



Williams Dam Flooding Analysis

Londonderry, Vermont

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SLR Project No.: 146.20433.00002

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Appendix A	Williams Dam (D&K, 2022)
Appendix B	Williams Dam, Londonderry, VT (NRCS, 2022)
Appendix C	VTDSP Dam Inspection
Appendix D	VTDSP Dam Breach Analysis
Appendix E	VTrans Boring Data for VT Route 11 Bridge



1.0 Introduction

1.1 Purpose

The Town of Londonderry has retained SLR Consulting (SLR) to perform a flood analysis of Williams Dam and the surrounding area along the West River in Londonderry, Vermont. The goal of this project is to provide the Town with information to assist with the decision to remove, repair, or replace the dam. Specifically, we will provide results of field assessment and hydraulic modeling to show the influence of dam removal. There is a long history of flooding at the dam and along the West River in Londonderry. In 2023, VT Route 11 and the area adjacent to the dam flooded in July and December. The analysis presented in this report builds upon past studies (D&K, 2022; NRCS, 2022) (Appendix A and B).

1.2 Project Location

Williams Dam is located on the West River 20 feet downstream of the Vermont Route 11 Bridge in Londonderry (Figure 1 and Figure 2).

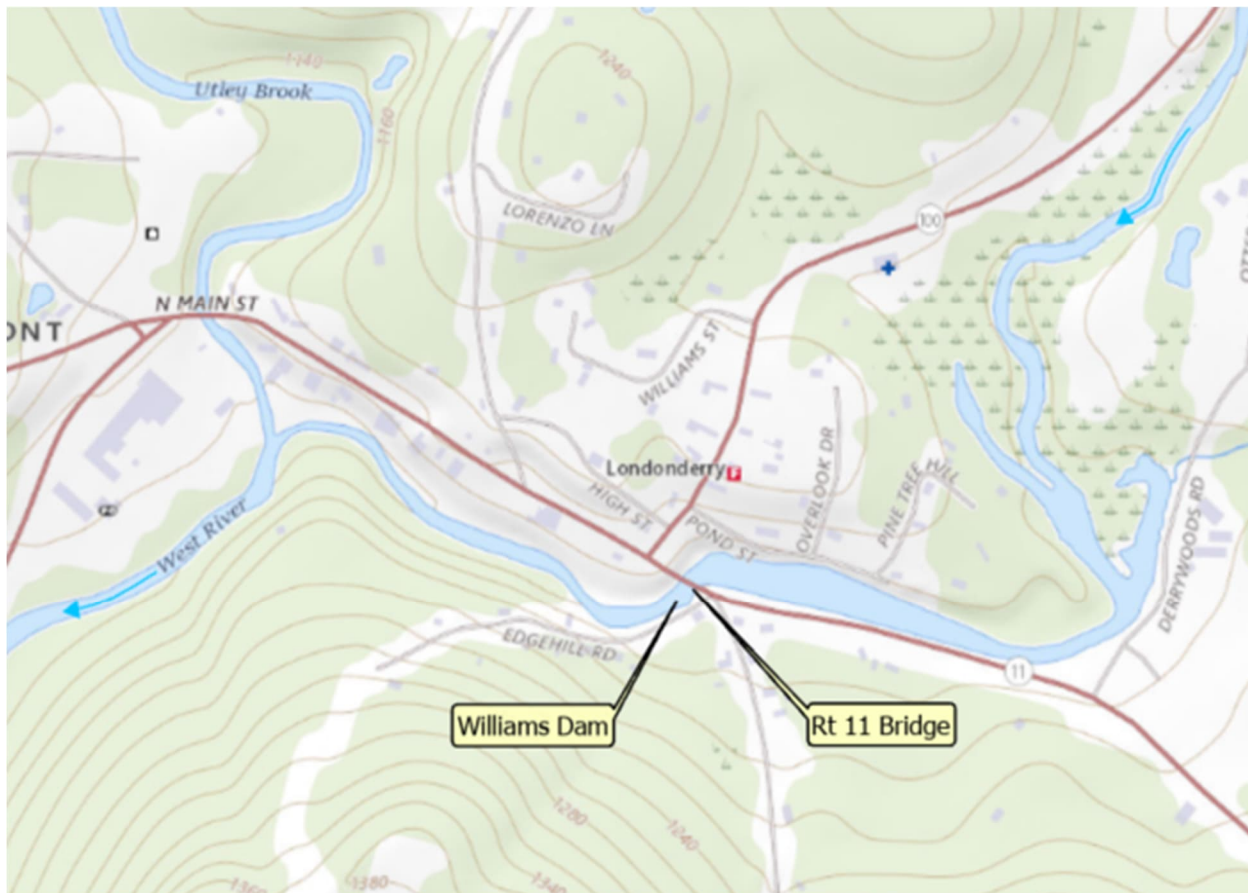


Figure 1: Topographic Location Map





Figure 2: Location Map with Aerial

1.3 Scope

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

- Review of past studies
- Stream assessment of the West River in the project area
- Supplemental survey of the river channel
- 2-Dimensional hydraulic modeling
- Dam removal alternatives analysis
- Reporting



2.0 Williams Dam

Williams Dam (VT ID #115.01) is a 17-foot-tall, 90-foot-long, run-of-river dam composed of stone masonry capped with concrete. The dam was originally constructed in the late 1800s to provide hydropower for a nearby machine shop. Based on the Vermont Dam Inventory, the normal surface area is 9.3 acres and the normal storage volume is 24.2 acre-feet. The maximum storage is 97.1 acre-feet at the top of the dam.

The primary spillway is a broad crested weir that is 66 feet long. The weir extends between the south (i.e., river left looking downstream) abutment and the concrete gatehouse along the north abutment. The gatehouse contains a low-level outlet that consists of a 6-foot-diameter corrugated metal pipe (CMP) with a vertical sluiceway at the inlet and a concrete flume at the outlet. A concrete training wall extends 15 feet upstream from the gate house, tying into the north abutment of the Route 11 Bridge. The south abutment is in direct contact with a bedrock outcropping.

In August 2015, the Vermont Dam Safety Program (VTDSP) performed an inspection of Williams Dam and rated the dam's overall conditions as Poor due to numerous structural deficiencies (Appendix C). VTDSP advised the Town of Londonderry to retain an engineering firm to perform a detailed assessment of Williams Dam and provide recommendations to address the deficiencies. DuBois & King, Inc. (D&K) was hired in 2021 to inspect the dam, perform a hydraulic analysis, and evaluate several alternatives for addressing the dam's deficiencies. D&K identified several other issues at the dam such as leakage through the bedrock and around the south abutment leading to erosion of the riprap along Edge Hill Road; continued deterioration of the concrete throughout the structure; and insufficient hydraulic capacity of the spillway.

In 2022, VTDSP performed a dam breach analysis for Williams Dam to evaluate the risks of dam failure (Appendix D). Based on the results of the analysis the hazard classification for Williams Dam was changed from Low to Significant. The hazard classification for Williams Dam was increased because the dam breach analysis showed that the dam could potentially lead to loss of life if the structure were to fail. Based on VT dam safety regulations for Significant hazard dams, Williams Dam is required to convey the 1,000-year flood without overtopping. According to modeling results from the D&K analysis, the dam currently does not have the hydraulic capacity to pass the 50-year flood.

SLR visited the project site December 21, 2023 and May 15, 2024 to verify information and collect supplemental field data. The deteriorated condition persists at the dam. A large tree was resting on the spillway. Sediment probing and close-up view of the dam from a canoe downstream illustrates seepage on the north side of the structure and a lower channel on the south side (Figure 3). The seepage is reported to vary with flow and time since the last large flood. The cross section below the seepage represents a potential bedrock shape and elevation that would remain if the dam were removed and is used in the hydraulic modeling to evaluate the effects of dam removal. Similar confined bedrock channel sections exist just downstream of the dam on the West River (Figure 4).





Figure 3: Williams Dam (Looking Upstream) and the Potential Underlying Bedrock Channel Section (Yellow Line)



Figure 4: Confined Bedrock Channel Section 420 Feet Downstream of Williams Dam (Looking Downstream)



3.0 VT Route 11 Bridge

The Vermont Route 11 Bridge is located approximately 20 feet upstream of Williams Dam (Figure 5). A bridge has crossed the West River at this location for over 100 years, and over the years the bridge had been replaced several times due to flood damages. The current bridge was built in 1995. The total span is 88 feet with a center pier. The dam and bridge are structurally connected by the concrete training wall that extends between the south abutments of each structure. The hydraulic model analysis by D&K suggests that the Route 11 Bridge constricts flows causing flooding upstream along Route 11 during the 10-year flood. During larger floods such as the 50-year flood, Williams Dam backwaters the Route 11 Bridge causing the bridge to overtop.



Figure 5: VT Route 11 Bridge (Looking Upstream from the Dam)

The bridge is not only a severe constriction of the West River channel but it also is hydraulically inefficient due to its poor alignment. Review of historic photos of the bridges in this location illustrate increasing fill on the bridge approaches that has narrowed the channel, the introduction of a center pier that has removed hydraulic capacity, and increasing skew relative to the river channel to presumably improve the highway alignment. The current bridge increases flood risks.



The bottom of the concrete bridge beams slope from downstream to upstream resulting in a smaller hydraulic opening at the upstream face of the bridge than at the downstream face of the bridge. This slope further reduces the hydraulic capacity of the bridge. The combination of the narrowed upstream bridge opening and the backing up of water through the bridge from the downstream due to Williams Dam, the combined structures limit flood capacity and increase local flood risks. Model runs with the dam removed and dam and bridge removed (i.e., natural conditions) were performed to evaluate the effect on flood patterns due to the structures.

The VT Route 11 Bridge is founded on channel-spanning bedrock at an average elevation of 1130 feet NAVD88 (Appendix E). This elevation aligns with recent sediment probing data and observations around the dam indicating the likely bottom of channel if the dam were removed. Note that the elevations in the VTrans bridge plans are given in the vertical datum of NGVD29 so need to be converted to the current vertical datum of NAVD88 for use in this hydraulic study (NAVD88 = NGVD29 – 0.4).

4.0 Flood History

Major floods have taken place in Londonderry over the past century including December 2023, July 2023, August 2011, June 1973, and November 1927. During the July 2023 flood, water spilled out of the West River onto the floodplain, overtopped the highway, and damaged buildings (Figure 6). The bridge backwatered by the dam filled during the flood and water was diverted towards the intersection of VT Routes 11 and 100.



Figure 6: July 2023 Flood (Looking Downstream) (Source: Town of Londonderry)



Review of flood photos provided by the Town illustrate flooding took place upstream and downstream of the dam and bridge. The information suggests that the flood was too large to fit in the valley without impacting property and infrastructure. Modeling will be used to verify this, and if the changes in flood storage associated with dam removal and floodplain restoration at the Utley Brook confluence will reduce flooding.

The USGS Flood Event Viewer ([Flood Event Viewer \(usgs.gov\)](https://www.usgs.gov/flood-event-viewer)) has documented high water marks in the Town from the July 2023 flooding (Figure 7) that will be used to validate the hydraulic model.

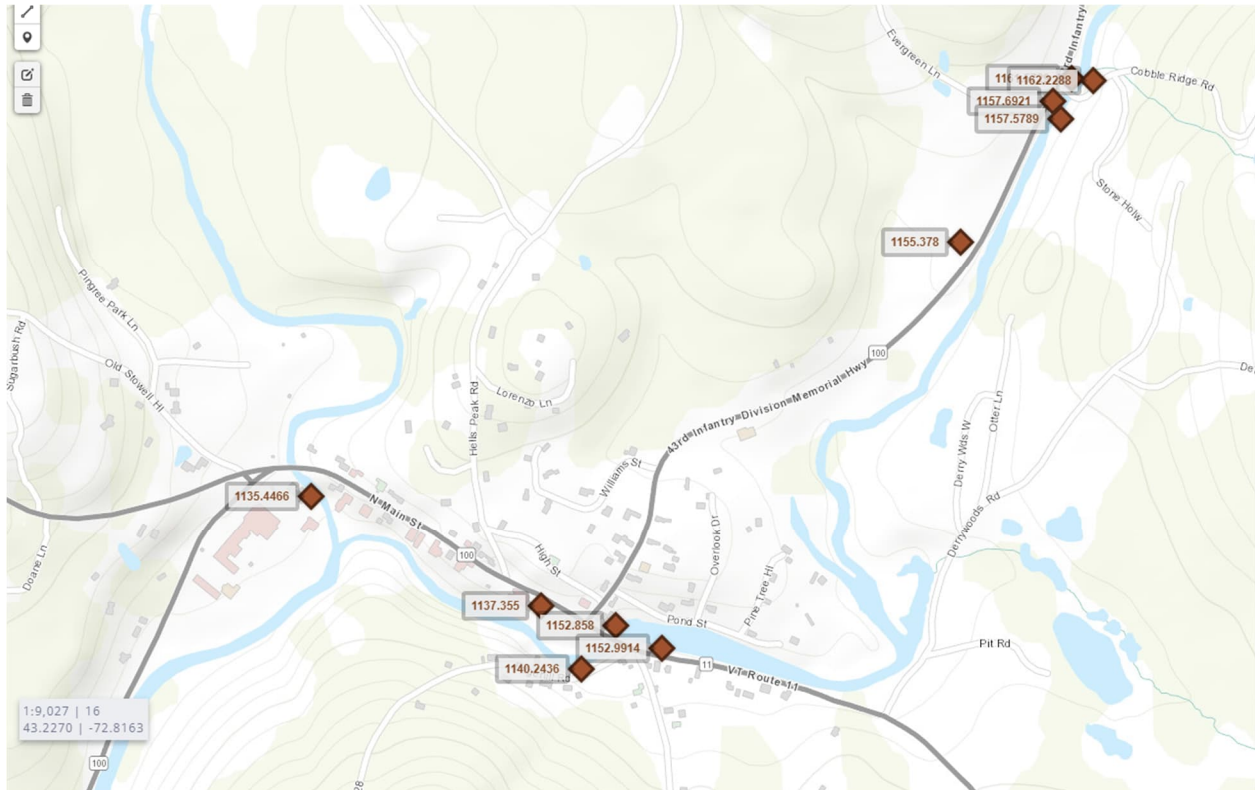


Figure 7: High Water Marks from the July 2023 Flood (Source: USGS)

5.0 Channel Morphology

5.1 The West River

The West River forms on the western slopes of South Mountain in Mount Holly, Vermont and flows south through Weston and Londonderry, eventually discharging into the Connecticut River in Brattleboro. The mountainous headwaters of the river transition from an average slope of almost 10% to a low slope of around 0.3% near Williams Dam (Figure 8). Upstream of Williams Dam, the river is moderately sinuous and has an estimated bankfull channel width of 71 feet (Olson, 2014). Downstream of the dam, the West River straightens and flows parallel to VT Route 100 through a narrow valley. There are several other dams located along the West River, including Weston Mill Dam, a small run-of-river dam located 7 miles upstream in the Town of Weston, and Ball Mountain Dam, a large flood control dam located 10 miles downstream in the Town of Jamaica (Figure 8).



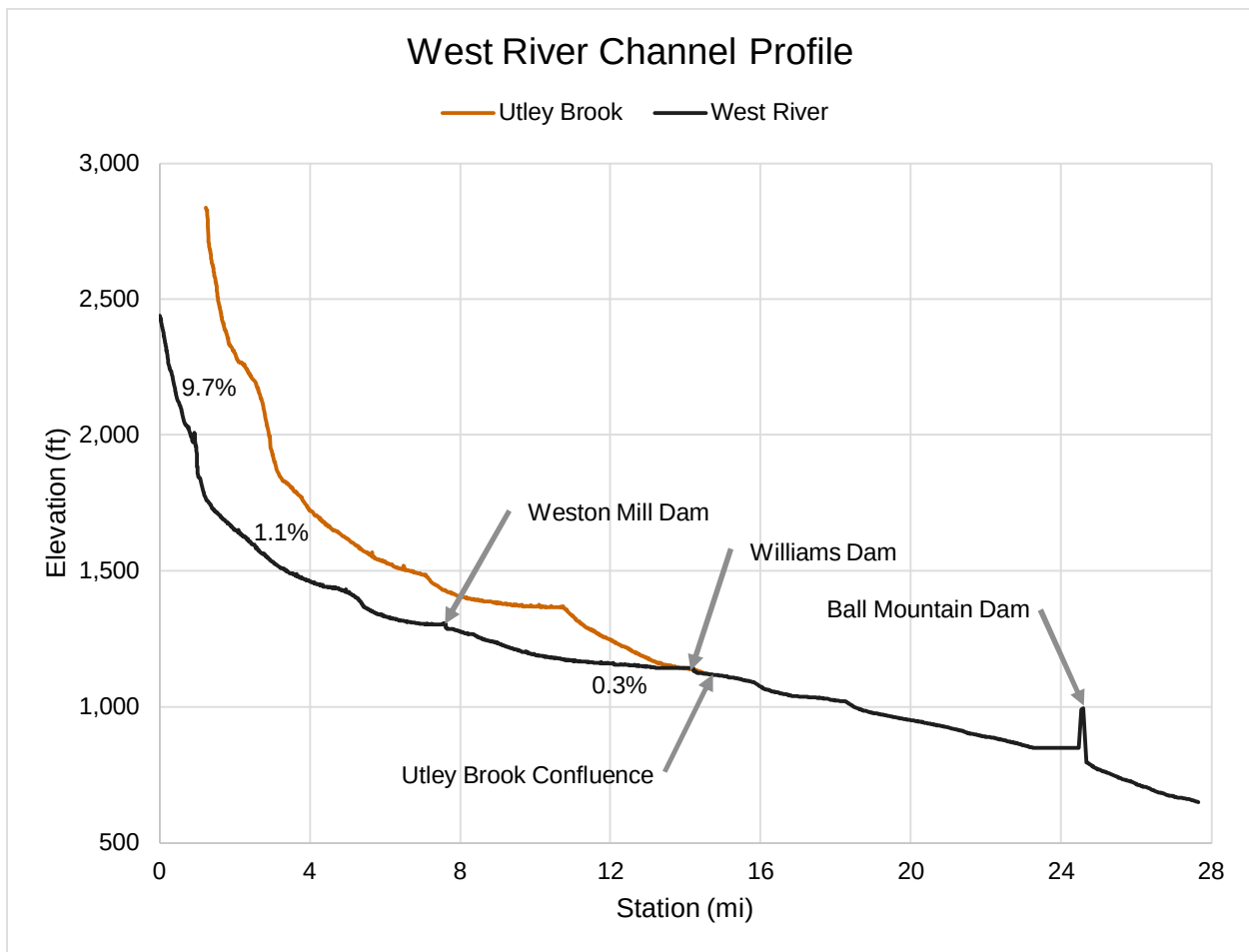


Figure 8: West River Channel Profile Derived from LiDAR Data

The West River in Londonderry is generally a meandering riffle-pool channel (Rosgen and Silvey, 1996) with a gravel and cobble bed, yet a paddle/wade down the river reveals three types of channels.

1. Where the channel is connected to naturally vegetated floodplains, a meandering gravel/cobble channel exists. Riverbanks tend to be tall due to past channel down-cutting. The bankfull channel width in this channel setting is typically between 60 and 70 feet.
2. Where broad floodplains exist and beavers are active building dams, flatter channels exist with several flow paths and ponded floodplains. Sediment is typically finer in these areas and floodprone widths are larger. This condition exists at the upstream end of the impoundment behind the dam. The bankfull channel width in this channel setting is typically between 65 and 70 feet.
3. In areas where the channel is made up of bedrock or where the river runs along property or infrastructure such as a road, the channel is straighter, steeper, and narrower. Bed material typically exists of cobble, boulder, or bedrock. This condition exists where bedrock controls the channel downstream of the dam, and where Route 100 parallels



the river close to the banks. The bankfull channel width in this channel setting is typically between 60 and 65 feet.

5.2 The Impoundment

The impoundment is filled with water and sediment that has accumulated to near the top of the spillway crest (Figure 9). Under normal flow (i.e., normal pool), the impoundment extends 3,600 feet upstream of the dam. This location is apparent in the field as downstream movement of water becomes visible, sandy sediment accumulation is replaced by a cobble bed, and the banks have erosion typical of flowing water. As with most run-of-river dams that are not regularly maintained, accumulated sediment fills more of the impoundment than water. Based on sediment probing, approximately 40,000 cubic yards of sediment is sitting upstream of Williams Dam. At normal pool, approximately 39,500 cubic yards of water (24 acre-feet) are regularly stored at the dam.

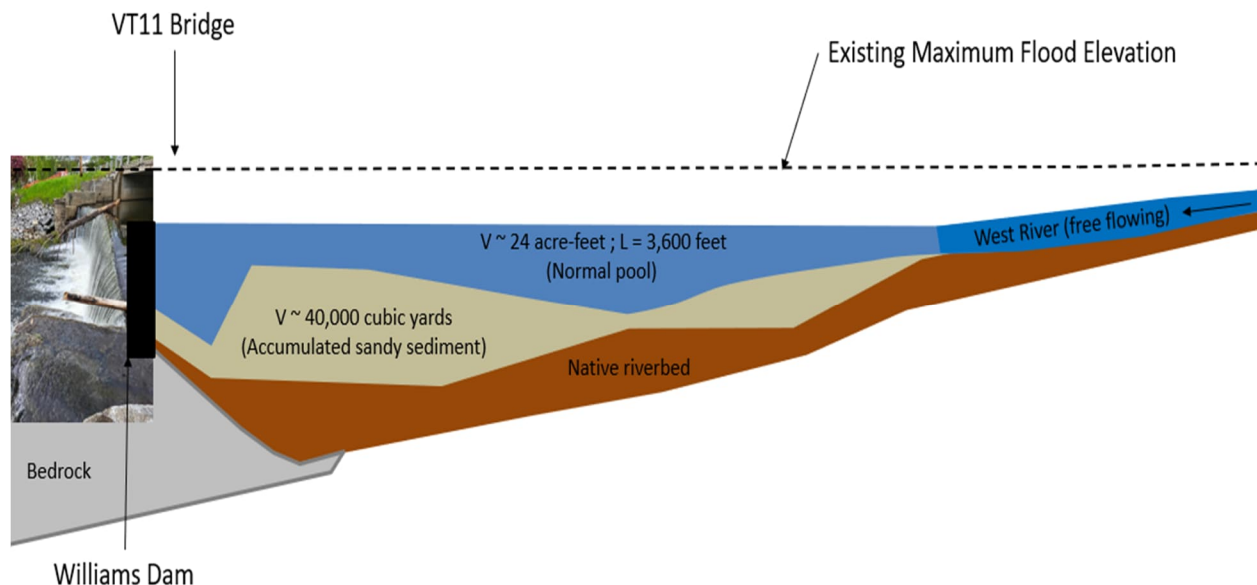


Figure 9: Impoundment Diagram – Existing Storage

During a flood, the impoundment swells to 4,800 feet long. The available storage capacity upstream of the dam/bridge before flooding takes place is 131 acre-feet (Figure 10, light blue area). Above this value, water starts to flow across the floodplains and infrastructure and property are at risk. Including the normal pool storage and volume taken up by accumulated sediment, the total volume of stored water and sediment upstream of the dam/bridge is 180 acre-feet. During a flood event, this volume is not available for storing and attenuating peak flows.



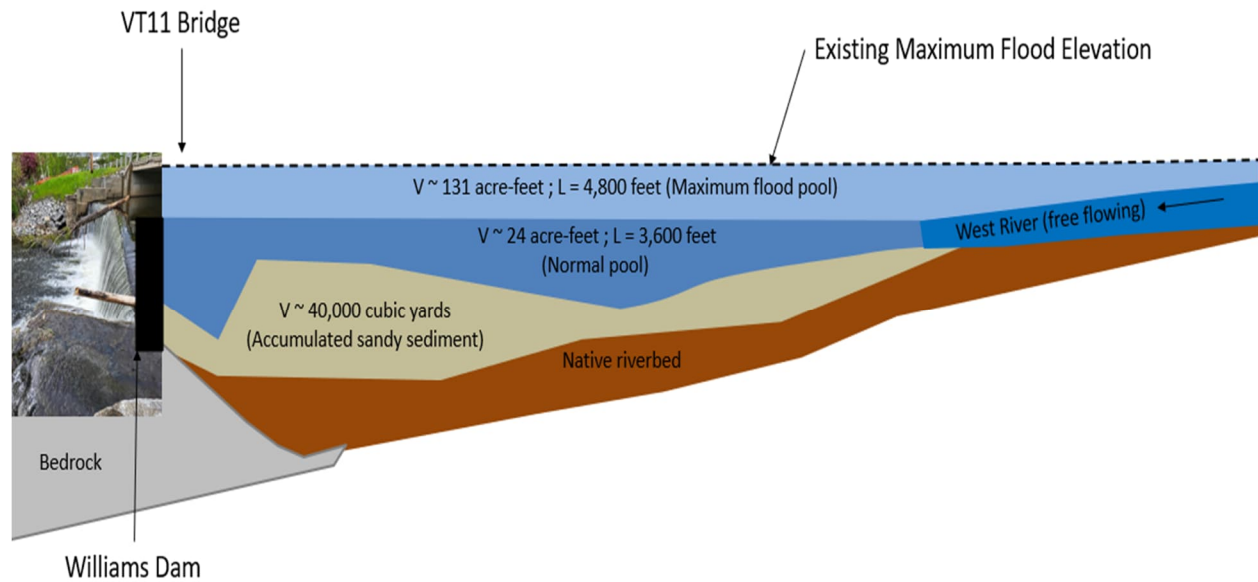


Figure 10: Impoundment Diagram – Full Storage Condition

6.0 Hydrology

6.1 Introduction

The West River has a drainage area of 40.8 square miles at Williams Dam (Figure 11). The drainage area increases to 68.6 square miles at the confluence with Utley Brook. The land throughout the watershed is primarily forested with some towns and farmland along the bottom of the river valley.

The flood flows for both the West River and Utley Brook were estimated using the USGS StreamStats software (Olson, 2014) and flood frequency analysis from nearby USGS stream gauges. Flow estimates were refined during hydraulic model validation to replicate the surveyed high water marks during the July 2023 flood.



