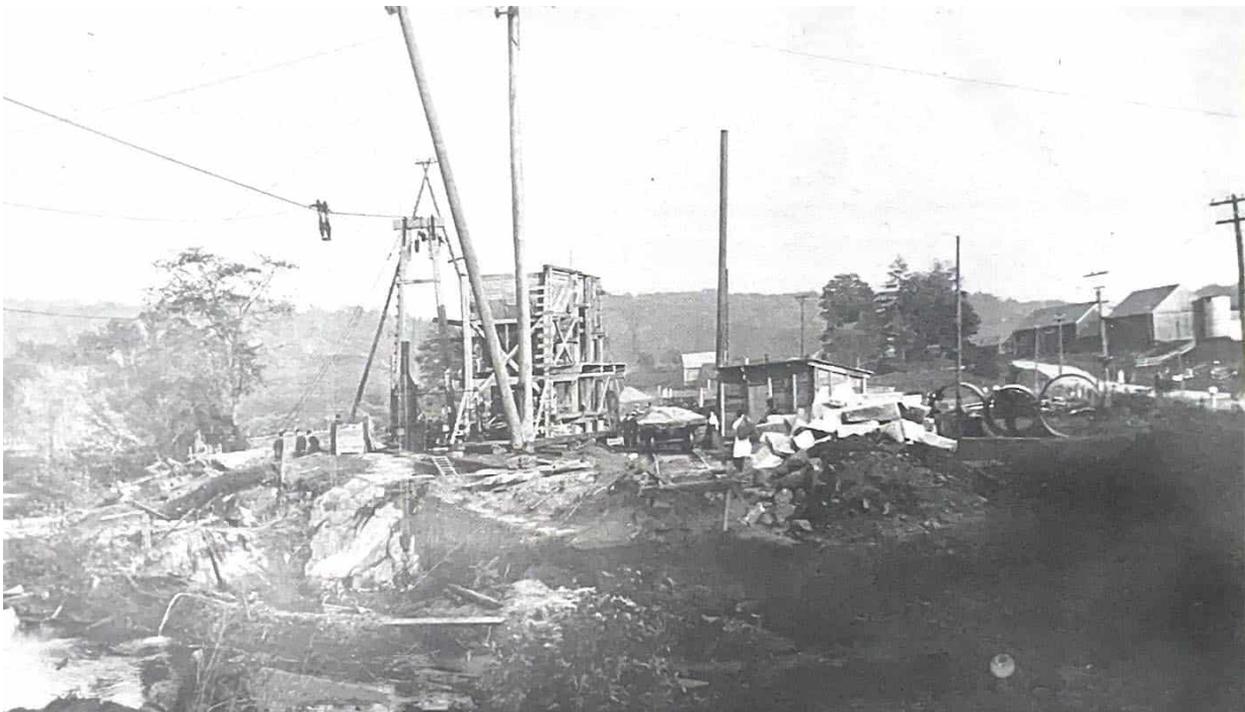


Figure 32: Jackson Dam during construction (Hardwick Historical Society, 1912)





Figure 33: Jackson Covered Bridge after dam construction (Hardwick Historical Society)



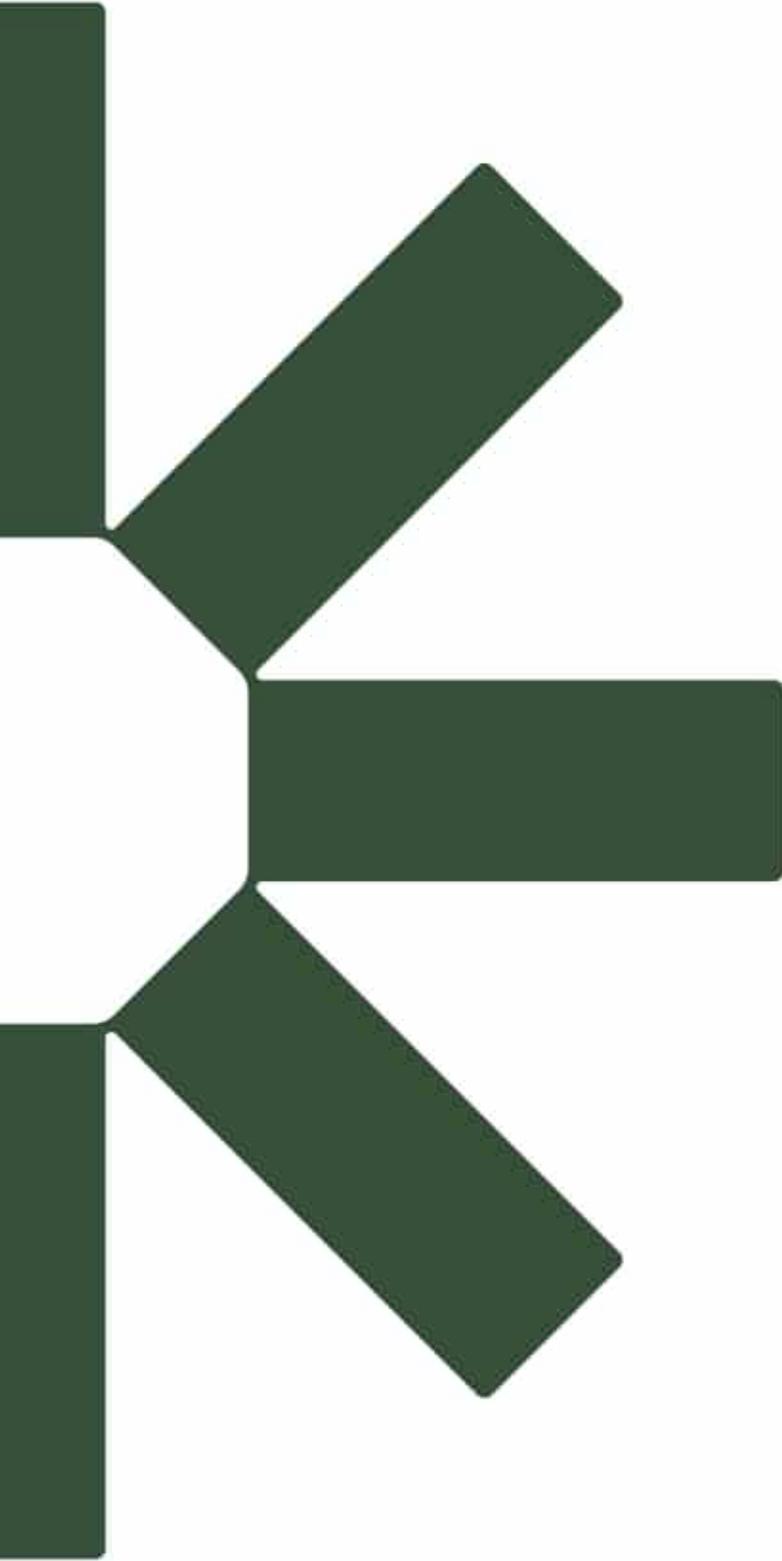
Figure 34: Jackson Covered Bridge and Dam looking east towards Town (Hardwick Historical Society)





Figure 35: Hardwick Lake when Jackson Dam is drawn down (Brown, 2013)





Making Sustainability Happen