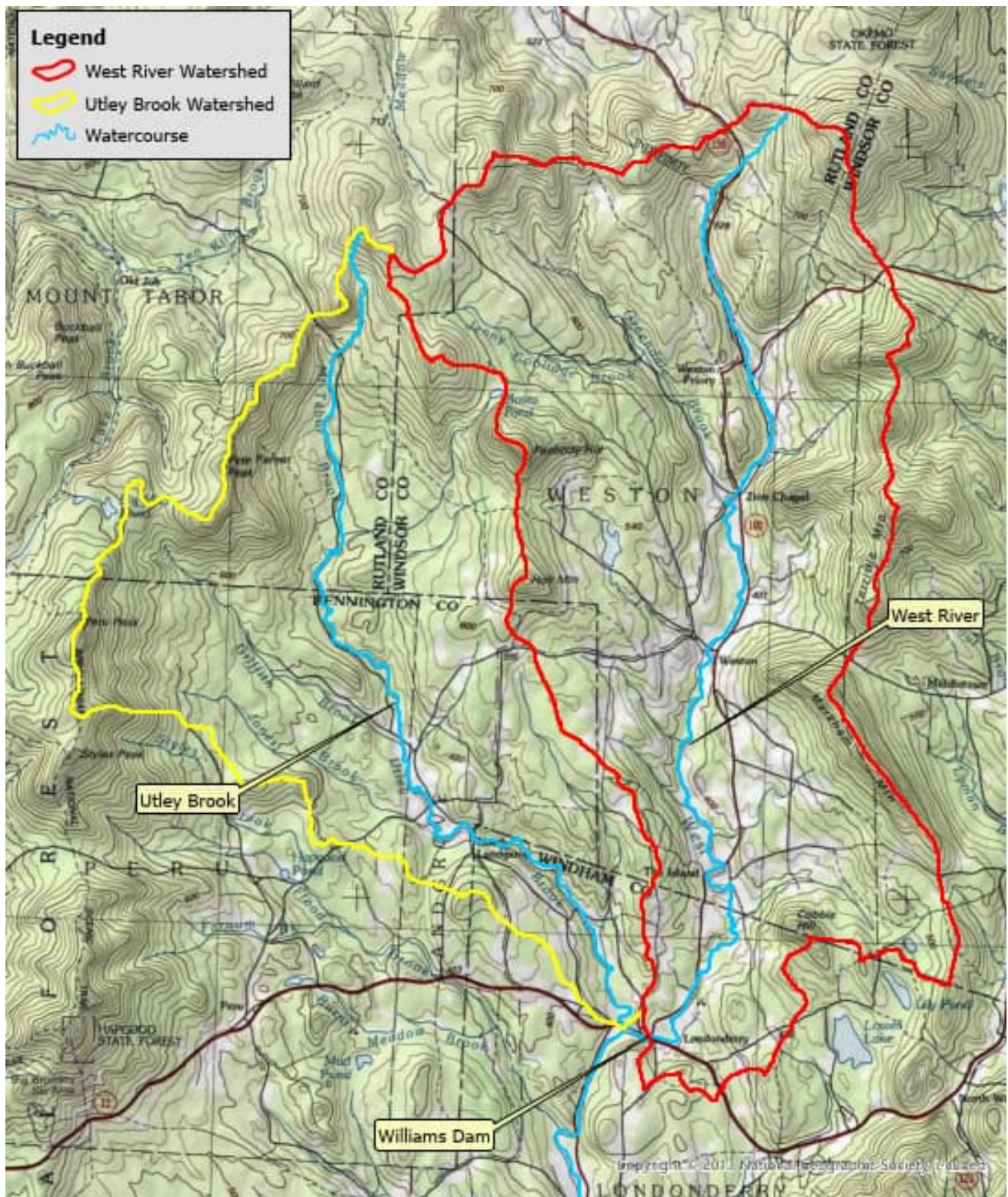


Figure 11: West River Watershed



6.1.1 FEMA Effective Flows

The effective flows were extracted from the FEMA flood insurance study (FIS) (Table 1). These peak flows were not used for the flood analysis because the flow estimates are based on a hydrologic analysis from 1977.

Table 1: FEMA Flood Flows (Windham County FIS, 2007)

Annual Exceedance Probability (AEP)	Return Frequency (Years)	West River Peak Flow (cfs)	Utley Brook Peak Flow (cfs)
10%	10	5,400	3,451
2%	50	9,386	6,406
1%	100	11,734	7,966
0.2%	500	20,534	14,766

6.1.2 USGS StreamStats

Peak flows were initially estimated with the USGS web-based StreamStats software (Table 2) (Olson, 2014). Synthetic hydrographs were developed for peak flows to allow for time-varying (i.e., unsteady) hydraulic modeling (Figure 12).

Table 2: Estimated Peak Flood Flows (Olson, 2014)

Annual Exceedance Probability (AEP)	Return Frequency (Years)	West River Peak-Flow (cfs)	Utley Brook Peak-Flow (cfs)
50%	2	1,650	1,140
20%	5	2,550	1,780
10%	10	3,250	2,280
4%	25	4,280	3,010
2%	50	5,170	3,640
1%	100	6,120	4,320
0.5%	200	7,170	5,080
0.2%	500	8,770	6,220



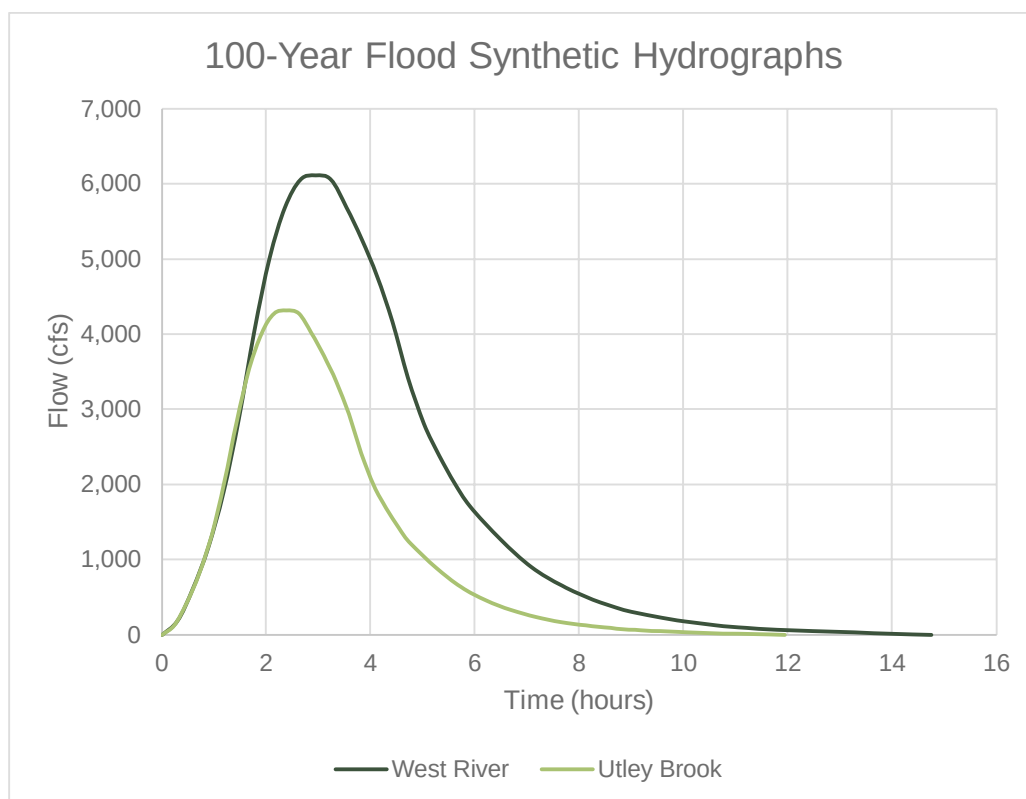


Figure 12: Synthetic Hydrographs for the 100-Year Flood

6.1.3 Gauge Analysis

Flood frequency analysis (USGS, 1982) was performed using scaled gauge data from USGS gauges located on the Williams River (USGS 01153550 Williams River near Rockingham, VT) (Table 3) and the Saxtons River (USGS 01154000 Saxtons River at Saxtons River, VT) (Table 4). The scaled flood flow estimates are generally larger than the StreamStats flow estimates.

Table 3: Estimated Peak Flood Flows Scaled from the Williams River

Annual Exceedance Probability (AEP)	Return Frequency (Years)	West River Peak-Flow (cfs)	Utley Brook Peak-Flow (cfs)
50%	2	2,322	1,703
20%	5	3,446	2,528
10%	10	4,435	3,253
4%	25	6,018	4,415
2%	50	7,484	5,491



Annual Exceedance Probability (AEP)	Return Frequency (Years)	West River Peak-Flow (cfs)	Utley Brook Peak-Flow (cfs)
1%	100	9,236	6,775
0.5%	200	11,331	8,312
0.2%	500	14,744	10,816

Table 4: Estimated Peak Flood Flows Scaled from the Saxtons River

Annual Exceedance Probability (AEP)	Return Frequency (Years)	West River Peak-Flow (cfs)	Utley Brook Peak-Flow (cfs)
50%	2	1,651	1,211
20%	5	2,763	2,027
10%	10	3,821	2,803
4%	25	5,640	4,138
2%	50	7,435	5,454
1%	100	9,696	7,113
0.5%	200	12,540	9,199
0.2%	500	17,449	12,801

Hydrographs were scaled from the surrogate gauge data to try and provide a more realistic shape for the regional July 2023 flood for use in the hydraulic modeling (Figure 13). Based on the results of the gauge analysis and calibration of the hydraulic model using high water marks, (see Section 7.2) the July 2023 flood had a return frequency between the 50- and 100-year event (i.e., 1% and 2% annual exceedance probability).



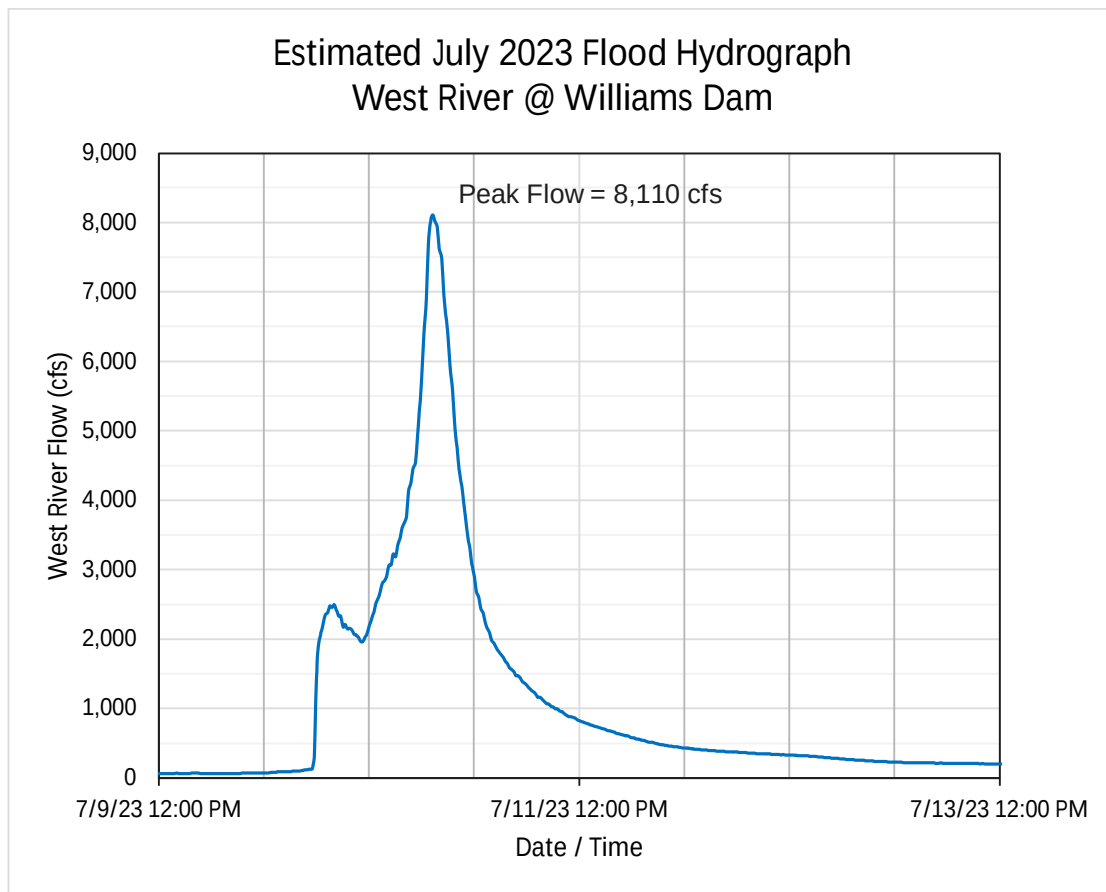


Figure 13: Scaled Hydrograph for the 100-Year Flood on the West River

7.0 Hydraulic Analysis

7.1 Introduction

A two-dimensional (2D) hydraulic model was developed to evaluate Williams Dam and the West River using the HEC-RAS river modeling software (USACE, 2023). Water surface elevations, flow depths, and velocities are computed for each cell in the 2D mesh based on the St. Venant shallow-water approximations of the Navier-Stokes equations that are solved using a finite-volume algorithm. Frictional energy losses are computed based on Manning's roughness coefficients applied to the terrain surface. Manning's roughness coefficients were categorized by landcover and assigned based on field assessment of vegetation type, cover, and density, and streambed material.

The 2D mesh for the West River model has an area of 380 acres and extends 10,000 feet along the West River and 3,400 feet along Uteley Brook (Figure 14). The model extent was selected to be able to explore changes to flood patterns from removal of Williams Dam and floodplain restoration at Uteley Brook.



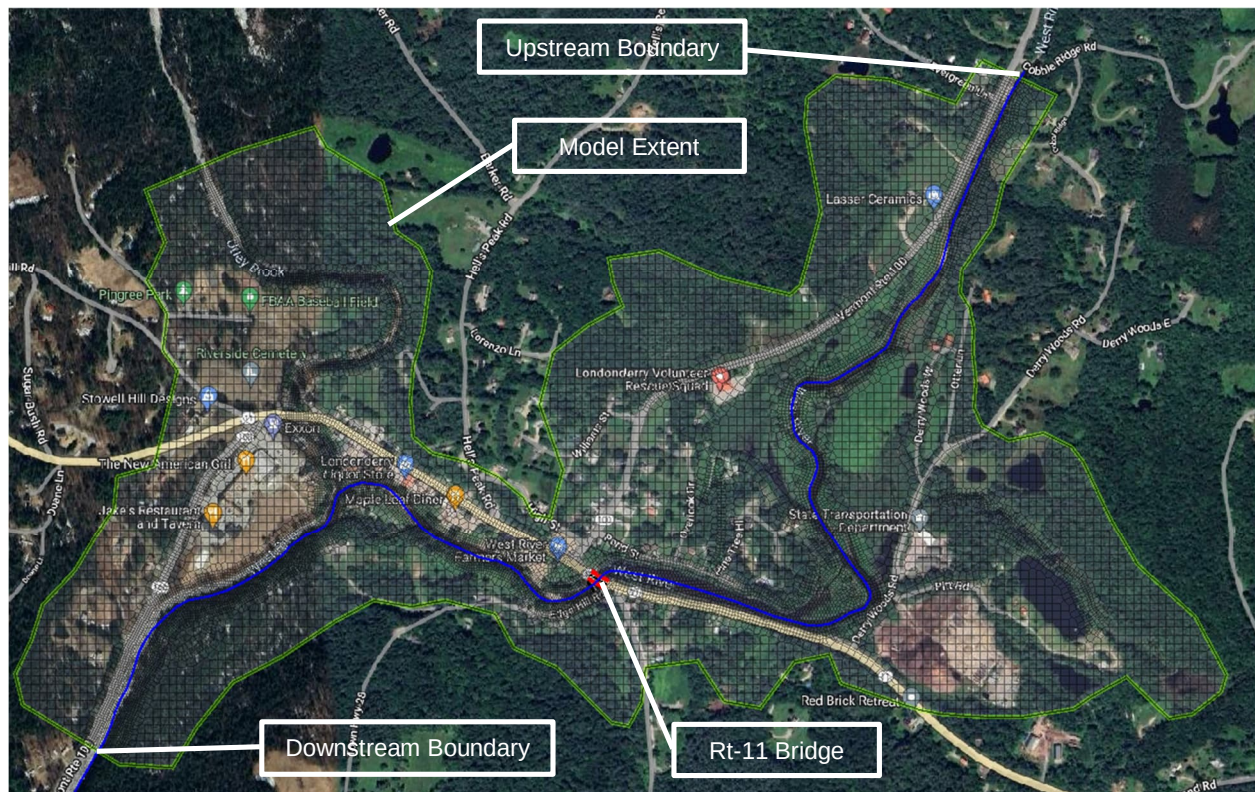


Figure 14: Hydraulic Model Mesh

7.2 Existing Conditions Model

7.2.1 Model Setup

The terrain for the model was developed from a combination of ground survey data collected by D&K in November 2021 and 0.7-meter resolution LiDAR data (VCGI, 2016). Various sections of the terrain were modified based on channel survey and field measurement performed by SLR. Buildings were incorporated into the terrain to simulate the flow around and between structures during a flood. Nominal node spacing in the computational domain was set to 50 feet. Breaklines were used to align the model cells with the stream channel, roadways, and other hydraulically significant terrain features. A cell spacing of 15 to 20 feet was used along the stream channel to help capture the details and shape of the channel. Williams Dam and the Route 11 Bridge were incorporated into the model mesh using a 2D connection that use weir, pressure, and momentum equations to simulate the hydraulics of each structure.

The hydraulic model was used to simulated both the estimated peak flood flows (i.e., steady flow) and the time-varying flood hydrographs (i.e., unsteady flow). Unsteady flow allows the model to account for the attenuating effects (i.e., flood reduction through storage) of the dam's impoundment and floodplain. The flows were input at upstream boundary conditions along the West River and Utley Brook in the hydraulic model. The downstream boundary condition for the model was determined using normal depth. Boundary conditions were located far enough upstream and downstream to avoid influencing modeling results in the primary study area around Williams Dam and the Utley Brook confluence.



7.2.2 Model Validation

Following the July 2023 flooding, USGS surveyed high water marks created by flood debris and staining on buildings in Londonderry (Figure 15). The elevations of the surveyed high water marks were compared to modeled flood water surface elevations for validation. Within the vicinity of Williams Dam, the difference between the measured and modelled water levels varied between 0.1 and 0.4 feet. The model was also validated by comparing the inundation extent in the model to aerial photos of the July 2023 flood (Figure 16). The validation effort indicated that the assembled hydraulic model is properly representing large floods in Londonderry and can be used for the Williams Dam flood analysis and evaluating flood mitigation alternatives.

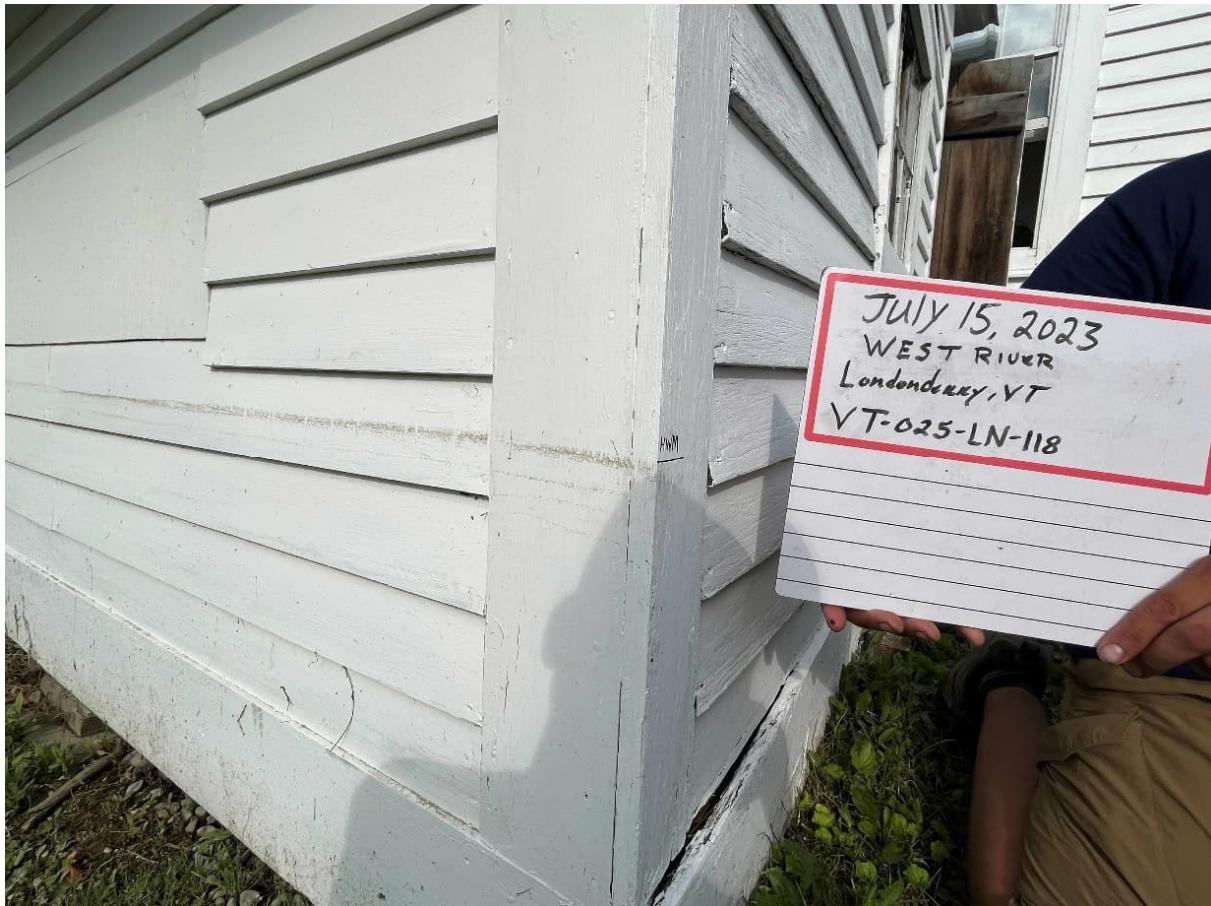


Figure 15: High Water Mark Along Route 100 Upstream of Williams Dam





Figure 16: Model Validation Using High Water Marks

7.2.3 Comparison to Previous Hydraulic Model

This study expands upon previous studies of Williams Dam and its effect on flooding within Londonderry. The study performed by D&K in 2021 used a hydraulic model to evaluate dam removal as one of four alternatives for addressing the existing deficiencies of the dam. A new hydraulic model was created for this study to serve as an independent check on previous efforts. For the 10-year flood, the flood depths and extent in both models are similar with minor differences along the floodplain and near the model boundaries. The difference between the model results is larger for the 100-year flood, especially when comparing the inundation extent in the downtown shopping plaza.

The discrepancies between the model results can be attributed to a variety of factors included difference in Manning's roughness coefficients, model extent, channel measurements, and boundary conditions. One of the main differences between the models is that the river channel in the D&K model terrain appears to have been developed from LiDAR data outside of the survey area near the dam. SLR modified the model terrain to include the channel dimensions with surveyed cross sections. Another major difference between the models is that the D&K model appears to have applied a higher roughness coefficient to simulate flooding in the



downtown area. SLR chose to incorporate the individual buildings into the model terrain to create more realistic simulation of the flooding around buildings.

7.2.4 Results

7.2.4.1 Existing Conditions

Various flood events were simulated using the hydraulic model to evaluate the effects of Williams Dam and the Route 11 Bridge on flooding in Londonderry. For the 10-year flood, the Route 11 Bridge does not overtop but flooding takes place upstream of the dam/bridge along Route 11 and Route 100, and downstream around the businesses and homes along Route 11.

During the 100-year flood, flows overtop the Route 11 Bridge by several feet, inundate the intersection of Route 11 and Route 100, and cause extensive flooding downtown. Similar results are produced for the July 2023 flood simulation (Figure 17). The bridge is not entirely overtopped but flood waters cross over Route 11 along both sides of the bridge and flow down the road through town. The model results show that the dam and bridge constrict flood flows along the West River raising the upstream water level and inundating roads and building along the edge of the impoundment. The influence of the dam/bridge constriction extends approximately one mile upstream to Cobble Ridge Road Bridge.

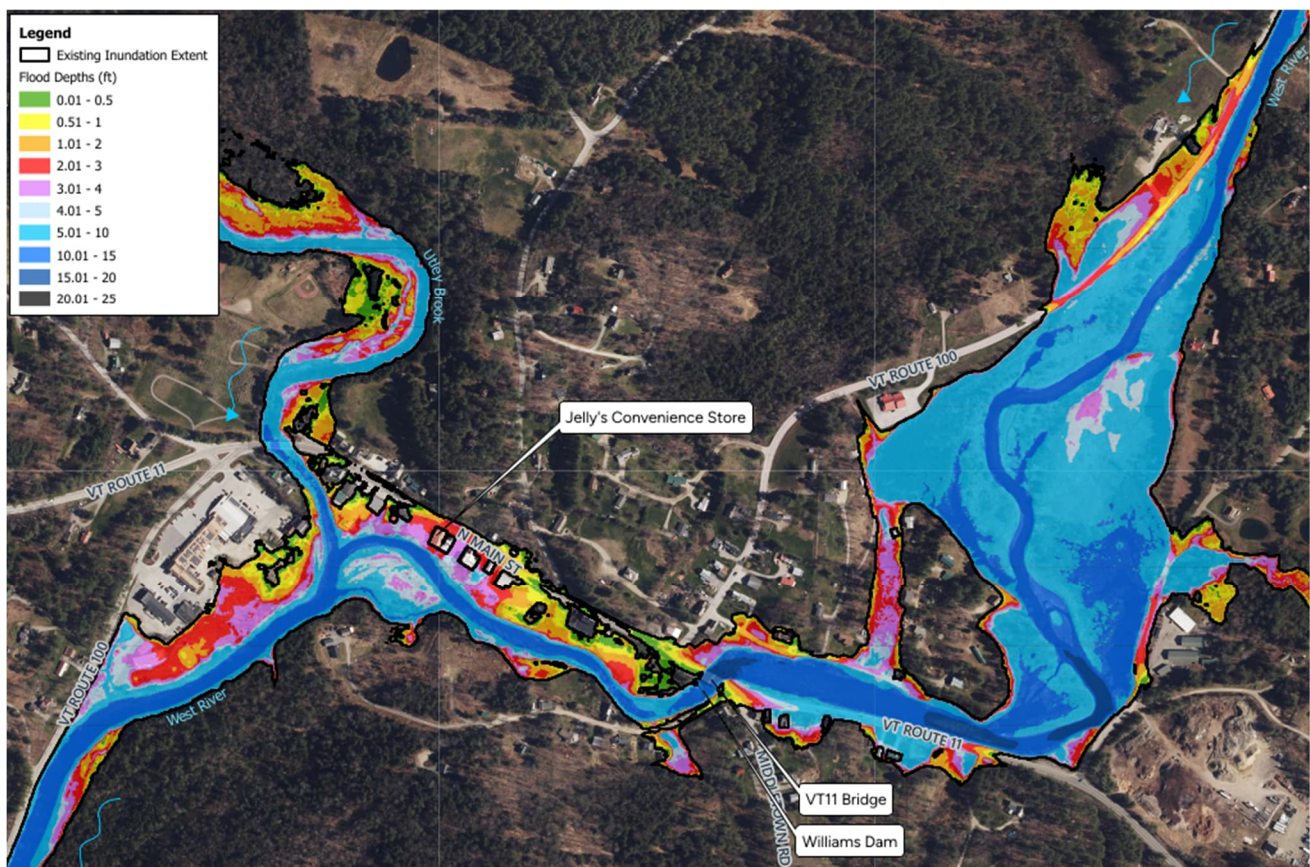


Figure 17: Modeled Flood Depths – July 2023 Flood – Existing Conditions



Model results indicate that the storage provided by the impoundment does not provide reduction of peak flows or reduce the extent of flooding downstream of the dam. Flood attenuation generated by the existing dam was evaluated by comparing the results from two model simulations – 1) the estimated flood hydrograph from the July 2023 flood and 2) the estimated constant peak flow from the July 2023 flood. The resulting flood extents produced by both simulations are nearly identical suggesting that the dam's impoundment does not provide enough storage to reduce flooding downtown during large floods.

7.2.4.2 Dam Removal

If Williams Dam were removed, more flood storage would be available as the water would start at a lower elevation when a flood arrives. Removing the dam and accumulated sediment could increase the total volume available for flood storage by 46 acre-feet. Due to the bedrock that the dam sits on, a small volume of water (approximately 3 acre-feet) would remain impounded at the site even if the dam is removed. Under the same flood flow conditions where the existing impoundment storage would be filled, the West River could provide an additional 91 acre-feet of storage if the dam and sediment were removed (Figure 18).

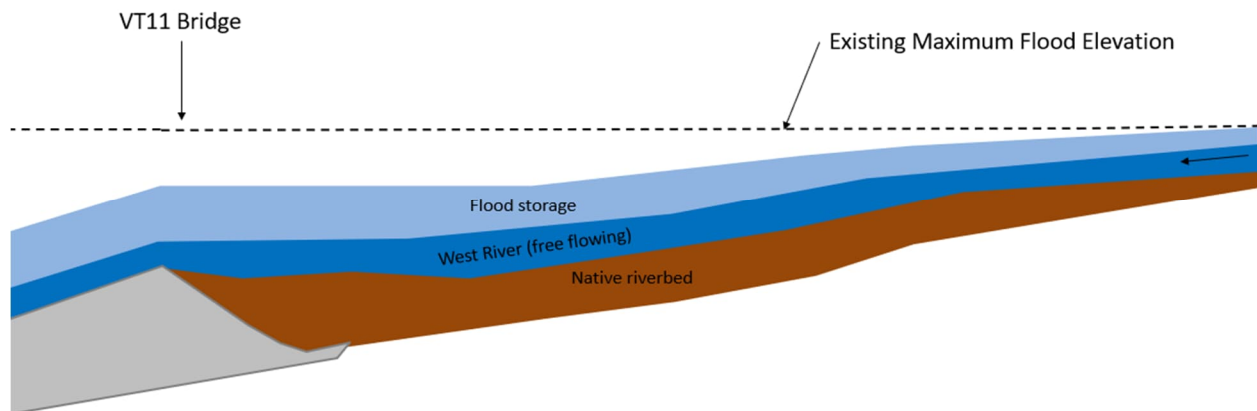


Figure 18: Impoundment Diagram – Post-Dam Removal

For the July 2023 flood, the model results suggest that dam removal would reduce flooding along Route 11 and Route 100 upstream of the dam/bridge. Removing the dam reduces the flow constriction at the Route 11 Bridge by increasing the flow area and hydraulic capacity of the bridge opening. The flood water elevation upstream of the dam/bridge would be reduced by up to 7.5 feet (Figure 19), preventing flood flows from crossing over Route 11.

Flood water would still inundate the upstream floodplains, but the depth of flooding would be reduced. The water level reductions would extend upstream to the Cobble Ridge Road Bridge. In the downtown area, flood depths and extent would remain unchanged following dam removal (Figure 20). The attenuation provided by the existing impoundment is insignificant compared to the size of the July 2023 flood. The impoundment fills long before the flood reaches its peak.



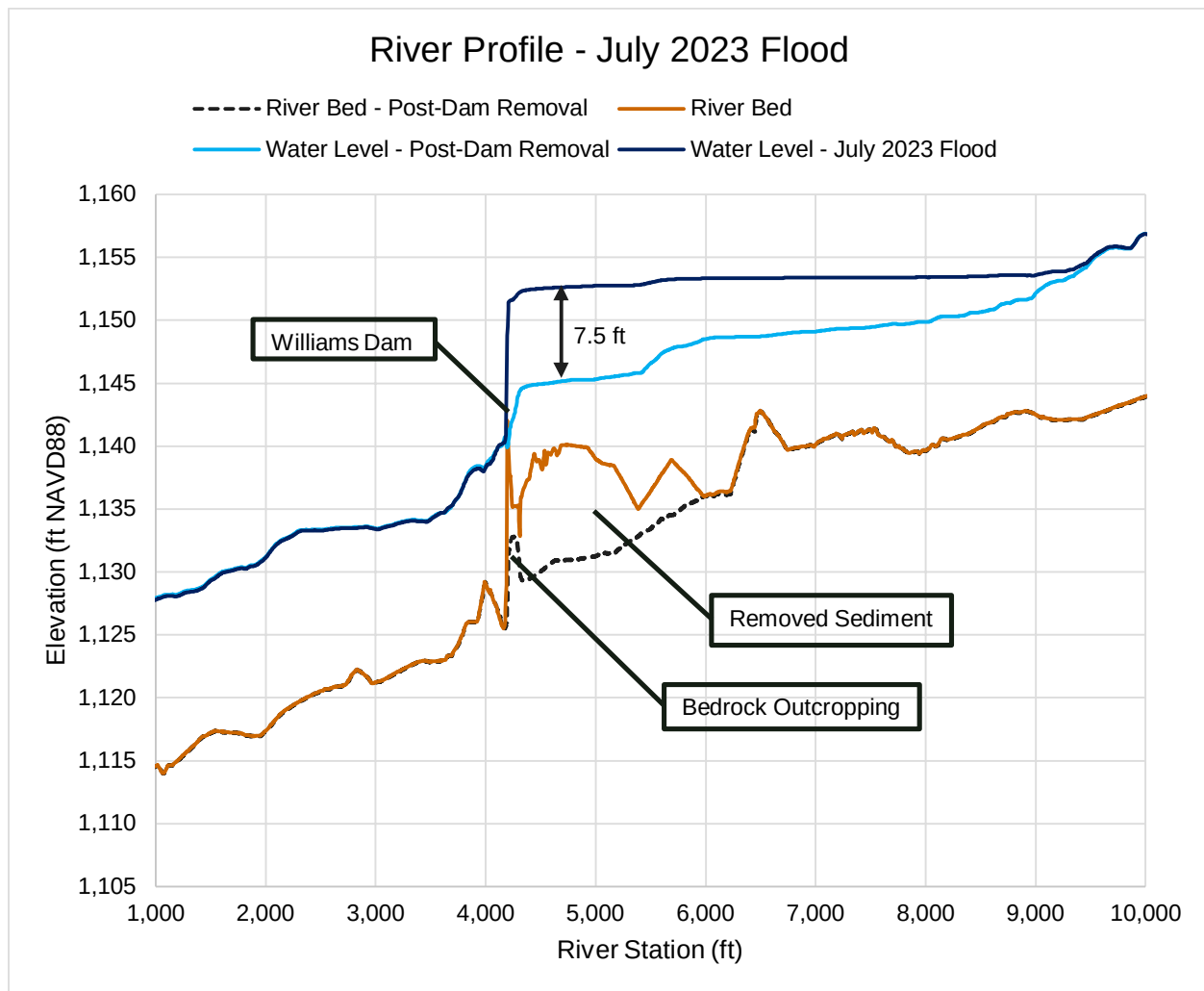


Figure 19: Flood Profile from the Hydraulic Model – July 2023 Flood



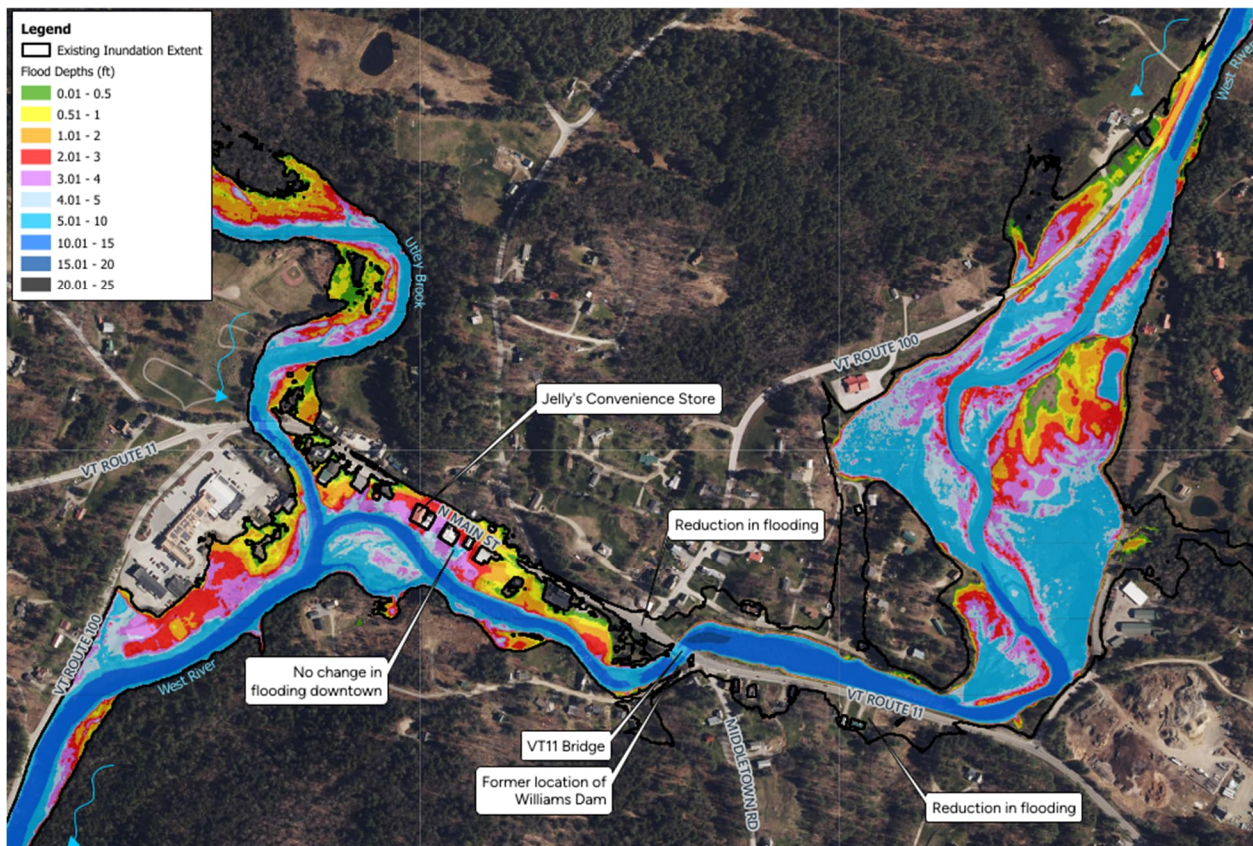


Figure 20: Modeled Flood Depths – July 2023 Flood – Post-Dam Removal

Model results indicate that the flood velocities within the upstream channel and the channel just downstream of Williams Dam would increase if the dam is removed. The formerly impounded water would be free to naturally flow downstream. At the Route 11 Bridge the flood flows that crossed over Route 11 would remain in the channel during large floods. The effects on velocity caused by the removal of the dam would extend a short distance downstream from the bridge. A steep, bedrock/boulder riffle, located approximately 200 feet downstream of Williams Dam controls flow depths and velocities (i.e., is a tailwater control). Below this riffle before the river bends to the right facing downstream, the river will not experience any changes due to dam removal.

7.2.4.3 Dam Removal and Bridge Removal (Natural Conditions)

Together, the dam and bridge create a major constriction along the West River. Upstream of the dam, the width of flow across the floodplain is over 800 feet in some locations. Flood flows must squeeze through a bridge opening that is only 88 feet wide (85 feet wide if you exclude the width of the pier). The dam reduces the hydraulic capacity of the bridge by raising the water level.

While the hydraulic capacity of the bridge would increase if the dam were removed, the bridge itself still constricts flood flows and raises the upstream water level. A simulated was performed with both the dam and bridge removed to determine how the constriction effects flooding and evaluate if a larger bridge would reduce flood levels upstream.



The model results suggest that the bridge raises the upstream water level, but that widening the bridge would only provide a slight reduction in water level during a flood. If Williams Dam and the accumulated sediment were removed, the channel upstream of the bridge would convey most of the flood flows. The bridge does not act as a major constriction under these conditions.

During large floods, Route 11 would be inundated before the bridge is overtopped. With the dam removed, the effects of the bridge only extend 1,300 feet upstream.

7.2.4.4 Floodplain Restoration at Utley Brook Confluence

The hydraulic model was used to evaluate if restoration of the floodplain located near the confluence of Utley Brook and the West River (Figure 21) would reduce flood levels. The floodplain covers an area of 2.1 acres. Results from the model suggest that excavating the floodplain to improve connection to the river and store more flood water will not reduce flood depth or extent during the July 2023 flood (Figure 22). The flood water level along Route 11 would decrease by less than 0.1 feet due to the floodplain restoration project. The floodplain reduces flood depths by up to 0.5 feet during the 10-year flood. The flood water surface profile suggests that a downstream floodplain constriction and the additional inflows from Utley Brook are backwatering the area and reducing the potential benefits of the floodplain reconnection.



Figure 21: Proposed Floodplain Restoration Site



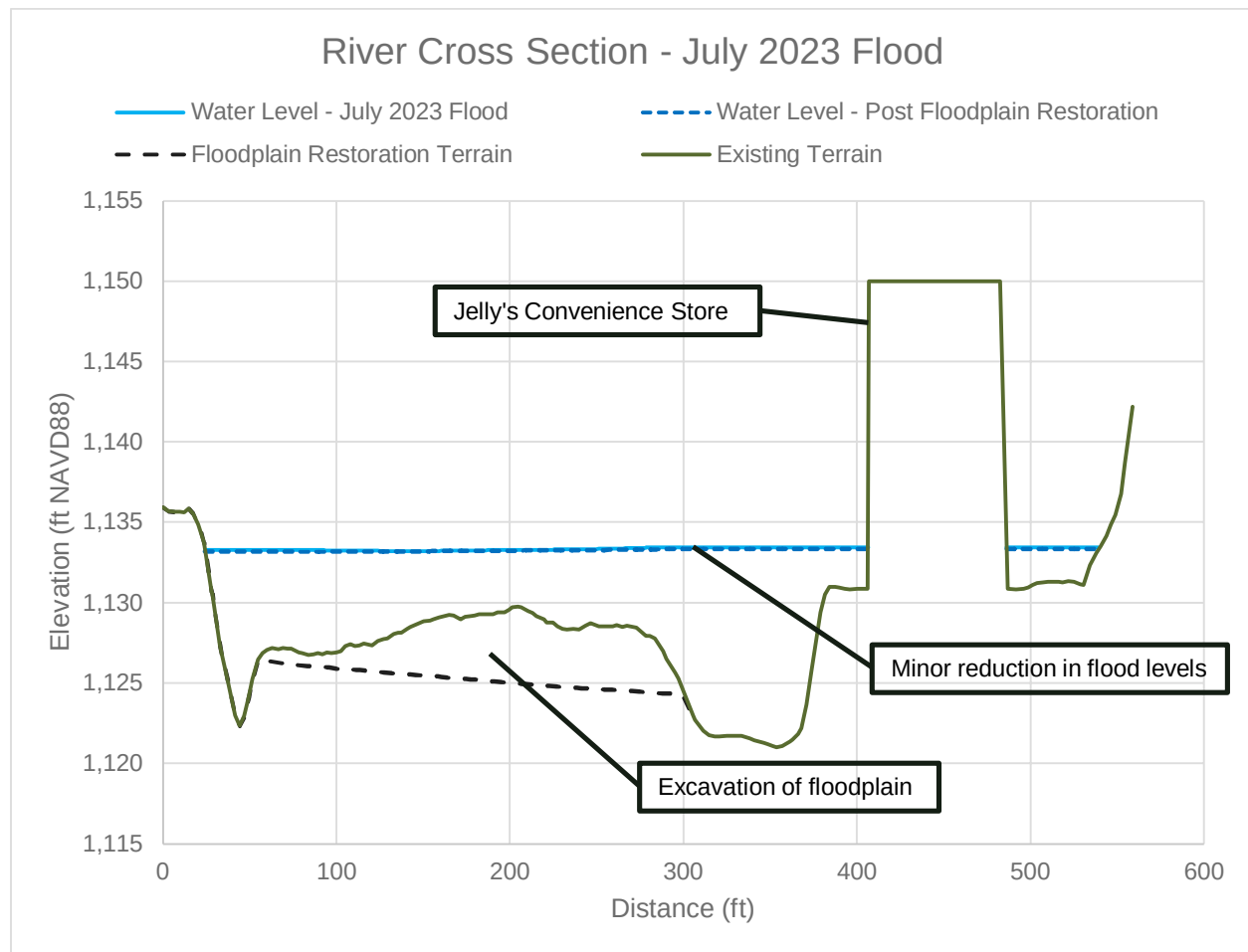


Figure 22: River Cross Section – July 2023 Flood – Floodplain Restoration

8.0 Conclusions and Recommendations

Based on the results of the hydraulic analysis, Williams Dam is constricting flood flows along the West River, increasing the depth of flooding, and increasing the extent of flooding upstream of the dam. The storage provided by the dam is insufficient to reduce flooding during large floods. Changes to downstream flooding are not predicted if the dam is removed.

Removal of the dam would increase the hydraulic capacity of the Route 11 Bridge, reduce flooding along Route 11 and Route 100, and reduce flooding for the properties upstream of the dam.

Previous study evaluated four alternatives for addressing the deficiencies with Williams Dam. Due to the poor condition of the structure, the “No Action” alternative was deemed to not be acceptable. Given the poor condition of the dam, the Town must either remove, replace, or repair the dam.

Previous information and the analysis performed here point to the recommendation for dam removal to eliminate the obsolete structure that requires substantial investment to repair or



replace. Dam removal provides small, local flood reduction benefits illustrated by the current hydraulic modeling, and more importantly eliminates the potential for a dam breach causing a large, unexpected flood wave in Town. If the dam fails, the large volume of sediment stored behind the dam would impact channel stability, fish habitat, and water quality for years as the material works its way through the system.

The removal of the dam will improve the hydraulic performance of the Route 11 Bridge.

Dam removal will slow the buildup of ice and reduce the likelihood of breakup ice jams. The lower starting water surface with the dam removed provides additional ice storage during thaws and spring ice out. The anticipated bedrock falls at the current dam location will continue to break up larger ice sheets that make it to the dam location. Dam removal will likely reduce ice jam flooding.

The anticipated presence of a bedrock cascade or falls at the dam site following removal will preserve the aesthetics of the site. The site and sound of falling water will be preserved in the center of Town, albeit at a lower elevation. If removal is selected by the Town, installation of a sign at the dam site is recommended to document the history of the dam.

Dam removal would eliminate dam registration fees and maintenance costs that are likely to be required with the recent changes to Vermont Dam Safety Rules. Many funding sources exist for dam removal so it is likely that the Town would be able to work with partners that would assist with project management and funding for dam removal.

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Appendix A Williams Dam (D&K, 2022)

Williams Dam Flooding Analysis

Londonderry, Vermont

SLR Project No.: 20433.00002

January 5, 2024



Williams Dam

Town of Londonderry



Prepared By:

**DuBois
& King** inc.

March 24, 2022



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Introduction

Williams Dam (State ID #115.01) is located on the West River in Londonderry, VT in close proximity to VT Route 11. The State of Vermont completed an inspection of the dam in August 2015, and recommended that the Town of Londonderry (Town) retain an engineer to evaluate the dam. The State recommendations included monitoring erosion occurring on the left abutment of the dam, and the evaluation and preparation of plans to repair, replace, or remove the dam. These recommendations were based upon the observed poor condition of the dam and the potential risk to the stability of the Vermont Route 11 (VT Rte 11) bridge and the downstream inundation area.

In November 2021, the Town authorized a comprehensive study of alternatives for Williams Dam. The Town engaged DuBois & King, Inc., to evaluate the condition of the dam and determine comparative costs for the dam's rehabilitation, replacement, or removal. This evaluation included:

- Inspection of the dam,
- Meetings with Town Staff and State of Vermont Dam Safety engineers,
- Review of available information and records,
- Development of alternatives including conceptual engineering plans and construction cost estimates,
- Evaluation of conceptual alternative permitting requirements, and
- A presentation to the Town.

Dam Description

Williams Dam is a run-of-the-river dam constructed of stone masonry and concrete in the 1800s. A run-of-the-river dam is a structure constructed to impound a portion of a river with the normal flow of water flowing over the dam. Williams Dam was originally constructed to generate power for an adjacent machinery shop.

The dam appears to be founded on bedrock, with stone masonry that was capped in concrete. The dam is approximately 20-ft tall from the downstream toe of the dam to the top of the intake structure and approximately 90-ft long between the abutments. The dam consists of a primary spillway and a low-level outlet structure. The low-level structure contains a 6-foot diameter corrugated metal outlet pipe and vertical slide gate on the upstream side of the structure.



Dam Background & History

The Londonderry Historical Society states that the Town was chartered in 1780, and by the 1800's the Town's population was approximately 1,300 people due to an increase in manufacturing jobs. The Gazetteer and Business Directory of Windham County, VT, 1724-1884, lists several manufacturing businesses from gristmills to a tub factory. A three-story machine shop on Main Street was erected in 1867. In 1883, Mr. Williams constructed a stone dam across the West River for the machine shop.



1908 – Mill Dam, Bridge and Bacon's Store in Londonderry, VT
Source: Shelburne Museum, Shelburne, Vermont

The Town of Londonderry resides within the Connecticut River watershed, and a majority of developed land within the Town occurs along the West River. The Town has experienced major flooding events along the West River near Williams Dam.

In the Fall of 1927, Vermont experienced what is considered the worst flooding event recorded. That fall, the State was experiencing unusually high rainfall. Between November 2nd and November 4th, 1927, the State of Vermont recorded a rainfall depth of 8.71 inches. Flooding within Vermont rivers destroyed approximately 1,285 bridges, and killed 84 people. Notes associated with the following photo describe the pictured bridge, upstream of Williams Dam, to have been damaged or destroyed and replaced in 1928. The photo also shows that the store and mill from the 1908 photo remain.



1928 – Bridge built after the flood of 1927, Bacon's store on right, Williams mill on other side of bridge.
Source: "Crossings, A History of Vermont Bridges" by Robert McCullough.

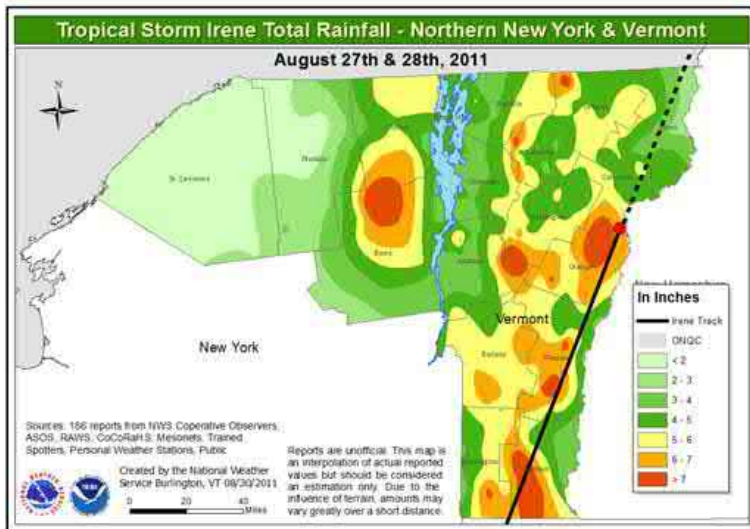
Documentation of flooding and other records of the dam between 1928 and the 1970's could not be found. However, in May and June 1973, Vermont again experienced above average rainfall. On June 28, 1973, a significant storm event with 7.19-inches of rainfall was recorded in South Londonderry. Notes associated with the following photo describe the bridge to be damaged again. In this photo, the mill structure appears to have been removed and there appears to be damage to the abutments of the dam. Vermont Dam safety reports that the last documented rehabilitation of the dam was in 1978 when the low-level gate structure was constructed and repairs were made to the primary spillway to address damages from the 1973 flood.



1973 – Intersection of Vt. Rte. 11 and 100 in north Londonderry village after 1973 flood
Source: Vermont State Archives and Record Administration

In June 2008, the Vermont Agency of Natural Resources issued Basin 11 Management Plan, West River, Williams River, Saxton River. This plan outlined known issues within the basin and effects to water quality, habitat, etc. The Plan discusses that Williams Dam be considered for dam removal due to deteriorating condition, blocking fish passage, sediment accumulations and potential safety hazards.

The second largest flooding event occurred in 2011, when Hurricane/Tropical Storm Irene passed through the Connecticut River watershed. NOAA reports that between 4 and 11-inches of rainfall occurred in Vermont on August 28, 2011. At Williams Dam in Londonderry, the West River overflowed the banks of the river and flooded the VT Rte 11 and 100 area.



2011 – Tropical Storm Irene Rainfall and Flooding in Londonderry on VT Route 100

Following the 2011 storm, discussion regarding flooding near Williams Dam resulted in structures adjacent the dam being removed to improve the floodplain in 2013. The 2016 Tactical Basin Plan for the West, Williams and Saxtons Rivers and adjacent Connecticut River Tributaries created a list of dams to be removed to have the greatest ecologic benefit, listing Williams Dam with the highest rank.



March 2022 - Ice from West River upstream of the Dam

Data Collection & Site Investigation

DuBois & King completed several site visits to collect information related to Williams Dam. This included a topographic and bathymetric survey of the dam, wetland review, a dam inspection, and sediment sampling.

Dam Survey

D&K conducted a limited survey of the Williams Dam and the surrounding area. The purpose of the survey was to collect key dam measurements and topographic/bathymetric information suitable for producing an existing conditions base plan and to develop conceptual alternative plans and construction cost estimates.

The survey took place on November 15 & 16, 2021. The survey was based upon the NAD83 VT feet State Plane horizontal datum and the NAVD88 feet vertical datum. The topographic survey included the dam and abutments, the VT Rte-11 bridge, ground shots along the upstream and downstream banks of the West River, and surrounding areas such as Edge Hill Road, the Veterans Park and existing dry hydrant location. In addition, a bathymetric survey was completed of a portion of the West River using a dual frequency sonar probe. The limits of the bathymetric survey extended 500-ft upstream of the dam and 100-ft downstream of the dam.

Survey data was imported to AutoCAD, a computer-aided engineering drafting software, to develop elevation models and site layout. This information was augmented with additional topographic information from a publicly available Light-Detection and Ranging (LiDAR) digital elevation model, Middle Connecticut River sub basin 2016 0.7-m DEM. An Existing Conditions Plan depicting Williams Dam and the surrounding area is included in **Appendix A**.

Wetland Review

D&K conducted a preliminary wetland investigation at the site. The purpose of the wetland investigation was to identify possible locations of wetland areas near the dam that may be impacted by modifications to the dam. This information is important to developing permitting requirements for each alternative.

Two wetlands were identified near the dam and approximate boundaries were established. This site visit occurred on November 30, 2021, outside of the growing season, and did not include formal wetland delineation. The wetlands are likely Class II because they are contiguous with the West River, but review by the district wetlands ecologist will be necessary to verify this wetland classification.

The Natural Resources Atlas Map shows no elements of concern (rare, threatened, or endangered species or significant natural communities) in the immediate project area. No significant natural communities were observed during the course

of fieldwork. A field survey during the growing season would be necessary to determine whether rare, threatened, or endangered species are present in the project area. A memorandum summarizing the wetland investigation is included in **Appendix B**.

Dam Inspection

On November 30, 2021, D&K engineers including Charles Johnston P.E., Andrew Sampsell, and Bobby Lanzilotta, conducted a site visit to inspect the dam, take additional measurements of the dam, review the upstream and downstream areas of the West River, and meet with the Town to discuss the project.

The inspection began with a review of the primary spillway and low-level structure. The days leading up to the inspection had a mix of rain and snow precipitation, which affected the conditions under which the inspection took place. The dam was observed to have approximately a foot of flow over the primary spillway and snow cover in the surrounding area. The primary spillway appears to be a stone masonry structure with a concrete cap. A concrete apron on the upstream side of the dam extends from the low-level structure on the right side of the river (directions looking downstream) to the left abutment. Pressurized leakage is occurring at different heights and locations on the downstream face of the structure.



November 2021 – Williams Dam

The low-level intake structure consists of a slide gate on the upstream face, a 6-foot corrugated metal outlet pipe, and open concrete flume on the downstream

side. The condition of the overall structure is very poor. The slide gate stem is bent making the gate inoperable. The gate is sealed on the upstream side of the outlet pipe but there is some seepage at the bottom of the gate. The bottom of the gate seals to a wooden sill, and during the inspection the wood was observed to be cracked and covered in ice. Silt has accumulated on the upstream side of the gate, which may contribute to it being inoperable. Fine textured sediment is leaking through the gate sill and accumulating in the outlet pipe.

The outlet pipe is heavily deteriorated with rusting observed throughout the pipe. Soundings on the pipe indicated the metal pipe has delaminated from the concrete. Pressurized water leaks through the pipe and water flowing between the pipe and concrete at the outlet end of the pipe are further indicators that the pipe is delaminated from the concrete.



November 2021 – Low-Level Outlet



November 2021 – Dam to concrete structure

The concrete portion of the structure was observed to be in very poor condition. The section of the structure that the outlet pipe appears to have been constructed as a concrete cap over the stone masonry dam. Large portions of this concrete have spalled, exposing the stones and allowing hydraulic connection to the upstream pool. The concrete flume wall, which extends downstream of the dam, has separated from the base slab of the structure and water can be seen flowing between the wall and slab. The flume wall also has large spalls, however, no steel reinforcement was found in areas where the concrete has separated from the structure. The right flume wall was noted to be out-of-plumb, which may indicate a global stability failure of the wall.



November 2021 – Primary Spillway



November 2021 – Right wall of Outlet Flume

The right abutment consists of several components including the VT Rte-11 bridge abutment, the concrete wall upstream of the intake structure, the intake structure, and a riprap slope. During the inspection the ground was covered in snow, however, no seepage was noted in the earthen abutment area. This may indicate the concrete walls are acting as sufficient hydraulic cut-offs. The slope of the abutment is steep with a portion of the riprap extending into the river.



November 2021 – Left Abutment



November 2021 – Flow through left abutment

The left abutment is comprised of the banks of the West River that supports Edge Hill Road. The dam contact at the abutment is a combination of exposed bedrock and large riprap stone. The river at the time of the inspection was flowing through the riprap and along an exposed portion of bedrock along the far left side of the river. The left abutment appears to have been washed out during a high flood event, which allows the river flow around the concrete dam. The depth of the flow

around the left side of the dam is difficult to determine due to a large portion being frozen at the time of the inspection.

The impounded area of the dam extends upstream of the VT Rte-11 bridge and through several bends of the West River. During the site visit, the majority of the impounded area was frozen with some exposed portions near the dam and along the edges of the river. The impoundment appears to be heavily filled with accumulated sediment. In one location, there appears to be a small island of sediment deposition near the right bank of the West River. A dry hydrant is located approximately 310-feet upstream of the dam.

Downstream of the dam, there is a scour hole at the toe of the dam, possibly from flow over the dam or from the natural formation of the bedrock the dam was constructed upon. Downstream, the inspection continued to observe crossings of the West River and Utley Brook, which converges with the West River approximately 1800-feet downstream of the dam. Other than the VT Rte-11 crossing at the dam, Rte-100 crosses the river twice downstream of the dam. Overall, the West River downstream of the dam consists of high banks with relatively flat surrounding floodplain.

Sediment Sampling

As part of the dam inspection, D&K collected two samples of sediment from the West River. The purpose of the sediment collection was to test the sediment for possible contaminant impacts. For future improvements, sediments removed during dredging activities may require testing for contaminants to verify if the sediment is acceptable to be disposed of as clean fill or development soils. River flow over the dam is disturbed and suspended sediments naturally collect upstream of the dam.

The first sample was collected on the left side of the west river under the VT Rte-11 Bridge. The second sample was collected from the edge of the river near the dry hydrant location. These sample location were selected due to the possible dredging that would be needed upstream of the dam for each of the evaluated alternatives, and potential dredging of the dry hydrant intake. The sample locations are shown on the Existing Conditions Plan in **Appendix A**.

Samples were sent to Endyne Inc. for testing. The samples were tested for:

- Total petroleum hydrocarbons in the gasoline and diesel range organics (EPA 8015 method),
- Oil & Grease (EPA 1664 method),
- Volatile and Semi-Volatile organic compounds (EPA 8260 & 8270 method),
- RCRA heavy metals (EPA 6020C/7471 method),
- Polychlorinated biphenyl (EPA 8082 method),
- Pesticides (EPA 8081B method), and
- Total Kjeldahl Nitrogen (TKN) (EPA 351.4 method)

The samples were tested and compared to the “Vermont Watershed Management Division’s Recommended Guidelines for Evaluating Contaminant Concentrations in Freshwater Sediments and the Potential for those Contaminants to Adversely Affect Aquatic Biota”. A summary of the results and comparison to Vermont standards are included in **Appendix C**.

The results of the sediment testing indicate that no contaminants were detected above the State of Vermont Threshold Effect Concentration (TEC) or Probable Effects Concentration (PEC) limits. Additional testing of material dredged from the West River will be required during construction; however, it was assumed the dredged sediment would be suitable for common fill in the alternative analysis.

Existing Conditions Hydraulic Analysis

To develop alternatives for Williams Dam, D&K conducted a hydraulic analysis of the dam. The purpose of this analysis was to model the dam during key design flood events (10-yr, 50-yr, 100-yr, and 1000-yr) and evaluate the dam’s performance in reference to the anticipated 2022 VT Dam Safety Program design requirements.

The hydraulic analysis was completed using US Army Corps of Engineers HEC-RAS (version 6.0) 2D hydraulic modeling software, which is a computer program that models the flow of water through two-dimensional terrain surfaces. The program is also used for analysis of peak water surface, velocities, flow, and mapping the extent of flooding.

The model was created utilizing the digital elevation model from the D&K survey and publically available LiDAR. The West River is part of the Federal Emergency Management Agency Flood Insurance Study (FEMA FIS) for Windham County, Vermont, which was completed to aid in the establishment of flood insurance rates. The FEMA studies model various aspects of watersheds and rivers to accurately establish extent of flooding for various storm events. FEMA FIS is widely accepted as an accurate measure of flooding. D&K utilized the study’s flow values for the hydraulic analysis of Williams Dam.

Flood Event	Flow (cubic feet per second (cfs))
10-year (10% probability)	5,419
50-year (2% probability)	11,500
100-year (1% probability)	11,759
500-year (0.2% probability)	20,552
1000-year (0.1% probability)	21,912

The existing conditions model began at a FEMA FIS cross-section approximately 4000-feet upstream of the dam. The model was extended 4100-feet downstream of the dam, beyond the confluence of Utley Brook and the West River. It was assumed that during larger storm events, Utley Brook, might cause backwater to Williams dam and have an impact upon flooding.

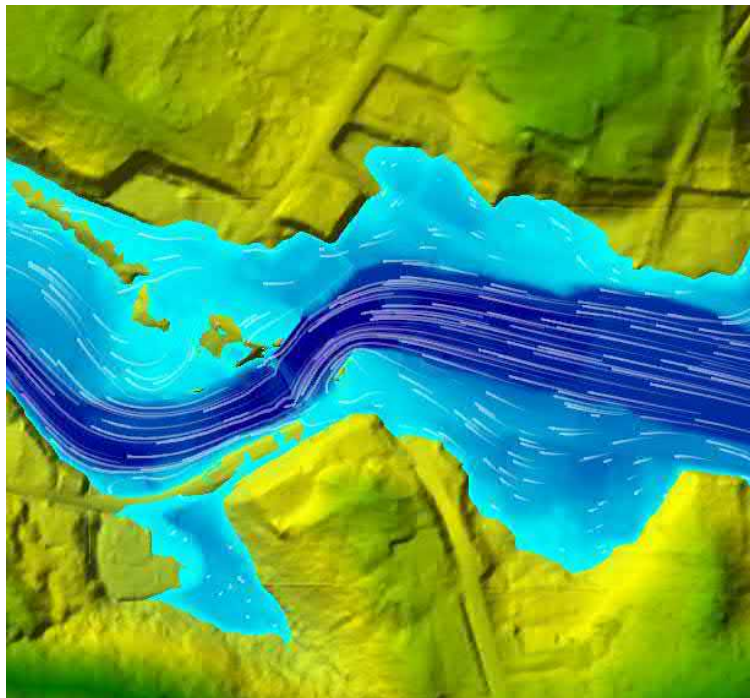
The model utilizes land cover aspects to determine flow along the terrain file. Land cover types such as open fields have different flow characteristics from wooded or urban areas. These land cover types were mapped utilizing ortho-imagery and notes from the site visit. In general, the Town of Londonderry was broken into three major land coverage complexes: agricultural, forest, and urban/residential.

The model also included features such as the VT Rte-11 bridge. The hydraulic opening of the bridge restricts the flow that reaches Williams Dam. Additional flow can reach the dam if flooding flows over or around the bridge. Due to this, the model includes information like the bridge deck, low chord steel beams, and concrete abutments.

Results from the model are separated into two important sections. The first section is taken at the upstream end of the bridge to capture information prior to the bridge restriction. The second section is taken at the dam.

Location	Associated Water Surface Elevation (ft.)				
	10-year	50-year	100-year	500-year	1000-year
Bridge (Deck El. 1151.7-ft)	1150.78	1154.14	1154.25	1156.88	1157.23
Dam (Spillway El. 1141.9-ft)	1145.08	1151.07	1151.25	1154.93	1155.33

Results from the model indicate that the bridge opening is restricting flow to the dam. Flow that diverts around the bridge flows through the surrounding area and re-enters the West River after to the dam. The model also shows the 10-year flood event is not expected to overtop the VT Rte-11 bridge. The flood inundation mapping associated with the existing dam for the 10-year and 100-year flood events are included in **Appendix D**.



HEC-RAS 2D Flow Analysis

Dam Safety Coordination

During the process of establishing the condition of Williams Dam, D&K coordinated with Vermont ANR Dam Safety Program (VT DSP). Meetings with the Town and VT DSP discussed the dam's condition, upcoming dam regulation changes, the dam's hazard classification, and other aspects of the dam.

Prior to D&K's involvement, VT DSP conducted an inspection of the Williams Dam on August 6, 2015. The inspection report identified concerns regarding the dam's condition and gives the dam an overall condition rating of Poor. Key observations from the 2015 inspection include:

- Numerous cracks within the concrete, forming spalls and voids and allowing leakage through the dam.
- Leakage through the wooden sill of the sluice gate at approximately 1,000 gallons per minute.
- The sluice gate stem is not operable due to a bend in the stem.
- Corrosion, leakage, and section loss in the 6-foot diameter outlet pipe.
- Cementitious material erosion is occurring within the construction joints in the right training wall.
- Leakage through the right abutment.

In the 2015 report, the State of Vermont classified Williams Dam as a Low Hazard Dam.

Dam hazard classifications are not based upon the current condition of the dam, but rather the potential impacts in the event of a dam failure. Dam classifications are defined as follows:

- Low Hazard – Dams where failure or mis-operation results in no probable loss of human life and low economic and environmental losses.
- Significant Hazard – Dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or other impacts of concern. 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.
- High Hazard – Dams where failure or mis-operation will probably cause loss of human life.

As part of this study, D&K coordinated with the Vermont Dam Safety Program to complete an updated hazard classification of the dam. The classification of the dam is important to the alternative analysis as it establishes the regulatory and design standards for the dam rehabilitation and replacement alternatives.

Dams in the State of Vermont are regulated by 10 V.S.A Chapter 43, and the engineering guidelines associated with the existing law are considered outdated. The Dam Safety Program recently adopted new Administrative Rules, which went into effect on August 1, 2020. The administrative rules establish hazard classification updates, inspection schedules, and other requirements for dam owners. In addition to the Administrative Rules, Standard Engineering Rules are expected to be adopted in 2023, which will establish engineering design requirements for new and existing dams.

To quantify the potential impacts of a dam failure, a breach analysis of the dam through the downstream floodplain is typically completed. A breach analysis is helpful tool, not only for emergency action planning purposes, but can also support the selection of a project alternative (i.e. if the consequence of the dam failing is significant/costly this can support the decision to make capital expenditures to avoid these consequences). In discussions with Vermont Dam Safety the source for the Low Hazard classification was unknown and sediment accumulation may impact the classification due to downstream impacts.

A memorandum, dated March 2, 2022, by Vermont Dam Safety is included in **Appendix E**, which outlines a breach analysis and reclassification of Williams Dam to Significant Hazard. D&K provided information the Dam Safety Program from the Existing Conditions Hydraulic Analysis and estimates of water and sediment volume impounded by the dam. The Dam Safety program completed the breach analysis utilizing the DSS-Wise Lite program and analyzed Williams Dam under several scenarios:

- Sunny Dam Failure (260 cfs)
- Storm Day Failure (1,620 cfs)
- Storm Day Failure (11,500 cfs)

The reclassification of the dam was based on the potential impacts for property loss in the event of a dam failure.

Summary of Deficiencies

Williams Dam is in poor condition and requires action by the Town of Londonderry. The following is a list of deficiencies identified during the site inspection, by Vermont Dam Safety, and from the analysis.

1. Dam Structural Integrity

The dam structure is no longer acting as an efficient hydraulic cut-off and the integrity of the structure is questionable. Visual indicators, such as pressurized leakage, large cracking and spalling, and walls out-of-plumb show that the dam is experiencing significant deterioration. The dam does not appear to have been constructed with modern materials and is assumed to rely on the weight of the structure to resist loading. Structural stability of the dam was not analyzed for this study, however, the dam is likely experiencing unintended loading from sediment deposition.

Other aspects, such as erosion in the left abutment, has led to the West River to continue to erode through a low point. This area is susceptible to continued erosion of the earthen material, which may lead to a partial breach.

2. Inadequate Dam Operating Controls

The Town lacks the ability to operate the low-level outlet stem to drain the impoundment in case of an emergency. The ability to reduce the water level behind the dam in a controlled way is crucial to increasing the stability of the dam in an emergency. Without the ability to lower the pond, a partial breach or full breach of the dam will result in an uncontrolled release.

In addition, with no way to regularly exercise the low-level outlet to flush sediment downstream, sediment accumulation behind the dam has increased significantly. Dams naturally act as sediment traps, and regularly exercising the low-level outlet allows for movement of sediment downstream.

3. Insufficient Spillway Hydraulic Capacity

Historical flooding near the dam structure has been documented. Hydraulic analysis by FEMA and D&K indicate that the combination of the VT Route 11 bridge and the dam restrict flow in the West River causing flooding upstream of the dam. Removal of the dam has been discussed in several ANR Basin Plans for the West River to reduce flooding and improve aquatic habitat.

Alternative Analysis

The Town of Londonderry requested the following scenarios to be analyzed:

- No Action
- Dam Rehabilitation
- Dam Replacement
- Dam Removal

D&K completed an analysis of these alternatives by outlining the key elements of each, preparing conceptual plans and opinion of construction costs, outlining permitting requirements and other dam safety concerns. Conceptual plans and overlay on ortho-imagery of each alternative are contained within **Appendix F** and estimated opinions of probable construction costs are in **Appendix G**. Each alternative is detailed below. The flood inundation mapping associated with the replacement and removal alternatives for the 10-year and 100-year flood events are included in **Appendix D**.

No Action Alternative

The focus of this alternative is to establish requirements and potential costs that the Town of Londonderry would encounter if one of the following alternatives were not implemented. In this case it was assumed the dam would remain in its current condition and that the Town would not implement any remedial measures to repair the dam.

Without improvements to the dam, the structure is expected to continue to deteriorate. The low-level structure flume walls are separating from the base of the structure, likely due to freeze and thaw of entrapped water between the wall and slab. In addition, the concrete cap of the stone dam is failing and exposing large portions of stone. The leakage through the stones may accelerate this process making the dam less stable. Failure of the dam may occur due to the deterioration of the dam. This alternative does not account for the costs associated with the potential downstream impacts of a failure or for reconstruction of the dam.

As outlined previously, the State of Vermont Dam Safety standards are in the process of being updated. These standards will continue to require the Dam Owner to continue to pay the annual dam registration fee, in addition to other expenses associated with future required inspections. The annual dam registration fee is \$350 for Significant Hazard Dams.

Other expenses the Town may incur due to the new rule change include engineering fees associated with periodic and comprehensive dam inspection. The new administrative rule requires a Significant Hazard dam to have a periodic inspection every 5-years. The Dam Safety Program intends to complete the majority of these inspections, however, depending on their workload, VT DSP may require the Dam Owner to hire an engineer to complete the inspection. This inspection includes review of existing information, a site inspection, and producing an inspection report. To accommodate for this potential expense, the annual fee for this alternative and other alternatives that maintain the dam, includes a set aside of \$500/year.

In addition to the periodic inspection, the Dam Safety program also requires a comprehensive inspection of Significant Hazard dams every 15-years. This is a more detailed inspection to be completed by an engineer hired by the Dam Owner. It involves a review and update to all studies and analyses (H&H, stability, breach, etc.), and an in-depth inspection of the dam. The requirements for this are not yet established, however, to accommodate this future expense the annual fee for this alternative and other alternatives that maintain the dam, includes a set aside of \$1,150/year.

Lastly, with the implementation of the new standards, the State of Vermont will focus initially on High and Significant Hazard Dams to ensure that action is taken to rehabilitate dams in poor condition. Due to the current condition of the dam and the reclassification to Significant

Hazard, a no action alternative may not be acceptable to the Dam Safety Program. Future inspections by the State will include similar recommendations as the 2015 inspection report, which was to prepare plans for repair, replacement, or removal of the dam. In the event the Town does not complete the required recommendations, the Dam Safety program may take enforcement actions to ensure public safety. The cost of completing future recommendations and the cost of future enforcement actions are not included in this alternative.

Dam Rehabilitation Alternative

This alternative retains the existing dam and maintains the current water level. The existing spillway is left in place with minor repairs. This alternative requires that a new concrete wall to be constructed on the upstream face of the dam. This wall will be designed to be structurally independent of the existing dam. The following is a list of improvements associated with this alternative:

- Construct new concrete spillway at the upstream face of the existing spillway.
- Dredge sediment for approximately 25-feet upstream of existing dam. This should allow for the construction of the new upstream concrete wall, and removes sediment load from the structure.
- Demolish a portion of the existing low-level outlet structure to remove the headwall, corrugated outlet pipe, and slide gate.
- Extend the new upstream wall across the existing outlet structure and construct a new headwall with access deck, new slide gate, and downstream concrete flume walls within existing walls.
- Construct new trashrack/debris diversion to protect slide gate and access deck.
- Install new abutment training walls and stone riprap along abutments to reduce erosion of river banks during large flood events.
- Dredge existing dry hydrant location.

This alternative is estimated to have a probable construction cost of \$800,000. This involves the new cast-in-place upstream wall, sediment dredging, channel restoration, and other construction related items. It was assumed that sediment dredged from the river would be retained and disposed of by the Contractor.

Beyond construction costs, there will be additional costs such as engineering and permitting fees. Engineering for this project will involve a preliminary design, coordination with various permitting agencies, permitting of the project, and final design. Other services such as bidding and construction administration and observation could be included. It is

estimated an additional \$80,000 will be needed to advance this alternative from a conceptual alternative to a complete construction package.

The following are anticipated permits and coordination required to be able to construct this alternative:

- Dam Alteration Order,
- Wetlands Permit,
- Stream Alteration & Crossings Permit,
- Army Corps of Engineers Section 404 Wetland Permit,
- Federal Permit for work in Rivers and Streams,
- Work in the State Right of Way Permit,
- Coordination with Vermont Division of Historic Preservation, and
- Coordination with Vermont Fish & Wildlife.

There may be other coordination items or permits required with specific construction techniques such as discharging of water from construction activities downstream. The permit application fees for the project vary depending upon areas of impact. The estimated area of impacts for this alternative is approximately 2,250 sq. feet. It is estimated the permitting fees for the project are approximately \$10,000. Information sheets discussing the permits are included in **Appendix H**.

Additional analysis was completed to detail a secondary rehabilitation alternative. This alternative utilized a roller compacted spillway on the downstream face of the dam to provide stability and hydraulic cut-off. An exhibit of this secondary rehabilitation alternative is included in **Appendix F**. This alternative is estimated to have a probable construction cost of \$675,000. This involves the new roller compacted concrete spillway, sediment dredging, channel restoration, and other construction related items. It was assumed that permitting fees and engineering fees associated with this alternative are similar to the upstream concrete wall alternative.

Dam Replacement Alternative

This alternative involves constructing a new concrete dam downstream of the existing dam. The location of the new dam, approximately 20-ft downstream was selected to allow for a longer spillway to improve hydraulics and to allow for construction of the new dam with the existing dam in-place. The following is a list of improvements associated with this alternative:

- Construct new concrete dam downstream of the existing dam. This will include a new spillway section, and new low-level outlet section. The new dam will maintain a similar normal pool and will be approximately 10-ft longer between the left abutment and outlet structure.

- New low-level outlet section will have similar improvements as the previous alternative. New slide gate, new trashrack/debris diversion, new access deck, and new outlet flume.
- Dredge sediment approximately 25-feet upstream of existing dam. Dredging is to allow for the demolition of existing dam.
- Demolish the existing dam. To preserve its historic significance, construct a public information board in Veterans' Park.
- Install new abutment training walls and stone riprap along abutments to reduce erosion of river banks during large flood events. Training wall would tie into the existing dam abutments to provide hardened stream edge to contain flow over the dam.
- Abandon existing hydrant location and install new hydrant location at the Veteran's Park. The intake/strainer will be positioned within the trashrack/sediment diversion to protect components.

This alternative is estimated to have a probable construction cost of \$1,186,000. This involves the construction of the new dam, demolition of the existing dam, sediment dredging, new dry hydrant, upstream and downstream channel restoration, and other construction related items. It was assumed that sediment dredged from the river would be retained and disposed of by the Contractor.

Similar to the previous alternative, this alternative will involve various engineering tasks and permitting assistance. It is estimated that \$120,000 will be needed to progress this alternative from a conceptual alternative to a complete construction package. This engineering fee is expected to be larger than the rehabilitation alternative due to both the increase in design requirements and permitting requirements compared to the rehabilitation alternative.

The following are anticipate permits and coordination required to be able to construct this alternative:

- Dam Alteration Order,
- Wetlands Permit,
- Stream Alteration & Crossings Permit,
- Army Corps of Engineers Section 404 Wetland Permit,
- Federal Permit for work in Rivers and Streams,
- Work in the State Right of Way Permit,
- Coordination with Vermont Division of Historic Preservation, and
- Coordination with Vermont Fish & Wildlife.

Similar to the previous alternative, additional permits and coordination that may be needed. The estimated area of impacts for this alternative is approximately 13,250 sq. feet. Due to increased impacts to wetlands and

stream alterations, the estimated the permitting fees for the project are \$23,000.

Dam Removal Alternative

This alternative involves dredging the West River and demolishing the existing dam. Based on the historic information and the downstream river bottom, it is presumed that there is a bedrock bottom of the West River below the sediment. The goal will be to remove the sediment to the natural bottom to create a stable channel. The following is a list of improvements associated with this alternative:

- Dredge upstream of the existing dam to the natural channel bottom or create a sloped stable channel using natural stabilization techniques and stone rip-rap.
- Demolish the existing dam. To preserve its historic significance, construct a public information board in Veterans' Park.
- Abandon existing hydrant location.

This alternative is estimated to have a probable construction cost of \$364,000. This involves demolition of the existing dam, sediment dredging, removal of the existing dry hydrant, upstream and downstream channel restoration, and other construction related items. It was assumed that sediment dredged from the river would be retained and disposed of by the Contractor.

Similar to the previous alternatives, this alternative will involve various engineering tasks and permitting assistance. The majority of the work will be involved with coordination with permitting agencies on the channel restoration. It is estimated that \$40,000 will be needed to progress this alternative from a conceptual alternative to a complete construction package.

The following are anticipate permits and coordination required to be able to construct this alternative:

- Dam Alteration Order,
- Wetlands Permit,
- Stream Alteration & Crossings Permit,
- Army Corps of Engineers Section 404 Wetland Permit,
- Federal Permit for work in Rivers and Streams,
- Work in the State Right of Way Permit,
- Coordination with Vermont Division of Historic Preservation, and
- Coordination with Vermont Fish & Wildlife.

Similar to the previous alternative, additional permits and coordination that may be needed. The estimated area of impacts for this alternative is approximately 21,750 sq. feet. Due to impacts to wetlands and stream

alterations, the estimated the permitting fees for the project are approximately \$21,000.

Summary of Alternative Costs & Possible Funding Sources

The estimated probable construction costs included a 30% contingency due to some gaps in information for each alternative. These include:

- Unknown soil conditions and depth of bedrock,
- Unconfirmed State of Vermont dam design standards, and
- Lack of records/plans depicting the original construction of the dam.

The following table outlines the total costs for each alternative:

Owner Costs	No-Action	Dam Rehabilitation A	Dam Rehabilitation B	Dam Replacement	Dam Removal
Annual Fees	\$2,000	\$2,000	\$2,000	\$2,000	-
Construction Cost	\$0	\$808,000	\$675,000	\$1,186,000	\$364,000
Engineering Fees	\$0	\$80,000	\$80,000	\$120,000	\$40,000
Permit Application Fees	\$0	\$10,000	\$10,000	\$23,000	\$21,000
Total	\$2,000	\$900,000	\$767,000	\$1,331,000	\$425,000

The funding for the selected alternative is anticipated to be by the Town of Londonderry; however, there are outside funding sources available. During the coordination meetings with the Dam Safety program, several funding sources we discussed.

The dam replacement alternative currently has no potential outside funding source. The Dam Safety program discussed a possible High Hazard Potential Dam Grant program through FEMA. This program is only for High Hazard dams but it may be expanded in the future.

The dam rehabilitation alternative could receive funding through the Vermont State Historic Preservation Grants. This program has funded dam rehabilitations in the past. To qualify for this grant, Williams Dam would need to be listed or determined eligible for listing in the National Register of Historic Places. This funding would likely not be available for the rehabilitation alternative that would cap the downstream side of the existing dam.

The dam removal alternative has a much larger source for potential outside funding. The Vermont Agency of Natural Resources maintains a list of dam removal funding sources, including Federal funding by NOAA, the US Fish and Wildlife services, and State grants. Successful examples of dam removal utilizing outside funding sources include the Magic Mountain Dam removal in Londonderry, which received fundraising and grant writing assistance from CRC. Funding for this alternative can contribute to the engineering design, permitting, and construction costs.

See **Appendix I** for a list of potential funding sources for the Alternatives.

Summary & Conclusions

	Dam Alternatives			
	No-Action	Dam Rehabilitation (both)	Dam Replacement	Dam Removal
Addresses Deficiencies	This alternative does not address any deficiencies.	✓✓ This alternative improves structural integrity, and dam controls	✓✓✓ This alternative replaces existing dam with dam design to all applicable standards.	✓✓✓ This alternative removes the existing dam.
Continued Maintenance Costs and Annual Fees		✓✓ Improves structural integrity and dam controls	✓✓✓ Replaces existing dam with dam design to all applicable standards.	✓✓✓ This alternative removes the existing dam.
Total Cost	\$2,000 Least expensive alternative, however requires future action which will result in additional costs.	✓✓ \$767,000/\$900.000	✓ \$1,331,000	✓✓✓ \$425,000 Most cost effective, removes dam related future expenses.
Additional Funding Available		✓ Possible funding through State Historic Preservation Grant		✓✓✓ Numerous funding options.

The following is a summary of the report findings and conclusions of analysis:

1. Williams Dam is in poor condition and requires action by the Owner to address deficiencies that may lead to a dam breach. Future anticipated (2023) dam safety standards would require the Owner to complete some remedial action to the dam.
2. The dam structure is no longer acting as an efficient hydraulic cut-off and the integrity of the structure is questionable. Visual indicators, such as pressurized leakage, large cracking and spalling, and walls out-of-plumb, show that the dam is experiencing significant deterioration.
3. The Town lacks the ability to drain the impoundment in case of an emergency due to damage to the low-level outlet stem. The ability to reduce the water level behind the dam in a controlled way is crucial to increasing the stability of the dam in an emergency. Without the ability to lower the pond, a partial breach or full breach of the dam will result in an uncontrolled release.
4. Hydraulic analysis by FEMA and D&K indicate that the combination of the VT Route 11 bridge and the dam restrict flow in the West River causing flooding upstream of the dam.
5. The No-Action Alternative is not recommended due to the condition of the dam. The Owner will likely be required by the State of Vermont to correct deficiencies in the near future.
6. The least costly alternative is Dam Removal. This alternative also addresses the existing dam deficiencies by removing the structure and hazard potential. There are no future dam fees and maintenance costs associated with the alternative. This alternative has several outside funding sources.
7. The Dam Rehabilitation alternative is the most cost effective alternative that maintains the dam. This alternative provides the structural integrity by being independent of the existing dam, and replaces inoperable controls at the dam. This alternative may have a potential outside funding source.
8. The Dam Replacement alternative addresses all the existing deficiencies and the new dam will be designed to current applicable standards. It is the most expensive option and may have most permitting requirements.

After the Town selects a preferred alternative, the next steps will be to coordinate with the State of Vermont Dam Safety program on the Town's intention for Williams Dam and to secure possible funding sources. Following those actions, the project would progress to preliminary design, permitting, final design, and construction of the project. Based upon the date of the upcoming Town Meeting day on April 30, 2022, and the time needed to design, permit, and bid the project, the construction of the project may not occur until the 2024 construction season.

Appendices

- Appendix A – Existing Conditions Plan
- Appendix B – Wetlands Memorandum
- Appendix C – Sediment Testing and Comparison
- Appendix D – Hydraulic Analysis Mapping
- Appendix E – Vermont Dam Safety Hazard Classification
- Appendix F – Alternative Plans
- Appendix G – Alternative Opinion of Probable Construction Costs
- Appendix H – Alternative Permitting
- Appendix I – Potential Funding Sources

References

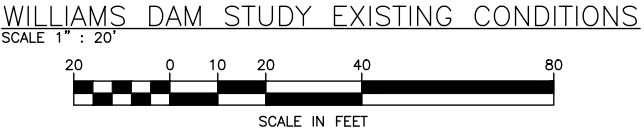
1. History. Londonderry Arts and Historical Society, www.lahsvt.org/history.
2. Child, Hamilton, b. 1836. Gazetteer And Business Directory of Windham County, Vt., 1724-1884. Syracuse, N.Y.: Printed at the Journal office, 1884.
3. US Department of Commerce, NOAA. “Flooding in Vermont.” National Weather Service, NOAA's National Weather Service, 19 Apr. 2018, www.weather.gov/safety/flood-states-vt.
4. Vermont Watershed Management Division’s Recommended Guidelines for Evaluating Contaminant Concentrations in Freshwater Sediments and the Potential for those Contaminants to Adversely Affect Aquatic Biota
5. Federal Emergency Management Agency Flood Insurance Study (FEMA FIS) for Windham County, Vermont. September 28, 2007
6. Vermont Environmental Protection Rules, Vermont Dam Safety Rules, August 1, 2020.
7. State Of Vermont, Agency of Commerce and Community Development, <https://accd.vermont.gov/historic-preservation/funding/historic-preservation-grants>

Appendix A

Existing Conditions Plan



DATUM:
VERTICAL: NAVD 88 GPS DERIVED
HORIZONTAL: NAD 83 GPS DERIVED



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PROFESSIONAL SEAL

NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION	BY	CK'D

TOWN OF LONDONDERRY
100 OLD SCHOOL STREET
S. LONDONDERRY, VT 05155

WILLIAMS DAM STUDY (#115.01)
LONDONDERRY, VT

SHEET TITLE
EXISTING CONDITIONS SITE PLAN

DRAWN BY RJL	DATE PROGRESS
CHECKED BY CWJ	D&K PROJECT # 827442
PROJ. ENG. CWJ	

SHEET NUMBER
1
SHEET 1 OF 9

Appendix B

Wetland Memorandum



MEMORANDUM

To: Charles Johnston, Project File
Date: December 2, 2021
From: Grace Glynn
Subject: Londonderry Williams Dam Wetlands Review
Project No.: 827442

This memorandum summarizes the preliminary wetlands investigation performed on November 30, 2021 at the Williams Dam at 2306 N Main St in Londonderry, VT, as shown on the attached Natural Resource Atlas Map.

Two wetlands were identified in the vicinity of the dam. This site visit occurred outside of the growing season and did not include formal wetland delineation, but the approximate wetland boundaries are shown on the attached map, and photos of the wetland are attached. Downstream of the dam, the river banks are generally steep and dominated by Japanese knotweed, a noxious invasive species.

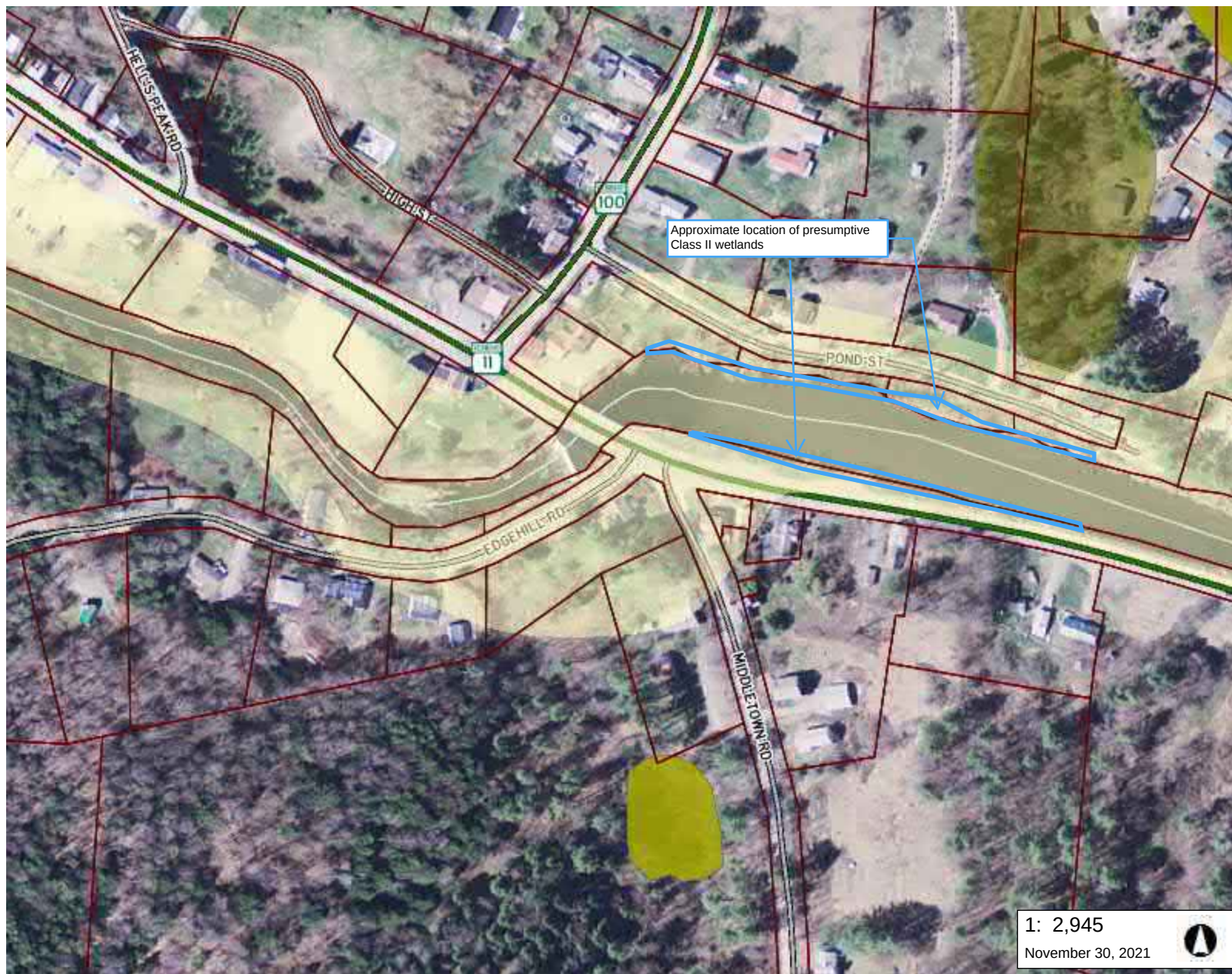
Both wetlands are palustrine emergent/scrub-shrub (PEM/SS) and are located along the edge of the West River, upstream from the dam. The wetlands appear to be dominated by purple loosestrife, soft rush, cattails, meadowsweet, water horehound, and reed canary grass. The wetlands principal functions and values likely include wildlife habitat and flood storage. The wetlands are likely Class II because they are contiguous with the West River, but review by the district wetlands ecologist would be necessary to verify this wetland classification.

Work in any wetland or below Ordinary High Water elevations within the West River would require an Army Corps of Engineers Section 404 Wetlands Permit. Work in any Class II wetland or in the 50ft jurisdictional buffer of any Class II wetland would require a VT Wetlands Permit. Because the wetlands above the dam are Surface Water Margins located along waters of the state, wetland and buffer zone impacts over 150 square feet would likely require an Individual Wetland permit from the VT Wetlands Program. In general, Individual Wetland permits can take from 3-6 months and authorizations under the Wetland General permit can take from 1-3 months to process from the receipt of complete application to issuance of permit decision.

In order to determine potential wetland impacts and permitting needs, wetlands should be formally delineated during the growing season in accordance with the COE 1987 Wetland Delineation Manual and the COE 2012 Regional Supplement for the Northcentral and Northeast Region.

Work within the mapped River Corridor of the West River may be subject to municipal regulation in order to comply with Vermont's Flood Hazard and River Corridor Rule. Work involving movement of over 10 CY of material within the riverbed may require a Stream Alteration permit through the VT Department of Environmental Conservation's River Management Program.

The Natural Resources Atlas Map of the area shows no elements of concern (rare, threatened, or endangered species or significant natural communities) in the immediate project area, as shown on the attached Natural Resources Map. No significant natural communities were observed during the course of field work. A field survey during the growing season would be necessary to determine whether rare, threatened, or endangered species are present in the project area.



LEGEND

Wetland - VSWI

- Class 1 Wetland
- Class 2 Wetland
- Buffer

Wetlands Advisory Layer

River Corridors (Aug 27, 2019)

.5 - 2 sqmi.

.25-.5 sqmi.

Soils - Hydric

Parcels (standardized)

Roads

- Interstate
- US Highway; 1
- State Highway
- Town Highway (Class 1)
- Town Highway (Class 2,3)
- Town Highway (Class 4)
- State Forest Trail
- National Forest Trail
- Legal Trail
- Private Road/Driveway
- Proposed Roads

Stream/River

- Stream
- Intermittent Stream

Town Boundary

1: 2,945

November 30, 2021



150.0 0 75.00 150.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

© Vermont Agency of Natural Resources

1" = 245 Ft. 1cm = 29 Meters

THIS MAP IS NOT TO BE USED FOR NAVIGATION

DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. ANR and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.

NOTES

Map created using ANR's Natural Resources Atlas

Williams Dam, Londonderry VT Wetlands Review
November 30, 2021



Surface margin wetland along the West River, looking west toward the dam



Downstream side of the dam, looking south from N Main St.

Appendix C

Sediment Testing and ANR Sediment Quality Guidelines

**Town of Londonderry
William's Dam Alternative Study
Upstream Sediment Sampling**

Substance	ANR		Sampling Locations	
	TEC	PEC	Bridge Abutment	Dry Hydrant
Metals (in mg/kg - ppm DW)				
Arsenic	9.79	33.0	ND < 3.6	ND < 7.5
Cadmium	0.99	4.98	ND < 0.36	ND < 0.75
Chromium	43.4	111.0	7.3	9.7
Copper	31.6	149.0	-	-
Lead	35.8	128.0	7.4	ND < 15.0
Mercury	0.18	1.1	ND < 0.051	ND < 0.093
Nickel	22.7	48.6	-	-
Zinc	121.0	459.0	-	-
Polycyclic Aromatic Hydrocarbons (in µg/kg - ppm DW)				
Anthracene	57.2	845.0	ND < 24.1	ND < 31.8
Benz(a)anthracene	108.0	1050.0	ND < 24.1	ND < 31.8
Benzo(a)pyrene	150.0	1450.0	ND < 12.0	ND < 15.9
Chrysene	166.0	1290.0	ND < 24.1	ND < 31.8
Dibenzo(a,h)anthracene	33.0		ND < 12.0	ND < 15.9
Fluoranthene	423.0	2230.0	ND < 24.1	ND < 31.8
Fluorene	77.4	536.0	ND < 24.1	ND < 31.8
Naphthalene	176.0	561.0	ND < 24.1	ND < 31.8
Phenanthrene	204.0	1170.0	ND < 24.1	ND < 31.8
Pyrene	195.0	1520.0	ND < 24.1	ND < 31.8
Total PAHs	1610.0	22800.0	204.8	270.3
Polychlorinated Biphenyls (in µg/kg - ppm DW)				
Total PCBs	59.8	676		
Organochlorine Pesticides (in µg/kg - ppm DW)				
Chlordane	3.24	17.6	ND < 25.0	ND < 31.9
Dieldrin	1.9	61.8	ND < 5.0	ND < 6.4
Sum DDD	4.88	28.0	ND < 5.0	ND < 6.4
Sum DDE	3.16	31.3	ND < 5.0	ND < 6.4
Sum DDT	4.16	62.9	ND < 5.0	ND < 6.4
Total DDTs	5.28	572.0		
Endrin	2.22	207.0	ND < 5.0	ND < 6.4
Heptachlor Epoxide	2.47	16.0	ND < 5.0	ND < 6.4
Lindane (gamma-BHC)	2.37	4.99	ND < 5.0	ND < 6.4

1. ANR Limits from Vermont Watershed Management Division's Recommended Guidelines for Evaluating Contaminant Concentrations in Freshwater Sediments and Potential for those Contaminants to Adversely Affect Aquatic Biota
2. TEC = Threshold Effect Concentration; PEC = Probable Effects Concentration
3. "ND < " result was below the detectable threshold for the test.

Dubois & King, Inc.

6 Green tree Drive

080439

So. Burlington, VT 05403

Atten: Charlie Johnston

PROJECT: Williams Dam

WORK ORDER: **2112-35270**

DATE RECEIVED: December 01, 2021

DATE REPORTED: December 17, 2021

SAMPLER: CWJ

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: 12/17/2021

CLIENT: Dubois & King, Inc.
PROJECT: Williams Dam

WORK ORDER: 2112-35270
DATE RECEIVED: 12/01/2021

001	Site: Bridge Location			Date Sampled: 11/30/21	Time: 11:30		
Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
TKN	1,100	mg/Kg, dry	EPA 351.2	12/8/21	N MAP	U	
Phosphorus, Total	440	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	U	
Mercury Digestion	Digested		EPA 7471B	12/8/21	W FAA	A	
Metals Solids Digestion	Digested		EPA 3050B	12/2/21	W FAA	A	
Arsenic, Total	< 3.6	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Barium, Total	42	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Cadmium, Total	< 0.36	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Chromium, Total	7.3	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Lead, Total	7.4	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Mercury, Total	< 0.051	mg/Kg, dry	EPA 7471B	12/9/21	W FAA	A	
Selenium, Total	< 7.2	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Silver, Total	< 3.6	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Oil & Grease	255	mg/Kg, Dry	modified EPA 1664A	12/14/21	W CLD	N	
Volatile Organic Compounds							
Prep EPA 5035A	Complete		EPA 5035A-H	12/1/21	W TRP	A	
Dichlorodifluoromethane	< 715	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Chloromethane	< 715	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Vinyl chloride	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Bromomethane	< 715	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Chloroethane	< 715	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Trichlorofluoromethane	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Diethyl ether	< 715	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
1,1-Dichloroethene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Acetone	< 1,430	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Carbon disulfide	< 715	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Methylene chloride	< 1,430	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
t-Butanol	< 3,580	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Methyl-t-butyl ether (MTBE)	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
trans-1,2-Dichloroethene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Di-isopropyl ether (DIPE)	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	U	
1,1-Dichloroethane	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Ethyl-t-butyl ether (ETBE)	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	U	
2-Butanone	< 2,860	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
2,2-Dichloropropane	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
cis-1,2-Dichloroethene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Bromochloromethane	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Chloroform	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Tetrahydrofuran	< 1,430	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	U	
1,1,1-Trichloroethane	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Carbon tetrachloride	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,1-Dichloropropene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Benzene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
t-Amylmethyl ether (TAME)	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	U	
1,2-Dichloroethane	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Trichloroethene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,2-Dichloropropane	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	

**ENDYNE Inc.**

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Laboratory Report

DATE REPORTED: 12/17/2021

CLIENT: Dubois & King, Inc.
PROJECT: Williams Dam

WORK ORDER: 2112-35270
DATE RECEIVED: 12/01/2021

001	Site: Bridge Location		Date Sampled: 11/30/21 Time: 11:30			
Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC Qual.
Dibromomethane	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
Bromodichloromethane	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
cis-1,3-Dichloropropene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
4-Methyl-2-pentanone (MIBK)	< 1,430	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
Toluene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
trans-1,3-Dichloropropene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,1,2-Trichloroethane	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
Tetrachloroethene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,3-Dichloropropane	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
2-Hexanone	< 1,430	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
Dibromochloromethane	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,2-Dibromoethane	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
Chlorobenzene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
Ethylbenzene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,1,1,2-Tetrachloroethane	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
Xylenes, Total	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
Styrene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
Bromoform	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
Isopropylbenzene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,1,2,2-Tetrachloroethane	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
Bromobenzene	< 143	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
n-Propylbenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,2,3-Trichloropropane	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
2-Chlorotoluene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
1,3,5-Trimethylbenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
4-Chlorotoluene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
t-Butylbenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,2,4-Trimethylbenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
s-Butylbenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
4-Isopropyltoluene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,3-Dichlorobenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,4-Dichlorobenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,2,3-Trimethylbenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
n-Butylbenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,2-Dichlorobenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,2-Dibromo-3-Chloropropane	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
1,2,4-Trichlorobenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
1,3,5-Trichlorobenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
Hexachlorobutadiene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
Naphthalene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A
1,2,3-Trichlorobenzene	< 286	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N
Surr. 1 (Dibromofluoromethane)	108	%	EPA 8260C	12/1/21	W TRP	U
Surr. 2 (Toluene d8)	102	%	EPA 8260C	12/1/21	W TRP	U
Surr. 3 (4-Bromofluorobenzene)	99	%	EPA 8260C	12/1/21	W TRP	U
Unidentified Peaks	0		EPA 8260C	12/1/21	W TRP	U
TPH-GRO Package						

Laboratory Report

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WORK ORDER: 2112-35270

PROJECT: Williams Dam

DATE RECEIVED: 12/01/2021

001	Site: Bridge Location		Date Sampled: 11/30/21 Time: 11:30			
Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC Qual.
Prep EPA 5035A High Level	Complete		EPA 5035A-H	12/2/21	W TRP	N
C5-C10 TPH GRO	< 11.4	mg/Kg, dry	EPA 8260C	12/2/21	W TRP	N
> C10 Volatile Hydrocarbons	< 11.4	mg/Kg, dry	EPA 8260C	12/2/21	W TRP	U
TPH DRO Package						
Extraction	Completed		EPA 3550C	12/10/21	W EM	A
C7-C10 TPH	< 28.6	mg/Kg, dry	EPA 8015D	12/13/21	W DPD	U
C10-C28 TPH-DRO	69.8	mg/Kg, dry	EPA 8015D	12/13/21	W DPD	A
C28-C40 TPH	22.5	mg/Kg, dry	EPA 8015D	12/13/21	W DPD	U
Tot. Petroleum Hydrocarbons	92.3	mg/Kg, dry	EPA 8015D	12/13/21	W DPD	U
Hydrocarbon Window	C14-C34		EPA 8015D	12/13/21	W DPD	U
Priority Pollutant Pesticides						
Extraction	Completed		EPA 3545A	12/13/21	W CLD	A
alpha-BHC	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
gamma-BHC (Lindane)	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
beta-BHC	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
delta-BHC	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Heptachlor	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Aldrin	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Heptachlor Epoxide	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
4,4'-DDE	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Endosulfan I	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Dieldrin	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Endrin	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
4,4'-DDD	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Endosulfan II	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
4,4'-DDT	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A AN1
Endrin Aldehyde	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Endosulfan Sulfate	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Methoxychlor	< 5.0	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A AN1
Chlordane	< 25.	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Toxaphene	< 25.	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A
Surrogate-TCMX	109	%	EPA 8081B	12/14/21	W DPD	A
Surrogate-DCB	85	%	EPA 8081B	12/14/21	W DPD	A
Poly-Chlorinated Biphenyls						
Extraction	Completed		EPA 3545A	12/13/21	W CLD	A
Aroclor 1016 (PCB-1016)	< 9.6	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A
Aroclor 1221 (PCB-1221)	< 9.6	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A
Aroclor 1232 (PCB-1232)	< 9.6	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A
Aroclor 1242 (PCB-1242)	< 9.6	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A
Aroclor 1248 (PCB-1248)	< 9.6	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A
Aroclor 1254 (PCB-1254)	< 9.6	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A
Aroclor 1260 (PCB-1260)	< 9.6	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A
Surrogate-TCMX	74	%	EPA 8082A	12/15/21	W DPD	A
Surrogate-DCB	99	%	EPA 8082A	12/15/21	W DPD	A
EPA 8270C Semi-VOA						
Extraction	Completed		EPA 3550C	12/6/21	W EM	A

Laboratory Report

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PROJECT: Williams Dam

WORK ORDER: 2112-35270
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001	Site: Bridge Location		Date Sampled: 11/30/21		Time: 11:30		
Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
N-Nitrosodimethylamine	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Pyridine	< 482	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Aniline	< 482	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Bis(2-chloroethyl)ether	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1,2-Dichlorobenzene	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1,3-Dichlorobenzene	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1,4-Dichlorobenzene	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzyl alcohol	< 964	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
2,2'-Oxybis(1-chloropropane)	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
N-Nitrosodi-n-propylamine	< 482	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Hexachloroethane	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Nitrobenzene	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
N-Nitrosopiperidine	< 482	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Isophorone	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Bis(2-chloroethoxy)methane	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1,2,4-Trichlorobenzene	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Naphthalene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
4-Chloroaniline	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Hexachlorobutadiene	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
N-Nitrosodi-n-butylamine	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
2-Methylnaphthalene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1-Methylnaphthalene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	U	
Hexachlorocyclopentadiene	< 964	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2-Chloronaphthalene	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1-Chloronaphthalene	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
2-Nitroaniline	< 964	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Dimethyl phthalate	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,6-Dinitrotoluene	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Acenaphthylene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
3-Nitroaniline	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Acenaphthene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Dibenzofuran	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
2,4-Dinitrotoluene	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1-Naphthylamine	< 482	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
2-Naphthylamine	< 482	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Fluorene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Diethyl phthalate	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
4-Chlorophenyl phenyl ether	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
4-Nitroaniline	< 964	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
N-Nitrosodiphenylamine	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Azobenzene/1,2-Diphenylhydrazine	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	U	
4-Bromophenyl phenyl ether	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Hexachlorobenzene	< 48.2	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Phenanthrene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Anthracene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Carbazole	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	

Laboratory Report

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001		Site: Bridge Location		Date Sampled: 11/30/21		Time: 11:30	
Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Di-n-butylphthalate	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Fluoranthene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzidine	< 964	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Pyrene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Butyl benzyl phthalate	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzo(a)anthracene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Chrysene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
3,3'-Dichlorobenzidine	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Bis(2-ethylhexyl)phthalate	< 964	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Di-n-octylphthalate	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzo(b)fluoranthene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzo(k)fluoranthene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzo(a)pyrene	< 12.0	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Indeno(1,2,3-cd)pyrene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Dibenzo(a,h)anthracene	< 12.0	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzo(g,h,i)perylene	< 24.1	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Phenol	< 96.4	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2-Chlorophenol	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2-Methylphenol (o-cresol)	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
3&4-Methylphenol (m&p-cresol)	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Cresols, Total	< 482	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	U	
2-Nitrophenol	< 482	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,4-Dimethylphenol	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,4-Dichlorophenol	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,6-Dichlorophenol	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
4-Chloro-3-methylphenol	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,4,5-Trichlorophenol	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,4,6-Trichlorophenol	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,4-Dinitrophenol	< 964	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
4-Nitrophenol	< 241	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
4,6-Dinitro-2-methylphenol	< 964	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Pentachlorophenol	< 482	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
BaP Toxic Equiv. Quotient	< 31.5	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	U	
B/N Surr.1 Nitrobenzene-d5	55	%	EPA 8270D	12/16/21	W EEP	U	
B/N Surr.2 2-Fluorobiphenyl	54	%	EPA 8270D	12/16/21	W EEP	U	
B/N Surr.3 Terphenyl-d14	66	%	EPA 8270D	12/16/21	W EEP	U	
Acid Surr.1 2-Fluorophenol	53	%	EPA 8270D	12/16/21	W EEP	U	
Acid Surr.2 Phenol-d5	58	%	EPA 8270D	12/16/21	W EEP	U	
Acid Surr.3 Tribromophenol	72	%	EPA 8270D	12/16/21	W EEP	U	
Unidentified Peaks	> 10		EPA 8270D	12/16/21	W EEP	U	

002		Site: Hydrant Location		Date Sampled: 11/30/21		Time: 12:00	
Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
TKN	1,800	mg/Kg, dry	EPA 351.2	12/8/21	N MAP	U	
Phosphorus, Total	570	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	U	

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002 Site: Hydrant Location Date Sampled: 11/30/21 Time: 12:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Mercury Digestion	Digested		EPA 7471B	12/8/21	W FAA	A	
Metals Solids Digestion	Digested		EPA 3050B	12/2/21	W FAA	A	
Arsenic, Total	< 7.5	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Barium, Total	58	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Cadmium, Total	< 0.75	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Chromium, Total	9.7	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Lead, Total	< 15	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Mercury, Total	< 0.093	mg/Kg, dry	EPA 7471B	12/9/21	W FAA	A	
Selenium, Total	< 15	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Silver, Total	< 7.5	mg/Kg, dry	EPA 6010C	12/3/21	W FAA	A	
Oil & Grease	253	mg/Kg, Dry	modified EPA 1664A	12/14/21	W CLD	N	
Volatile Organic Compounds							
Prep EPA 5035A	Complete		EPA 5035A-H	12/1/21	W TRP	A	
Dichlorodifluoromethane	< 1,260	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Chloromethane	< 1,260	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Vinyl chloride	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Bromomethane	< 1,260	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Chloroethane	< 1,260	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Trichlorofluoromethane	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Diethyl ether	< 1,260	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
1,1-Dichloroethene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Acetone	< 2,520	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Carbon disulfide	< 1,260	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Methylene chloride	< 2,520	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
t-Butanol	< 6,300	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Methyl-t-butyl ether (MTBE)	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
trans-1,2-Dichloroethene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Di-isopropyl ether (DIPE)	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	U	
1,1-Dichloroethane	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Ethyl-t-butyl ether (ETBE)	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	U	
2-Butanone	< 5,040	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
2,2-Dichloropropane	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
cis-1,2-Dichloroethene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Bromochloromethane	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Chloroform	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Tetrahydrofuran	< 2,520	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	U	
1,1,1-Trichloroethane	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Carbon tetrachloride	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,1-Dichloropropene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Benzene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
t-Amylmethyl ether (TAME)	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	U	
1,2-Dichloroethane	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Trichloroethene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,2-Dichloropropane	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Dibromomethane	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Bromodichloromethane	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	

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Laboratory Report

DATE REPORTED: 12/17/2021

CLIENT: Dubois & King, Inc.
PROJECT: Williams Dam

WORK ORDER: 2112-35270
DATE RECEIVED: 12/01/2021

002	Site: Hydrant Location		Date Sampled: 11/30/21		Time: 12:00		
Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
cis-1,3-Dichloropropene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
4-Methyl-2-pentanone (MIBK)	< 2,520	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Toluene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
trans-1,3-Dichloropropene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,1,2-Trichloroethane	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Tetrachloroethene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,3-Dichloropropane	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
2-Hexanone	< 2,520	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Dibromochloromethane	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,2-Dibromoethane	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Chlorobenzene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Ethylbenzene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,1,1,2-Tetrachloroethane	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Xylenes, Total	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Styrene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Bromoform	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Isopropylbenzene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,1,2,2-Tetrachloroethane	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
Bromobenzene	< 252	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
n-Propylbenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,2,3-Trichloropropane	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
2-Chlorotoluene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
1,3,5-Trimethylbenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
4-Chlorotoluene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
t-Butylbenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,2,4-Trimethylbenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
s-Butylbenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
4-Isopropyltoluene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,3-Dichlorobenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,4-Dichlorobenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,2,3-Trimethylbenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
n-Butylbenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,2-Dichlorobenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,2-Dibromo-3-Chloropropane	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
1,2,4-Trichlorobenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
1,3,5-Trichlorobenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Hexachlorobutadiene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Naphthalene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	A	
1,2,3-Trichlorobenzene	< 504	ug/Kg, Dry	EPA 8260C	12/1/21	W TRP	N	
Surr. 1 (Dibromofluoromethane)	106	%	EPA 8260C	12/1/21	W TRP	U	
Surr. 2 (Toluene d8)	101	%	EPA 8260C	12/1/21	W TRP	U	
Surr. 3 (4-Bromofluorobenzene)	100	%	EPA 8260C	12/1/21	W TRP	U	
Unidentified Peaks	0		EPA 8260C	12/1/21	W TRP	U	
TPH-GRO Package							
Prep EPA 5035A High Level	Complete		EPA 5035A-H	12/2/21	W TRP	N	
C5-C10 TPH GRO	< 20.1	mg/Kg, dry	EPA 8260C	12/2/21	W TRP	N	

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002		Site: Hydrant Location			Date Sampled: 11/30/21		Time: 12:00	
Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.	
> C10 Volatile Hydrocarbons	< 20.1	mg/Kg, dry	EPA 8260C	12/2/21	W TRP	U		
TPH DRO Package								
Extraction	Completed		EPA 3550C	12/10/21	W EM	A		
C7-C10 TPH	< 41.4	mg/Kg, dry	EPA 8015D	12/13/21	W DPD	U		
C10-C28 TPH-DRO	45.7	mg/Kg, dry	EPA 8015D	12/13/21	W DPD	A		
C28-C40 TPH	43.3	mg/Kg, dry	EPA 8015D	12/13/21	W DPD	U		
Tot. Petroleum Hydrocarbons	89.1	mg/Kg, dry	EPA 8015D	12/13/21	W DPD	U		
Hydrocarbon Window	C14-C34		EPA 8015D	12/13/21	W DPD	U		
Priority Pollutant Pesticides								
Extraction	Completed		EPA 3545A	12/13/21	W CLD	A		
alpha-BHC	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
gamma-BHC (Lindane)	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
beta-BHC	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
delta-BHC	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Heptachlor	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Aldrin	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Heptachlor Epoxide	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
4,4'-DDE	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Endosulfan I	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Dieldrin	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Endrin	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
4,4'-DDD	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Endosulfan II	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
4,4'-DDT	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A	AN1	
Endrin Aldehyde	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Endosulfan Sulfate	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Methoxychlor	< 6.4	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A	AN1	
Chlordane	< 31.9	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Toxaphene	< 31.9	ug/Kg, dry	EPA 8081B	12/14/21	W DPD	A		
Surrogate-TCMX	74	%	EPA 8081B	12/14/21	W DPD	A		
Surrogate-DCB	71	%	EPA 8081B	12/14/21	W DPD	A		
Poly-Chlorinated Biphenyls								
Extraction	Completed		EPA 3545A	12/13/21	W CLD	A		
Aroclor 1016 (PCB-1016)	< 12.8	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A		
Aroclor 1221 (PCB-1221)	< 12.8	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A		
Aroclor 1232 (PCB-1232)	< 12.8	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A		
Aroclor 1242 (PCB-1242)	< 12.8	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A		
Aroclor 1248 (PCB-1248)	< 12.8	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A		
Aroclor 1254 (PCB-1254)	< 12.8	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A		
Aroclor 1260 (PCB-1260)	< 12.8	ug/Kg, dry	EPA 8082A	12/15/21	W DPD	A		
Surrogate-TCMX	69	%	EPA 8082A	12/15/21	W DPD	A		
Surrogate-DCB	96	%	EPA 8082A	12/15/21	W DPD	A		
EPA 8270C Semi-VOA								
Extraction	Completed		EPA 3550C	12/6/21	W EM	A		
N-Nitrosodimethylamine	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A		
Pyridine	< 637	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A		

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002

Site: Hydrant Location

Date Sampled: 11/30/21 Time: 12:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Aniline	< 637	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Bis(2-chloroethyl)ether	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1,2-Dichlorobenzene	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1,3-Dichlorobenzene	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1,4-Dichlorobenzene	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzyl alcohol	< 1,270	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
2,2'-Oxybis(1-chloropropane)	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
N-Nitrosodi-n-propylamine	< 637	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Hexachloroethane	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Nitrobenzene	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
N-Nitrosopiperidine	< 637	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Isophorone	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Bis(2-chloroethoxy)methane	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1,2,4-Trichlorobenzene	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Naphthalene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
4-Chloroaniline	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Hexachlorobutadiene	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
N-Nitrosodi-n-butylamine	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
2-Methylnaphthalene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1-Methylnaphthalene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	U	
Hexachlorocyclopentadiene	< 1,270	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2-Chloronaphthalene	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1-Chloronaphthalene	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
2-Nitroaniline	< 1,270	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Dimethyl phthalate	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,6-Dinitrotoluene	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Acenaphthylene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
3-Nitroaniline	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Acenaphthene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Dibenzofuran	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
2,4-Dinitrotoluene	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
1-Naphthylamine	< 637	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
2-Naphthylamine	< 637	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Fluorene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Diethyl phthalate	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
4-Chlorophenyl phenyl ether	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
4-Nitroaniline	< 1,270	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
N-Nitrosodiphenylamine	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Azobenzene/1,2-Diphenylhydrazine	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	U	
4-Bromophenyl phenyl ether	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Hexachlorobenzene	< 63.7	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Phenanthrene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Anthracene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Carbazole	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
Di-n-butylphthalate	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Fluoranthene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	

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002

Site: Hydrant Location

Date Sampled: 11/30/21 Time: 12:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Benzidine	< 1,270	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Pyrene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Butyl benzyl phthalate	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzo(a)anthracene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Chrysene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
3,3'-Dichlorobenzidine	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Bis(2-ethylhexyl)phthalate	< 1,270	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Di-n-octylphthalate	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzo(b)fluoranthene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzo(k)fluoranthene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzo(a)pyrene	< 15.9	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Indeno(1,2,3-cd)pyrene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Dibenzo(a,h)anthracene	< 15.9	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Benzo(g,h,i)perylene	< 31.8	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Phenol	< 127	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2-Chlorophenol	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2-Methylphenol (o-cresol)	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
3&4-Methylphenol (m&p-cresol)	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Cresols, Total	< 637	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	U	
2-Nitrophenol	< 637	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,4-Dimethylphenol	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,4-Dichlorophenol	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,6-Dichlorophenol	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	N	
4-Chloro-3-methylphenol	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,4,5-Trichlorophenol	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,4,6-Trichlorophenol	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
2,4-Dinitrophenol	< 1,270	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
4-Nitrophenol	< 318	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
4,6-Dinitro-2-methylphenol	< 1,270	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
Pentachlorophenol	< 637	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	A	
BaP Toxic Equiv. Quotient	< 41.7	ug/Kg, dry	EPA 8270D	12/16/21	W EEP	U	
B/N Surr.1 Nitrobenzene-d5	61	%	EPA 8270D	12/16/21	W EEP	U	
B/N Surr.2 2-Fluorobiphenyl	70	%	EPA 8270D	12/16/21	W EEP	U	
B/N Surr.3 Terphenyl-d14	84	%	EPA 8270D	12/16/21	W EEP	U	
Acid Surr.1 2-Fluorophenol	64	%	EPA 8270D	12/16/21	W EEP	U	
Acid Surr.2 Phenol-d5	72	%	EPA 8270D	12/16/21	W EEP	U	
Acid Surr.3 Tribromophenol	96	%	EPA 8270D	12/16/21	W EEP	U	
Unidentified Peaks	> 10		EPA 8270D	12/16/21	W EEP	U	

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PROJECT: Williams Dam

DATE RECEIVED: 12/01/2021

Report Summary of Qualifiers and Notes

GRO values are based on the response and calibration of Unleaded Gasoline.

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

DRO values are based on the response and calibration of Diesel/#2 Fuel Oil.

AN1: Instrument performance degraded during the analytical sequence due to the nature of the samples analyzed.

Result of the closing calibration check standard was below method control limits for this parameter. Reported result may be biased low.

Appendix D

Hydraulic Modeling Exhibits



Figure 1

**Existing Conditions
10-Yr Water Depth**

**Williams Dam Study
(#115.01)**

**Town of Londonderry
100 Old School Street
S. Londonderry
VT 05155**

Legend

Existing 10-Yr Flood Depth

Value

High : 18.4 ft
Low : 0.01 ft

0 0.0125 0.025 0.05
Miles



**DuBois
& King inc.**



Figure 2

Alt 1 Dam Removal
10-Yr Water Depth

Williams Dam Study
(#115.01)

Town of Londonderry
100 Old School Street
S. Londonderry
VT 05155

Legend

Removal 10-Yr Flood Depth
Value

High : 11.8

Low : 0.01

00.01250.0250.05

Miles





Figure 3

Alt 2 Dam Replacement
10-Yr Water Depth

Williams Dam Study
(#115.01)

Town of Londonderry
100 Old School Street
S. Londonderry
VT 05155

Legend

Replacement 10-Yr Flood Depth

Value

High : 18.0

Low : 0.01

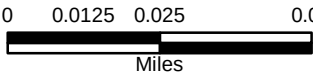




Figure 4

**Existing Conditions
100-Yr Water Depth**

**Williams Dam Study
(#115.01)**

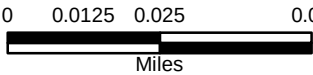
**Town of Londonderry
100 Old School Street
S. Londonderry
VT 05155**

Legend

**Existing 100-yr Flood Depth
Value**

High : 22.2 ft

Low : 0.01 ft



**DuBois
& King inc.**



Figure 5

**Alt 1 Dam Removal
100-Yr Water Depth**

**Williams Dam Study
(#115.01)**

**Town of Londonderry
100 Old School Street
S. Londonderry
VT 05155**

Legend

**Removal 100-Yr Flood Depth
Value**

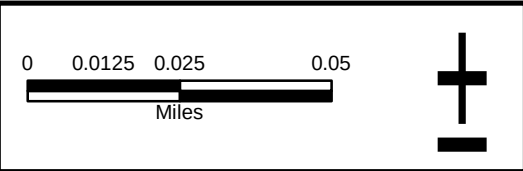
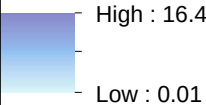




Figure 6

**Alt 2 Dam Replacement
100-Yr Water Depth**

**Williams Dam Study
(#115.01)**

**Town of Londonderry
100 Old School Street
S. Londonderry
VT 05155**

Legend

Replacement 100-Yr Flood Depth

Value

High : 21.4

Low : 0.01

00.01250.0250.05

Miles

**DuBois
& King inc.**

Appendix E

Vermont Dam Safety - Williams Dam Failure Analysis and Hazard Potential Classification Study

Vermont Department of Environmental Conservation*Agency of Natural Resources*

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

MEMORANDUM

TO: Town of Londonderry – Dam Owner
Charles Johnston, PE, Dubois & King, Inc.

FROM: Benjamin Green, PE, VTDEC Dam Safety Program (DSP) - Dam Safety Engineer
Andrew Sampsell, DSP - Dam Safety Engineer

DATE: March 2nd, 2022

SUBJECT: DSS-Wise Lite Dam Failure Analysis and Hazard Potential Classification Study
Williams Dam, Londonderry, Vermont
State ID No: 115.01, National ID: VT00257

This memorandum summarizes the methods, assumptions, and results of a simplified dam failure and downstream flood inundation analysis using the Decision System for Water Infrastructural Security (DSS-Wise Lite) model for the Williams Dam located in Londonderry, VT. The following attachments are included for the modeling scenario that controlled the hazard potential classification selection for the dam:

- **Attachment A:** Flood Inundation Map
- **Attachment B:** DSS-Wise Lite Reservoir Simulation Results
- **Attachment C:** DSS-Wise Lite Reservoir Simulation Human Consequences Final Report

It should be noted that **Attachments B** and **C** are automatically generated reports by the DSS-Wise Lite Program.

Purpose:

The analysis was performed to investigate the hazard potential classification of the dam and to gain a greater understanding of the potential ranges of consequences of a dam failure or incident. Updated hazard potential classification review is needed for many dams in the State's inventory due to the adoption of new definitions and processes in the Dam Safety Rules and the potential for downstream development that could impact classification. This analysis will evaluate the hazard potential classification using a simplified procedure and publicly available data. In addition, it is our hope that the flood inundation map generated from this work can be used in future emergency action planning for the dam.

Dam Overview:

Williams Dam is a run-of-the-river stone masonry and concrete gravity dam with an outlet gate that is currently classified as a LOW hazard potential dam. A dam at the site dates back to at least 1900 and likely earlier. The last documented rehabilitation of the dam was in 1978 when the gate structure was installed and repairs were made to address damages from the 1976 flood. The dam is located just downstream of the VT Route 11 Bridge. The dam was last inspected by the DSP in August 2015 and was found to be in POOR condition. The dam spans approximately 90 feet across the West River (from abutment to abutment). The 90-foot length includes an approximately 73 foot long broad-crested weir principal spillway with the remaining 14 feet being the concrete framed gate structure. The dam appears to be founded on bedrock. At the right abutment is a concrete training wall that extends from the gate approximately 15 feet upstream to the VT Route 11 Bridge. The left abutment contacts a bedrock outcrop adjacent to Edge Hill Road. The height of the dam from the downstream channel invert to the principal spillway crest is approximately 13 feet and to the top of the gate structure or dam crest is about 17 feet per recent survey. Based on USGS StreamStats, the drainage area of the West River at the dam is approximately 40.8 square miles.

Downstream Conditions:

Williams Dam is located on the West River which flows through the Town of Londonderry. Utleigh Brook, which has a drainage area of approximately 27.7 square miles (USGS StreamStats), joins the West River approximately 1,900 feet downstream of Williams Dam. The West River flows South alongside Route 100 until it reaches Main Street in the Town of South Londonderry where Route 100 diverges west, while the West River continues south. After flowing through the Town of South Londonderry, the floodplain becomes less developed, until the West River reaches the US Army Corps of Engineers Ball Mountain Flood Control Dam located between Winhall Brook Campground and Jamaica State Park. The Ball Mountain Dam is approximately 7.3 miles downstream of Williams Dam. The drainage area of the West River at the Ball Mountain Dam is approximately 169.0 square miles according to USGS StreamStats.

Background / Supporting Data:

The Town of Londonderry recently contracted with the consulting engineering firm Dubois & King, Inc. (D&K) to analyze potential alternatives to either rehabilitate or remove the dam. As part of the alternatives study, D&K was able to collect limited bathymetry and sediment probing data that was provided to the DSP. Outside field survey limits, D&K relied on LIDAR, FEMA Flood Insurance Study (FIS) data, and design plans for the VT Route 11 Bridge to develop a reasonable estimate of reservoir storage volume. Table 1, below, summarizes elevation and estimated storage data.

Table 1: Elevation and Storage Data

	Elevation	Impoundment Surface Area	Sediment Volume ¹	Total Storage Volume ^{1,2}
	NAVD88 FT	Acres	Acre-ft	Acre-ft
Downstream Channel Invert	1,129	0	0	0
Principal Spillway Crest	1,142	9.3	3.8	24.2
Top of Dam (Top of gate structure)	1,146	29.9	3.8	97.1
Low Chord of VT RT 11 Bridge	1,150	41.8	3.8	244.7

¹ Sediment and total storage volumes are estimates based on the combination of field measurements and available mapping.

² Includes estimated volume of sediment storage behind the dam.

Hydrologic and Hydraulic Methods:

The DSP prepared six DSS-Wise Lite simulations/scenarios of the Williams Dam and the downstream floodplain in order to evaluate the dam's hazard potential classification. DSS-Wise Lite is a publicly available flood modeling and consequence analysis tool developed by The National Center for Computational Hydroscience and Engineering at the University of Mississippi. DSS-Wise Lite is a web-based program that allows the user to setup an automated two-dimensional dam failure model with minimal inputs and provides results including inundation maps, flood arrival times, hydrographs, and other life consequence information. As noted in program literature, DSS-Wise Lite is a simplified analysis producing rough, approximate results that are not intended to replace more detailed modeling processes/programs. The following key limitations of DSS-Wise Lite should be understood, additional limitations are described in the user's manual and technical documentation:

- The model relies on a national LIDAR digital elevation model (DEM). The resolution of the DEMs used in the model is 1 meter by 1 meter (3.281 feet). The user has no ability to edit or correct the elevations of the LIDAR DEM outside of inputting the dam structure and levees.
- The model relies on a national land cover dataset to approximate roughness coefficients of the stream channel and floodplain for use in the hydraulic computations. The resolution of the national land cover data base is 30 meters by 30 meters (98.4 feet).
- The smallest cell size for the computation mesh used to perform the 2D hydraulic calculations is 15 feet by 15 feet. Limitations with this cell size, for example, are that it could prevent the model from accurately representing cases with dramatic elevation changes in a small horizontal distance or cases where varying roughness values apply within one cell.
- Large bridges can be input in the model but are modeled as an opening with no bridge deck. The program does not allow for the modeling of culverts at downstream road crossings.
- As with any dam failure analysis, the model relies on the input values of normal and maximum pool storage in the reservoir. In many cases, these values may be rough estimates based on measurements from maps or coarse

field measurements, followed by the application of empirical equations, which may or may not accurately represent the actual storage volume that could be lost during a dam failure.

- The model performs the hydraulic computations using the 2D Shallow Water Equations, which assume a hydrostatic pressure distribution within the water column. This assumption becomes invalid in areas with steep slopes or vertical drops (i.e. calculations in steeply graded flow areas potentially have a higher error).
- No detailed/site specific hydrology besides estimating peak flows using rudimentary methods were performed in this simplified analysis. Since development of a detailed unsteady flood hydrograph is beyond the scope of this analysis, a simplified unsteady flood hydrograph is used that combines steady state peak flows during Storm Day conditions with a basic dam failure flood hydrograph.
- The model is limited to a single discharge input location, which is at the dam/origin of the dam failure. This limitation means that lateral inflows from downstream tributaries during flooding conditions cannot be included in the model. Due to this limitation, “Storm Day” failure analysis comparisons may be limited in ability to accurately represent flooding elevations during regional storm events. The further downstream from the dam, the greater the potential for model error due to the inability to account for flood flow in other tributaries.

Model Scenarios:

Table 2, below, outlines each of the six scenarios modeled for Williams Dam using DSS-Wise Lite. For each selected starting water level/flow condition at the dam, the model was run assuming “no dam failure” and then with “dam failure” to gain an understanding of the potential impacts and incremental consequences of dam failure over baseline flooding in the river.

Table 2: Dam Failure Analysis Scenarios

No.	Scenario	Water Surface Elev. at Start of Simulation (feet) ¹	Failure Type	DSS-Wise Failure Method	Base River Flow
1	Sunny Day - No Dam Failure	1,143	No Failure	Specified Hydrograph	~260 cfs ²
2	Sunny Day - Dam Failure	1,143	Froehlich Piping Failure	Specified Hydrograph	~260 cfs ²
3	Storm Day - No Dam Failure	1,146	No Failure	Specified Hydrograph	~1,620 cfs ²
4	Storm Day - Dam Failure	1,146	Froehlich Piping Failure	Specified Hydrograph	~1,620 cfs ²
5	Storm Day - No Dam Failure	1,150	No Failure	Specified Hydrograph	~ 11,500 cfs ³
6	Storm Day - Dam Failure	1,150	Froehlich Piping Failure	Specified Hydrograph	~ 11,500 cfs ³

¹ Water levels at El. 1,143 represents approximately 1 foot of flow over the principal spillway weir, while E. 1,146 and El. 1,150 represent 4 feet of flow and water levels at the dam crest and 8 feet of flow and water levels at the low chord of the VT Route 11 Bridge, respectively.

² Base river discharges were computed using the weir equation and a discharge coefficient of ~2.9 to determine the amount of flow at the dam required to achieve the specified elevation in column 3.

³ The 100-yr flood discharge from the FEMA Flood Insurance Study was modeled based on the historic LOW hazard potential classification of the Williams Dam. Based on FEMA 100-yr floodplain mapping, the 100-yr flood results in water flowing out of the channel and around the VT Route 11 Bridge and the dam. The DSP decided to limit the reservoir elevation at time of failure to the low chord elevation of the bridge (El. 1,150).

Dam failure parameters were calculated based on the geometry, material composition, and reservoir storage capacity using the Froehlich 2008 method. The Froehlich 2008 method estimates failure parameters using empirical equations developed from past dam failure case study data. The computed failure parameters were then included in a US Army Corps of Engineers (USACE) HEC-HMS hydrologic model to compute a dam failure outflow hydrograph for use in DSS-Wise Lite. A summary of key failure parameters and resulting peak outflow for each failure scenario is provided in Table 3 below. A sensitivity analysis of the range of potential failure parameters was not completed and is beyond the scope of this study.

Table 3: Dam Failure Parameters and Peak Outflow

Scenario	Bottom Opening Width	Formation Time	Piping Coefficient	Peak Discharge
	ft	hrs		cfs
2 - Sunny Day (El. 1,143)	33	0.2	0.6	4,435
4 - Storm Day (El. 1,146)	40	0.2	0.6	8,712
6 - Storm Day (El. 1,150)	60	0.2	0.6	18,182

In the non-failure scenarios, a 24-hour steady state discharge hydrograph representing the base river flow was input into the model immediately downstream of the dam. In the dam failure scenarios, a 6-hour steady state base river flow was input immediately downstream of the dam to “prime” the downstream channel before the unsteady dam failure hydrograph occurred. The steady state discharge was set to continue following the dam failure hydrograph until flood waters reached the model end point (Ball Mountain Flood Control Dam).

Hazard Potential Classification Definitions and Guidance:

Hazard potential classification for dams in Vermont is determined in accordance with the Dam Safety Rules (effective August 1, 2020). Hazard potential classification definitions for HIGH, SIGNIFICANT, and LOW Hazard dams and guidance for evaluating the four main loss types caused by dam failure (direct loss of life, property loss, lifeline loss and environmental loss) are provided in the Rule at the following link: <https://dec.vermont.gov/water-investment/dam-safety/dam-safety-statute-and-rules>. Of particular interest are the definitions of the hazard potential classification definitions considered for Williams Dam:

HIGH Hazard Potential Dam means dams where failure or mis-operation will probably cause loss of human life.

SIGNIFICANT Hazard Potential Dam means dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental 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 Hazard Potential Dam means dams where failure or mis-operation results in no probable loss of human life and low economic and environmental losses.

Model Results and Hazard Potential Classification:

The DSS-Wise Lite model results are summarized in *Attachments A* through *C*. The dam failure flood results were compared to the potential loss types as required by the Dam Safety Rule.

Direct Loss of Life:

Loss of Life was evaluated in reference to criteria established in Downstream Hazard Classification Guidelines developed by the US Bureau of Reclamation in 1988 (ACER Technical Memorandum No. 11). For Williams Dam, Direct Loss of Life focuses on life loss potential of people inside structures at the time of the dam failure. While there is a possibility people could be caught outside within the flood inundation area during a dam failure, in this case, it is reasonable to assume that they would be able to self-evacuate to higher ground. The following two figures depict estimated dam failure flood flow depths and velocities and resulting loss of life potential during dam failure versus non-failure for each of the scenarios at the top four impacted downstream structures. The top four impacted downstream structures are located just downstream of the dam and include the following commercial buildings:

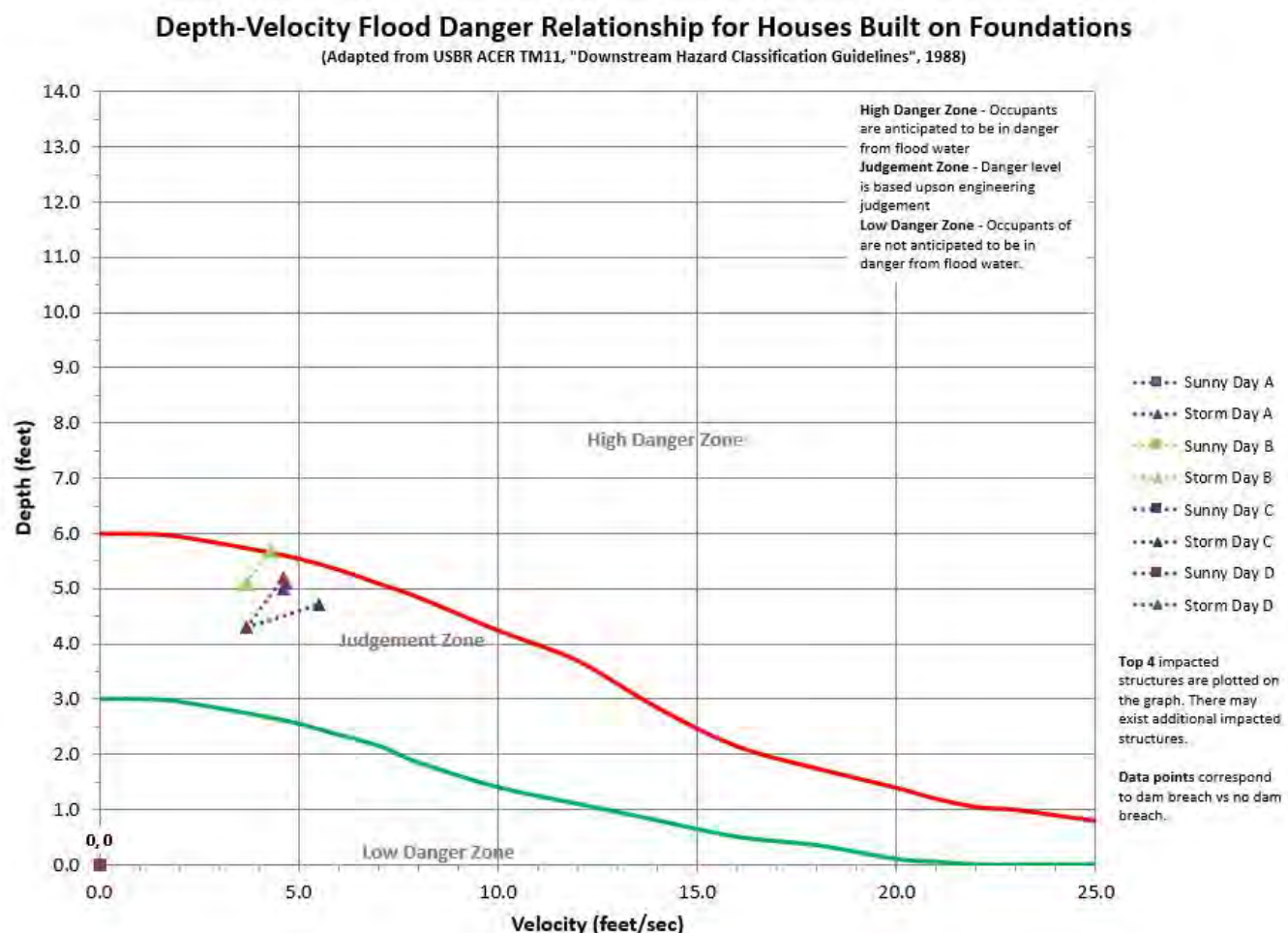
- 2136 North Main Street – Garden Café and Gallery - (A)
- Route 11, 2116 North Main Street – Garden Market - (B)
- 2170/2180 North Main Street – Maple Leaf Diner and Main Street Market and Deli – (C)
- 2152 North Main Street – unknown – (D)

Depths were evaluated above the first-floor elevation of buildings. For this simplified analysis, it was assumed that the first-floor elevations of buildings were 1 foot above the LIDAR DEM elevation around the footprint of the building.

During Scenarios 1/2 (El. 1,143 Sunny Day Baseflow Failure/Non-Failure), when comparing flood depth and velocity combinations at buildings within the downstream floodplain, there appears to be no difference in potential for life loss as no structures are anticipated to experience flooding above their first-floor elevation, whether under non-failure or failure conditions. Accordingly, it is anticipated there would be no direct loss of life from this scenario.

Similarly, during Scenarios 5/6 (El. 1,150 Storm Day Failure/Non-Failure), comparing flood depth and velocity combinations at buildings within the downstream floodplain indicates there is only minor differences between non-failure and failure conditions. While depth and velocity combinations are potentially hazardous at the four structures (depths in the 4-to-5-foot range, velocities in the 3 to 5 ft/s range and plot in the “Judgement Zone”), the incremental increase in flood depth and velocities from dam failure over baseline flooding appears limited to generally less than 1 foot and 1 ft/s and values remain plotted in the “Judgment Zone” as opposed to the “High Danger Zone”. Accordingly, the potential risk to life is present during the flood/non-failure condition and not measurably worsened by dam failure. Therefore, loss of life during this scenario due to dam failure is not considered probable. See the plot below that shows flood depth and velocity combinations during this scenario under non-failure and failure flows and the minor incremental increases due to failure.

Figure 1: USBR ACER No. 11 Life loss Potential (Scenario 5/6, El. 1,150 Storm Day Comparison)



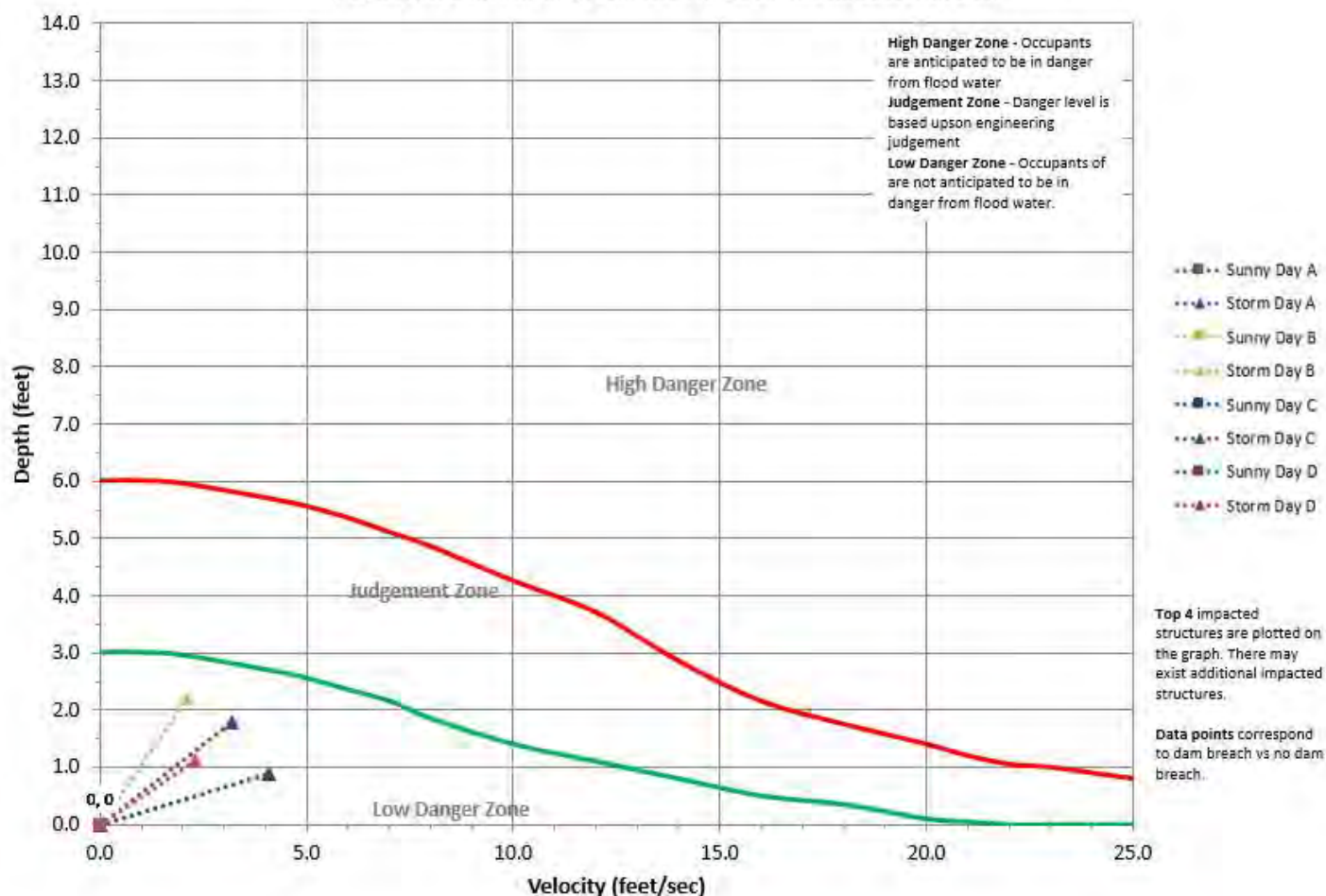
However, Scenarios 3/4 (El. 1,146 Storm Dam Non-Failure/Failure) appear to control in terms of potential for damages and direct loss of life due to the failure of Williams Dam. The Human Consequences Report (HCOM) module within DSS-Wise for these scenarios provides an estimated range of Population at Risk (PAR), which is defined as the estimated number of people located within the inundation limits of a simulated dam failure (not necessarily the number of potential fatalities, as depths and velocities within the inundation extents can range from little to no impact/non-life threatening to life threatening). While PAR is not specifically used for hazard potential classification, understanding the potential range of PAR for a dam failure can be useful in emergency planning. The estimated PAR for Williams Dam could range from approximately 10 to 50 people .

In comparing flood depth and velocity combinations at buildings within the downstream floodplain, there appears to be notable differences between non-failure and failure conditions. While depth and velocity combinations under non-failure conditions do not appear to be potentially hazardous as no buildings are flooded, the incremental increase in flood depth and velocities from dam failure over baseline flooding appears to range from 1 to 2 feet and 2 to 4 ft/s above estimated first floor elevations. However, these increased depths and velocities still plot within the Low Danger zone of the ACER plot, indicating that loss of life during this scenario due to dam failure, is also not considered probable. See the plot below that shows flood depth and velocity combinations during this scenario under non-failure and failure flows and the incremental increases due to failure.

Figure 2: USBR ACER No. 11 Life loss Potential (Scenario 3/4, El. 1,146 Storm Day Comparison)

Depth-Velocity Flood Danger Relationship for Houses Built on Foundations

(Adapted from USBR ACER TM11, "Downstream Hazard Classification Guidelines", 1988)



Based on these results, the potential for direct loss of life due to a failure of Williams Dam does not appear probable. Accordingly, based on this analysis, the hazard potential classification of HIGH is eliminated from consideration and the hazard potential classification of SIGNIFICANT shall be considered through the evaluation of potential property, lifeline, and environmental losses, below.

Property Losses:

Based on reviewing the potential for property damage to occur (using DSS-Wise Results, Orthoimagery, and LIDAR elevation data) it was found that Scenarios 3/4 (El. 1,146 Storm Dam Non-Failure/Failure), as was noted above, are the controlling scenarios. The total number of impacted structures for each scenario is presented in Table 4 below. An estimated total of 11 structures, including mainly commercial buildings and several homes are impacted as a result of the flood flows plus dam failure, versus 0 for non-failure conditions. Flooding depths at these structures attributed to dam failure ranged from less than one foot to approximately 3 feet adjacent to the structures and multiple structures were surrounded by flooding. As a result, it is anticipated that property damage would occur to these structures as flooding up to 2 feet above first floor elevations could be realized.

Scenario	Number of Impacted Structures
1 - Sunny Day (El. 1,143) Non-Failure	0
2 - Sunny Day (El. 1,143) Dam Failure	5
3 - Storm Day (El. 1,146) Non-Failure	0
4 - Storm Day (El. 1,146) Dam Failure	11
5 - Storm Day (El. 1,150) Non-Failure	37
6 - Storm Day (El. 1,150) Dam Failure	37

Based on these results, the potential for property losses due to a failure of Williams Dam appear to be fairly extensive to occupied buildings. Accordingly, based on this analysis, the hazard potential classification of at least SIGNIFICANT is considered appropriate due to the potential for property loss.

Lifeline Losses:

Under the Dam Safety Rules, the hazard potential classification cannot be increased above SIGNIFICANT as a result of lifeline losses. Therefore, since property losses already drives the hazard potential classification to SIGNIFICANT, lifeline losses are not considered a hazard classification driver. However, it should be noted that during Scenario 4, VT Route 11 (North Main Street) would overtop due to dam failure to a depth of approximately 1.5 feet and velocity of 3 ft/s. The overtopping location is in the vicinity of 2180 North Main Street. It is anticipated that these depth and velocity combinations could cause some damage to the roadway. No other bridge/roadway overtopping locations were identified during this scenario.

Environmental Losses:

Similarly to Lifeline Losses, above, the hazard potential classification cannot be increased above SIGNIFICANT as a result of environmental losses, so environmental losses are not considered a hazard classification driver. It should be noted that D&K has estimated that approximately 3.8 acre-feet of sediment is impounded by the dam, which could be potentially released in the event of a dam failure, stressing water quality and habitat in downstream areas.

Conclusions:

Based on this analysis, the hazard potential classification of Williams Dam should be increased from LOW to SIGNIFICANT based on the potential for property losses in the event of a dam failure. SIGNIFICANT hazard potential dams are subject to additional requirements over LOW hazard potential dams, including more frequent inspections, Emergency Action Planning requirements, and compliance with more rigorous design and construction standards.

The DSP recommends that the dam owner develop an Emergency Action Plan (EAP) for the dam, using the flood inundation map attached here-in. We would also be happy to provide a copy of the current EAP template for SIGNIFICANT hazard

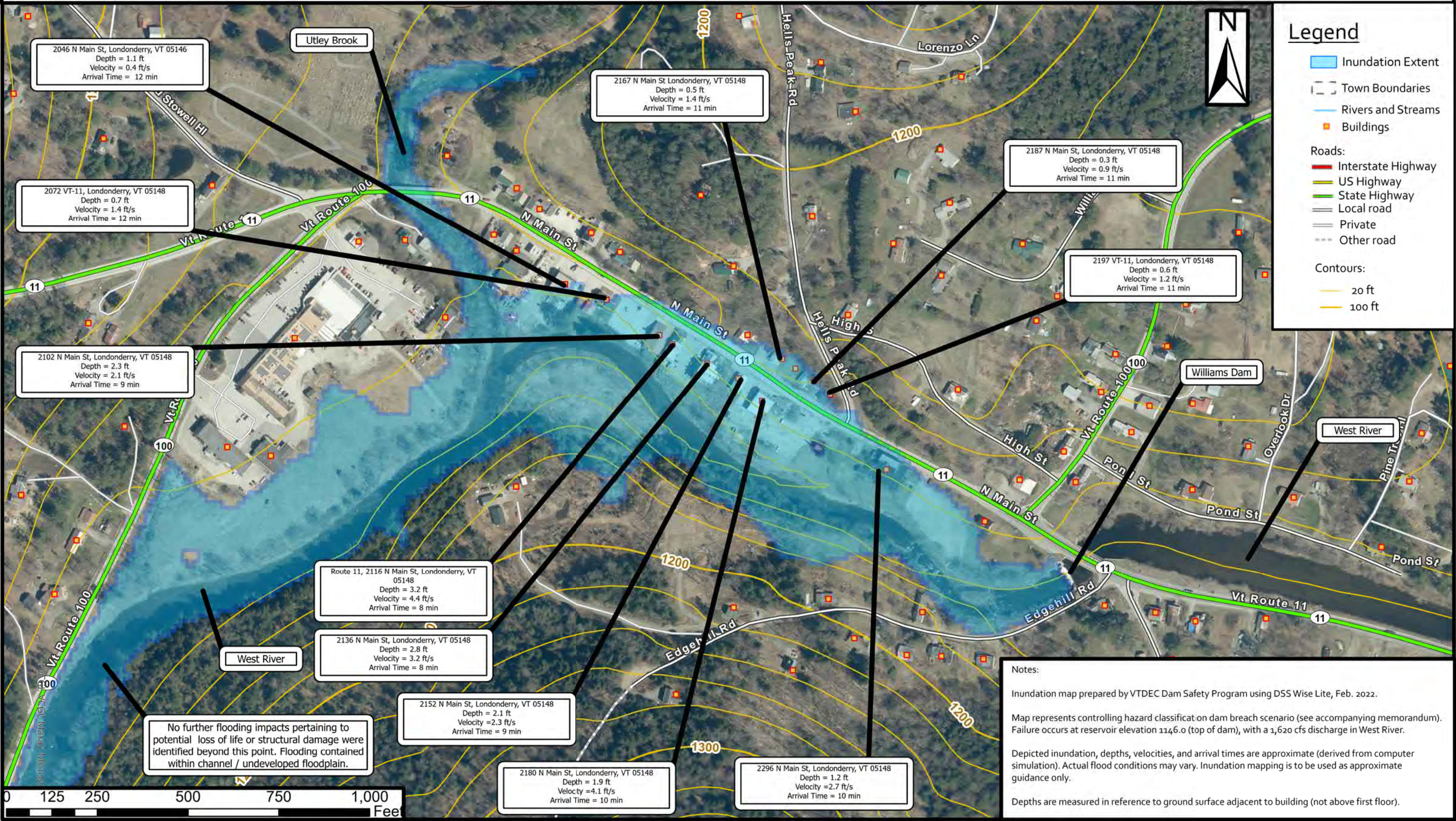
potential dams. EAPs are documents that include pre-planned actions in the case of a dam incident or failure and identify key emergency personnel as well as potential evacuation areas for emergency response planning.

This analysis used simplified methods, assumptions, and techniques, and focused on a limited number of dam failure and flooding scenarios. It is possible that additional losses could be realized in a scenario or flow condition that was not considered in this study. It is recommended to apply caution and conservancy when using the results of this simplified analysis for decision making and emergency action planning. If the dam owner disagrees with the classification assigned based on this study, they may apply to the DSP to reconsider the classification in accordance with Dam Safety Rule, 37-109(5) Hazard Potential Reconsideration.



Williams Dam (No. 115.01) - Londonderry, VT - Flood Inundation Map

Vermont Agency of Natural Resources - Department of Environmental Conservation - Dam Safety Program



ATTACHMENT B



DSS-WISE™ Lite Flood Simulation Report

Storm Day (1146.0) Dam Breach (Froehlich Partial)

Williams Dam

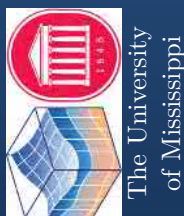
NAXXXXXX

February 18, 2022

Contact Information:

DSS-WISE™ Lite modeling questions: admin@dsswiseweb.ncche.olemiss.edu

National Center for Computational
Hydroscience and Engineering (NCCHE)



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1.0 Overview

The Decision Support System for Water Infrastructure Security (DSS-WISE™) is an integrated software package combining 2D numerical flood modeling capabilities with a series of GIS-based decision support tools. It was developed by the National Center for Computational Hydroscience and Engineering (NCCHE) at the University of Mississippi and was initiated by the US Department of Homeland Security (DHS) Science and Technology Directorate through the Southeast Region Research Initiative (SERRI) Program.

A simplified, and fully automated, version of the DSS-WISE™ software suite (DSS-WISE™ Lite Ver 1.0) was developed on behalf of the US Army Corps of Engineers (USACE) Critical Infrastructure Protection and Resilience (CIPR) Program and the DHS Office of Infrastructure Protection. This simplified dam break flood modeling capability was available to interested parties through the Dams Sector Analysis Tool (DSAT) secure web portal until November 2014. An updated version with more features was developed on behalf of Federal Emergency Management (FEMA) and is available at dsswiseweb.ncche.olemiss.edu.

The DSS-WISE™ Lite software suite, running on NCCHE servers, automatically processes input files for dam-break modeling scenarios submitted by an user. DSS-WISE™ Lite further simplifies simulations by making several general overarching assumptions in an effort to streamline data preparation and computations.

The results produced by this simplified dam-break flood simulation tool represent a rough approximation. They are not intended to replace more detailed flood inundation modeling and mapping products or capabilities developed by hydraulic and hydrologic engineers and GIS professionals.

The user is, therefore, warned that professional engineering judgment should be used in the interpolation of the results generated by this simplified and automated dam-break flood analysis.

To learn more about DSS-WISE™ and DSS-WISE™ Lite visit us at:
<https://dsswiseweb.ncche.olemiss.edu>

Disclaimer

The National Center for Computational Hydroscience and Engineering (NCCHE), The University of Mississippi, makes no representations pertaining to the suitability of the results provided herein for any purpose whatsoever. All content contained herein is provided "as is" and is not presented with any warranty of any form. NCCHE hereby disclaims all conditions and warranties in regard to the content, including but not limited to any and all conditions of merchantability and implied warranties, suitability for a particular purpose or purposes, non-infringement and title. In no event shall NCCHE be liable for any indirect, special, consequential or exemplary damages or any damages whatsoever, including but not limited to the loss of data, use or profits, without regard to the form of any action, including but not limited to negligence or other tortious actions that arise out of or in connection with the copying, display or use of the content provided herein.

Elevation Datum

All reported elevations use the North American Vertical Datum of 1988 (NAVD 88).

2.0 Modeling Parameters and Conditions

2.1 Project Information

Project Name:	Williams Dam
Scenario Name:	Storm Day (1146.0) Dam Breach (Froehlich Partial)
NIDID:	NAXXXXXX
Scenario Description:	Storm Day (1146.0) Dam Breach Froehlich Partial Breach HEC-HMS Hydrograph 1624 cfs Baseflow 40 Bottom Breach Width 0.2 hr Failure Time 8712.4 cfs Peak Discharge 7.5 sq. mi. 2 days 15 ft x 15 ft cell size
User e-mail:	andrew.sampsell@vermont.gov

2.2 Simulation Parameters

Domain buffer distance (miles):	7.5
Simulation cell size requested (ft):	15.0
Simulation duration requested (days):	2

2.3 Impounding Structure(s) Characteristics

Number of Structures: 1

Structure Name:	Williams Dam
Structure Type:	Embankment
Hydraulic Height (ft):	17.0
Crest Elevation (ft):	1150.0
Length (ft):	97.0982233099

2.4 Bridge(s) to be Removed

Number of Bridges: 0

2.5 User-Specified Breach Hydrograph

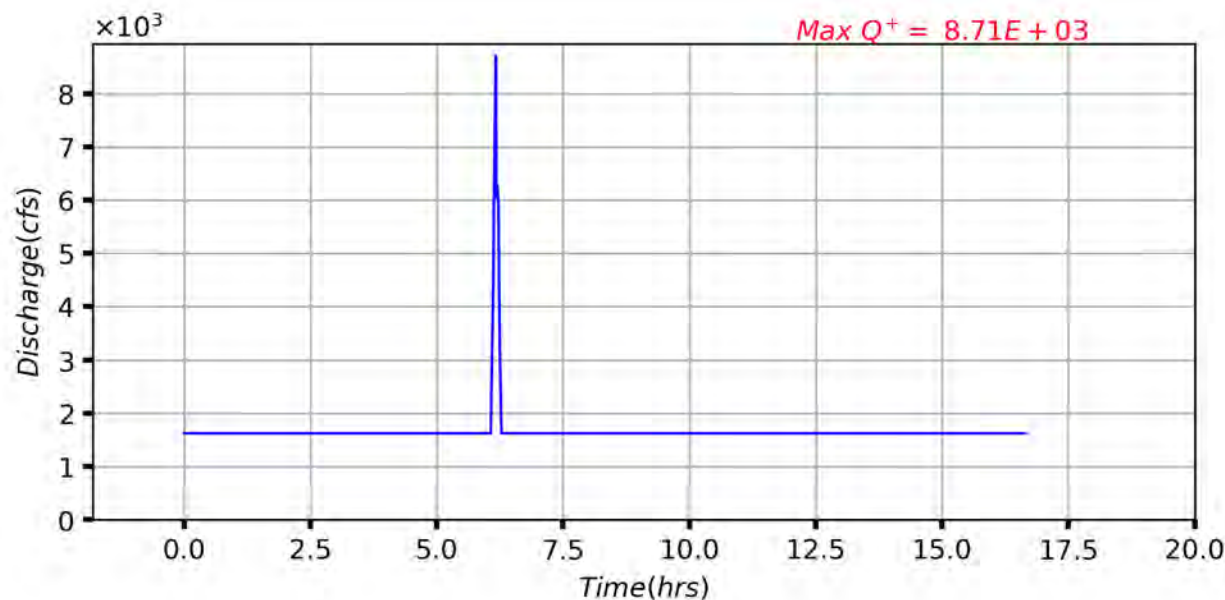


Figure 1. Breach inflow hydrograph for: Williams Dam.

2.6 Reservoir Characteristics

Number of Reservoirs: 1

Reservoir Name:	Williams Dam Reservoir
Selected Reservoir Point (Latitude/Longitude):	43.2266717542/-72.8063386331
Pool Elevation @ Max Storage (ft):	1146.0
Maximum Storage Volume (ac-ft):	97.1
Pool Elevation @ Normal Storage (ft):	1143.0
Normal Storage Volume (ac-ft):	42.43
Pool Elevation @ Failure (ft):	1146.0
Failure Storage Volume (ac-ft):	97.1

2.7 Failure Conditions

Structure ID:	1
Structure Name:	Williams Dam
Structure Type:	Embankment
Failure Mode:	Partial Dam Breach
Breach Width (ft):	40.0
Breach Location (Latitude/Longitude):	43.226506097/-72.8072398148

3.0 Automated Data Preparation and Job Flow Summary

3.1 Job Flow Summary

1. Prepare Digital Elevation Model (DEM) and Land Use/Land Cover (LULC) tiles for the Area of Interest (AOI) based on requested cellsize and maximum downstream distance.
2. Burn U.S. Army Corps of Engineers (USACE) levee lines into DEM for the AOI.
3. Assign Manning's coefficients based on LULC classifications.
4. Validate user provided simulation input parameters.
5. Remove user identified bridges from the DEM.
6. Estimate reservoir bathymetry.
7. Extend impounding structures if the specified reservoir level cannot be contained.
8. Fill reservoir to specified failure elevation.
9. Prepare boundary condition and all input data for simulation.

3.2 Reservoir Bathymetry and Filling

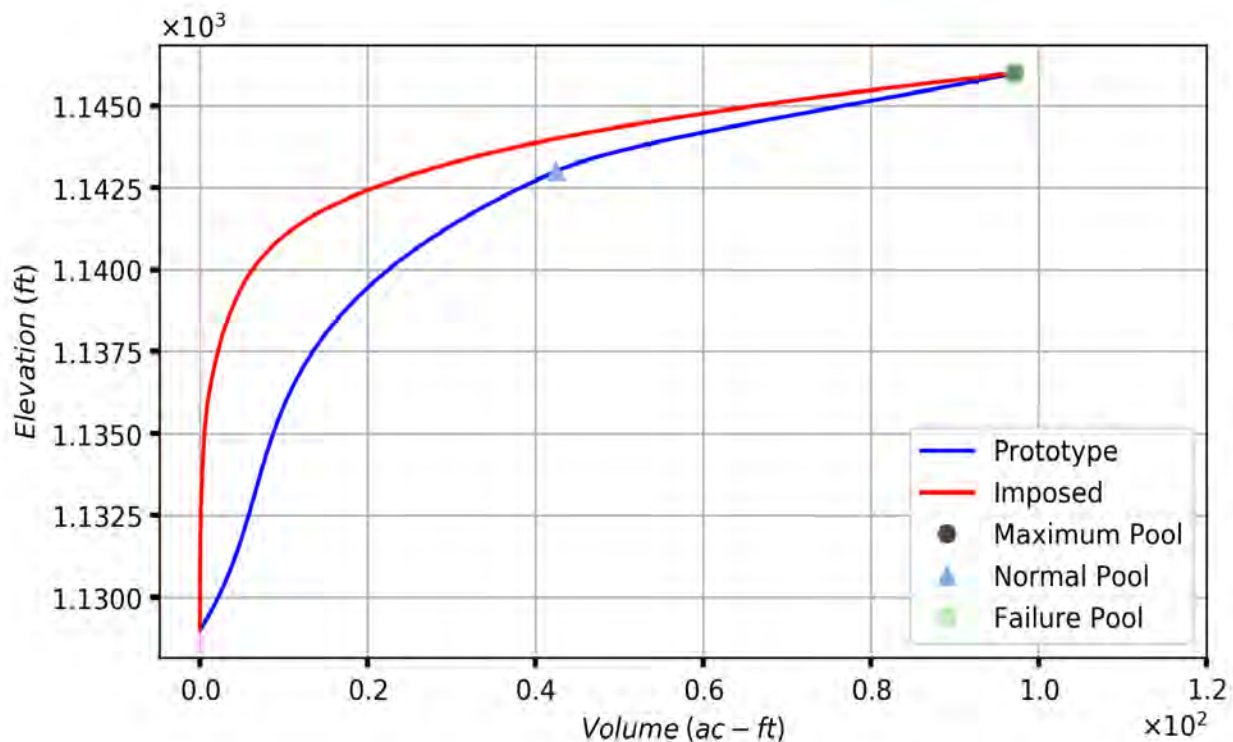


Figure 2. Stage-Volume Curve for Reservoir: Williams Dam Reservoir.

Prototype: Theoretical cubic Hermite spline curve generated from user-provided reservoir elevation and volume information.

Imposed: Measured from reservoir bathymetry after filling to the failure elevation.

The reservoir water surface was detected to be in the DEM, so bathymetry estimation was performed using the prototype stage-volume curve shown above.

User-given Storage Volume at Failure (ac-ft): 97.1

Imposed Storage Volume at Failure (ac-ft): 97.1

After filling to the failure elevation, the imposed reservoir volume matched 100.0% of the prototype volume.

3.3 Data Sources

1. Digital Elevation Models

Sources: USGS 2018 National Elevation Dataset, NOAA, DEM provided by group.

Resolutions: 2, 1, 1/3, 1/9, 0.15 arc-seconds, 1 meter, and 10 feet based on availability

Vertical Datum: NAVD88

Horizontal Datum: NAD83

2. National Land Use/Land Cover Data

Source: USGS 2016 National Land Cover Database

Resolution: 30 m

3. National Levee Database

Source: USACE

3.4 Digital Elevation Model

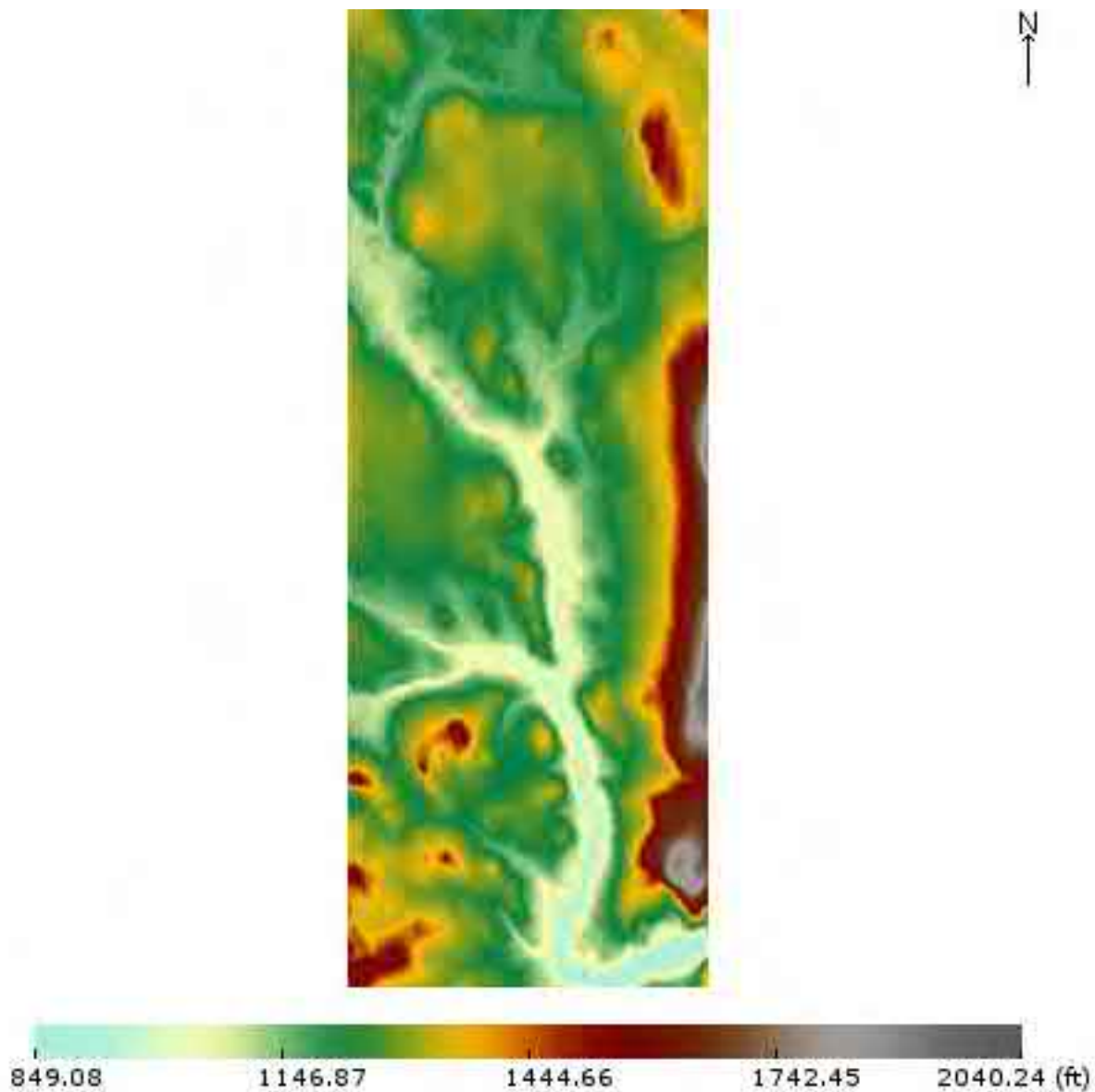


Image Dimensions: N-S: 7.750 miles E-W: 2.849 miles
Figure 3. Map of Digital Elevation Model with Levees for AOI.

3.5 Reservoir Boundary and Breaching Structure

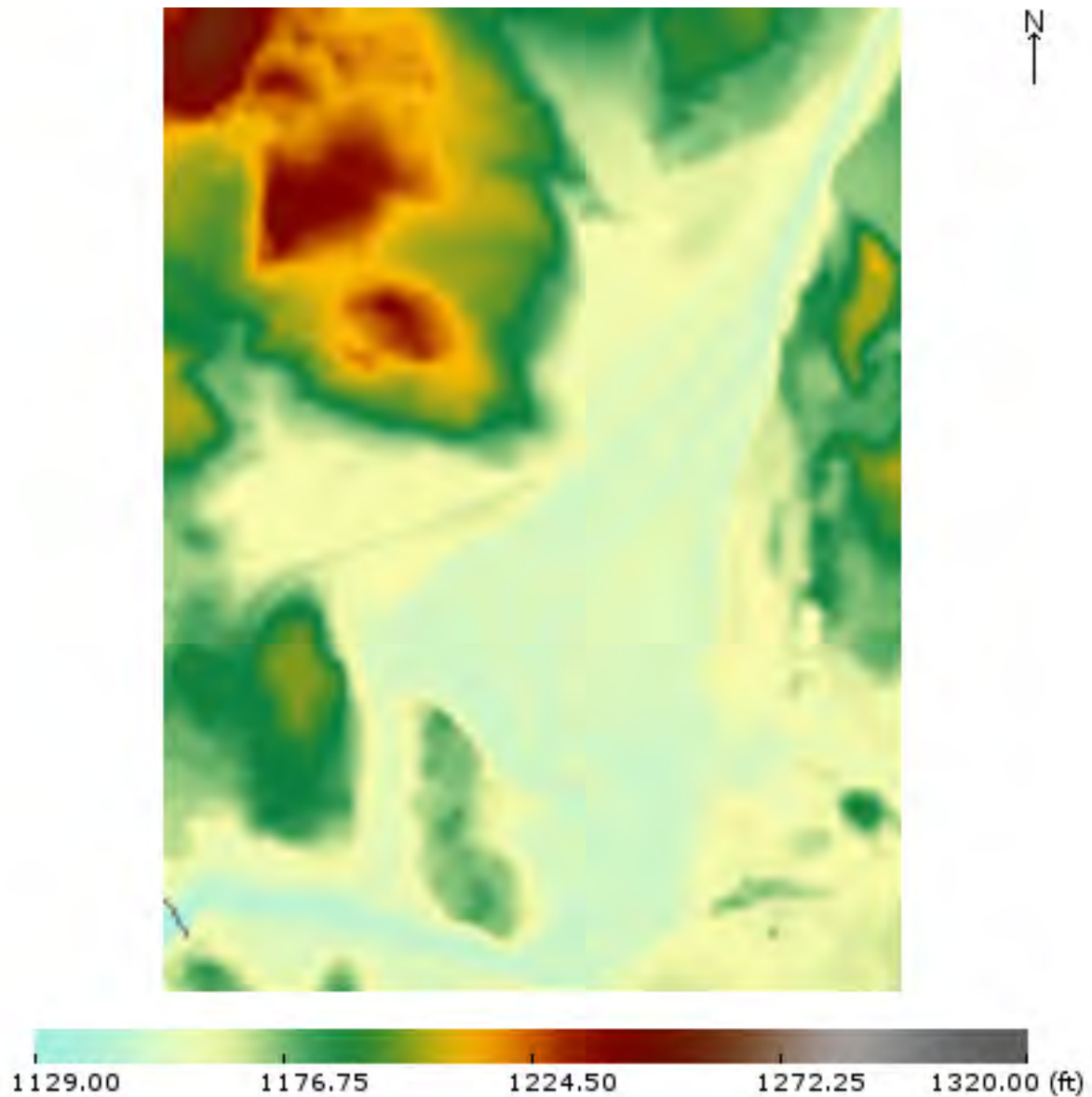


Figure 4. Map of Reservoir Boundary and Breached Structure.

3.6 Reservoir Initial Depth Profile

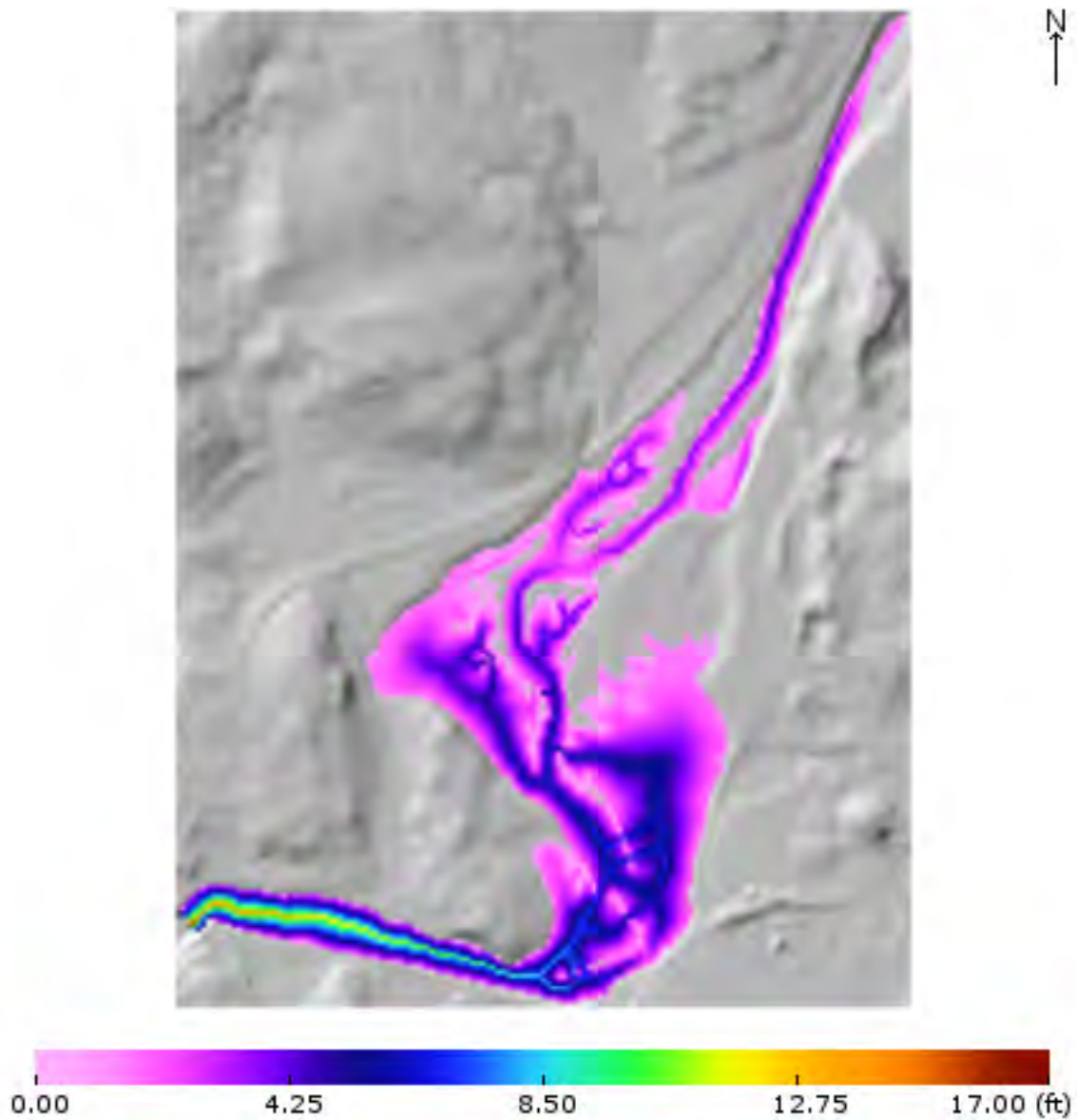


Image Dimensions: N-S: 0.679 miles E-W: 0.503 miles
Figure 5. Map of Initial Depths in Reservoir at Failure Conditions.

3.7 Land Use/Land Cover



Image Dimensions: N-S: 7.750 miles E-W: 2.849 miles

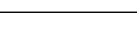
Figure 6. Map of Land Use for AOI.

4.0 Simulation Results

4.1 Simulation Summary

Simulation Request Received:	11:08 AM CST (02/18/2022)
Simulation Start Time:	11:09 AM CST (02/18/2022)
Simulation End Time:	11:17 AM CST (02/18/2022)
DEM resolution used for simulation (ft):	15.0
DEM resolution requested (ft):	15.0
Final distance reached downstream (miles):	7.2
Domain buffer distance (miles):	7.5
Elapsed simulation time after breach initiation (hrs):	23.2
Termination condition:	Water stopped spreading.

4.2 Land Use and Manning's Roughness Coefficient for Inundated Area

Land Use Description	% of Inundated Area	n-Value($m^{-1/3}s$)	Code	Color
Open Water	32.20	0.0330	11	
Evergreen Forest *	17.51	0.1000	42	
Woody Wetlands	16.24	0.1500	90	
Deciduous Forest *	8.22	0.1000	41	
Hay/Pasture	6.44	0.0350	81	
Barren Land	4.50	0.0113	31	
Developed, Low Density	3.81	0.0678	22	
Emergent Herbaceous Wetlands	2.74	0.1825	95	
Developed, Medium Density	2.42	0.0678	23	
Developed, Open Space	1.90	0.0404	21	
Mixed Forest *	1.59	0.1200	43	
Grassland/Herbaceous	1.04	0.0400	71	
Shrub/Scrub	0.91	0.0400	52	
Developed, High Density	0.31	0.0404	24	
Cultivated Crops	0.09	0.0700	82	
Unclassified	0.00	0.0350	0	
Perennial Snow/Ice	0.00	0.0100	12	
Dwarf Scrub *	0.00	0.0350	51	
Sedge/Herbaceous *	0.00	0.0350	72	
Lichens *	0.00	0.0350	73	
Moss *	0.00	0.0350	74	

Note: * indicates an n-value estimated by NCCHE. ** indicates an n-value given by the user. Other values are taken from literature.

4.3 Coverage and Sources of DEM Raster Datasets



Figure 7. Coverage of DEM Raster Datasets in the Inundation Area.

DEM Source	Source Resolution	Source Dataset	Color
USGS	1 arc-second	usgs_1as	
USGS	1/3 arc-seconds	usgs_13as	
USGS	1 meter	usgs_utm_z18_1m	

Note: The DEM for this job was created from the source DEM raster datasets listed above. These DEM raster datasets were resampled and reprojected to the user defined cell size and UTM zone, respectively. Resampled and projected DEM raster datasets were then stacked in the order specific to the group under which this simulation was submitted.

4.4 Maximum Flood Depth

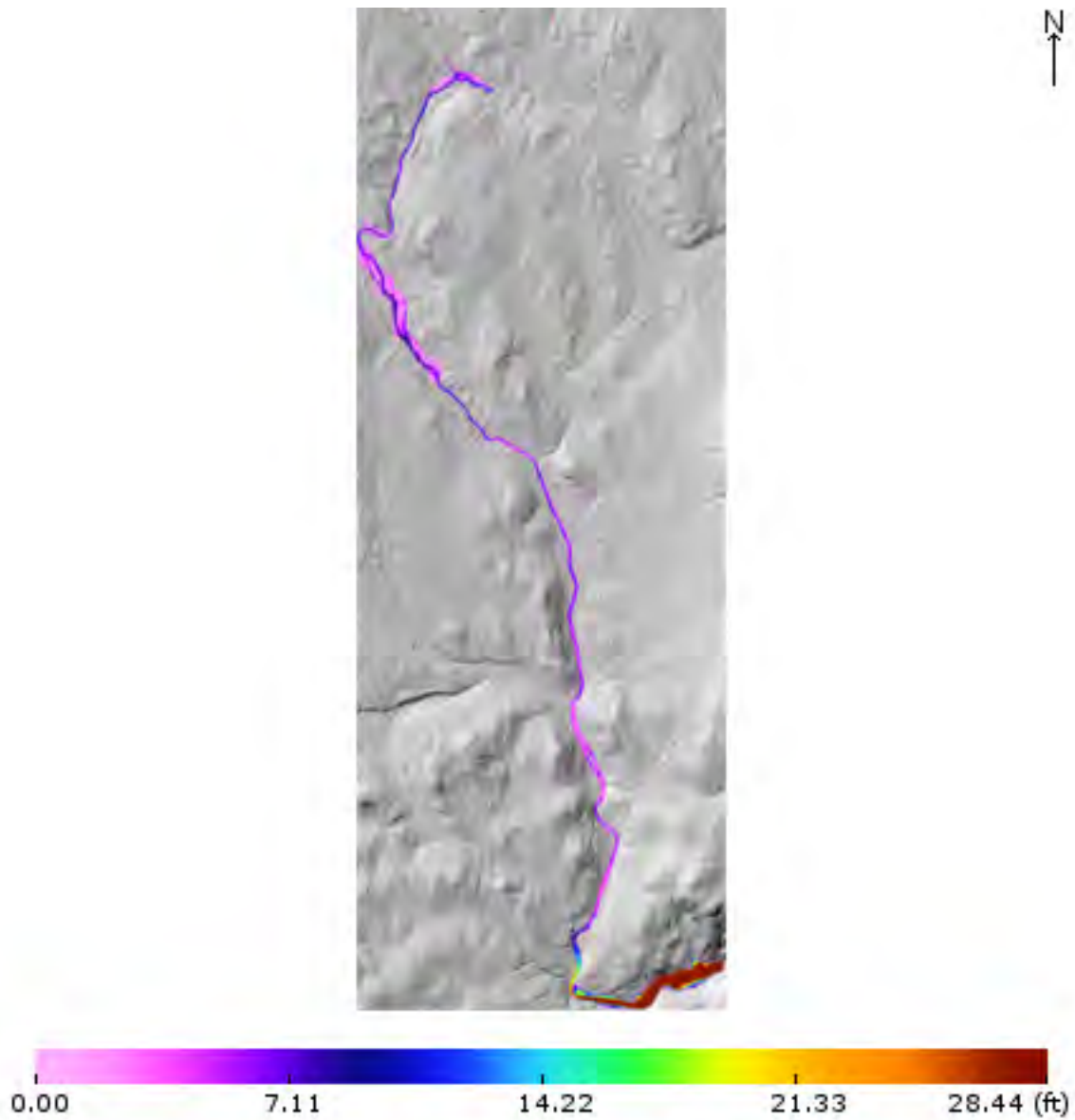


Image Dimensions: N-S: 7.761 miles E-W: 2.861 miles
Figure 8. Maximum Flood Depth Map.

4.5 Flood Arrival Time

Flood arrival time is measured from the beginning of the simulation.

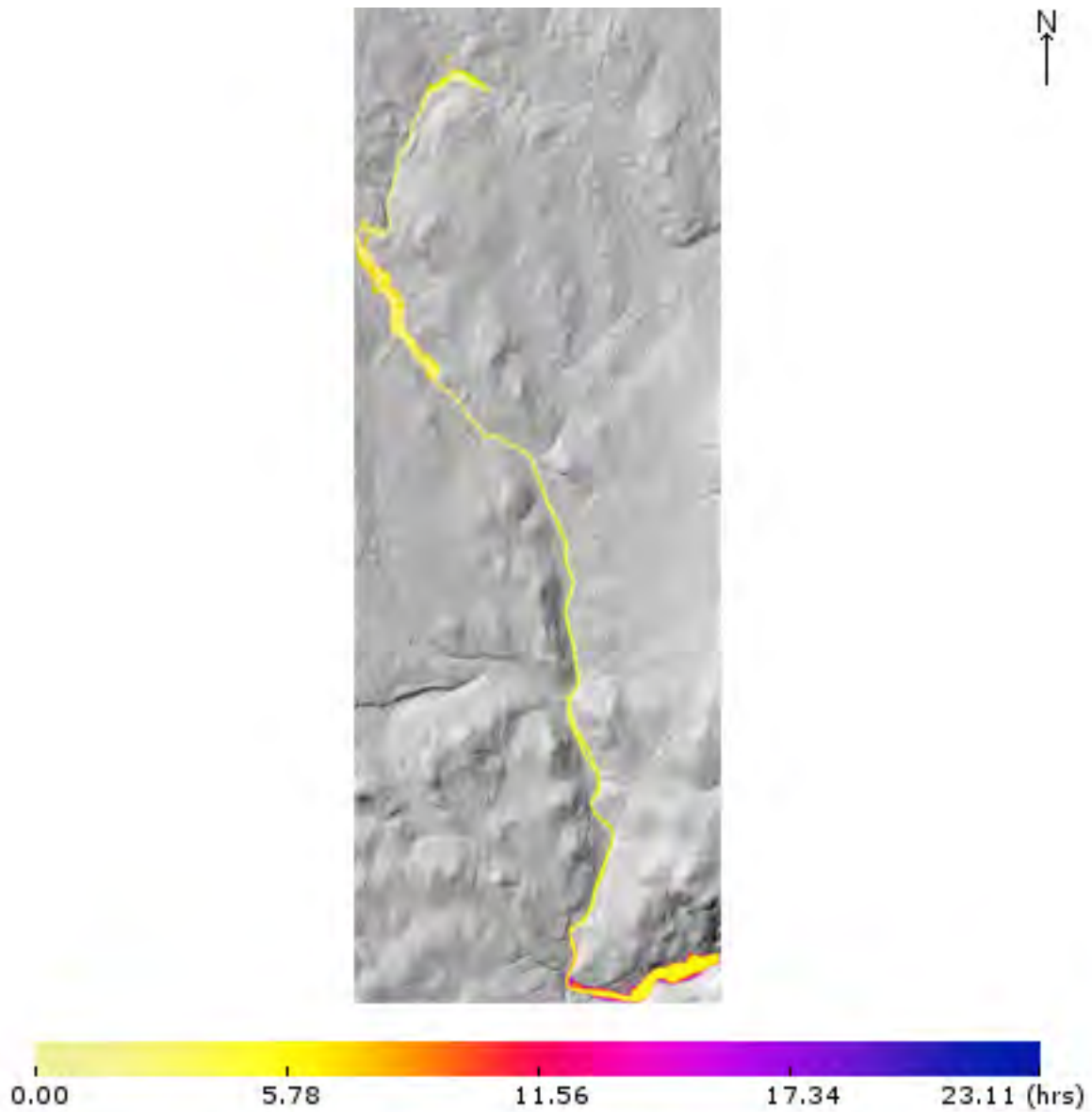


Image Dimensions: N-S: 7.761 miles E-W: 2.861 miles

Figure 9. Flood Arrival Time Map.

4.6 Downloading Simulation Results

The simulation results can be accessed at the following web address:

`https://dsswiseweb.ncche.olemiss.edu/download`

Job ID: 44667

ATTACHMENT C



FEMA

DSS-WISE™ HCOM HUMAN CONSEQUENCE REPORT

Williams Dam

Storm Day (1146.0) Dam Breach (Froehlich Partial)

NAXXXXXX

February 18, 2022

DSS-WISE Lite Simulation ID: 44667

National Center for Computational
Hydroscience and Engineering (NCCHE)



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EXECUTIVE SUMMARY

This document reports the human consequences assessment for the DSS-WISE Lite simulation ID: **44667**

INUNDATION EXTENT

Total inundated area (acres)(see [figure 1](#)): 323.02

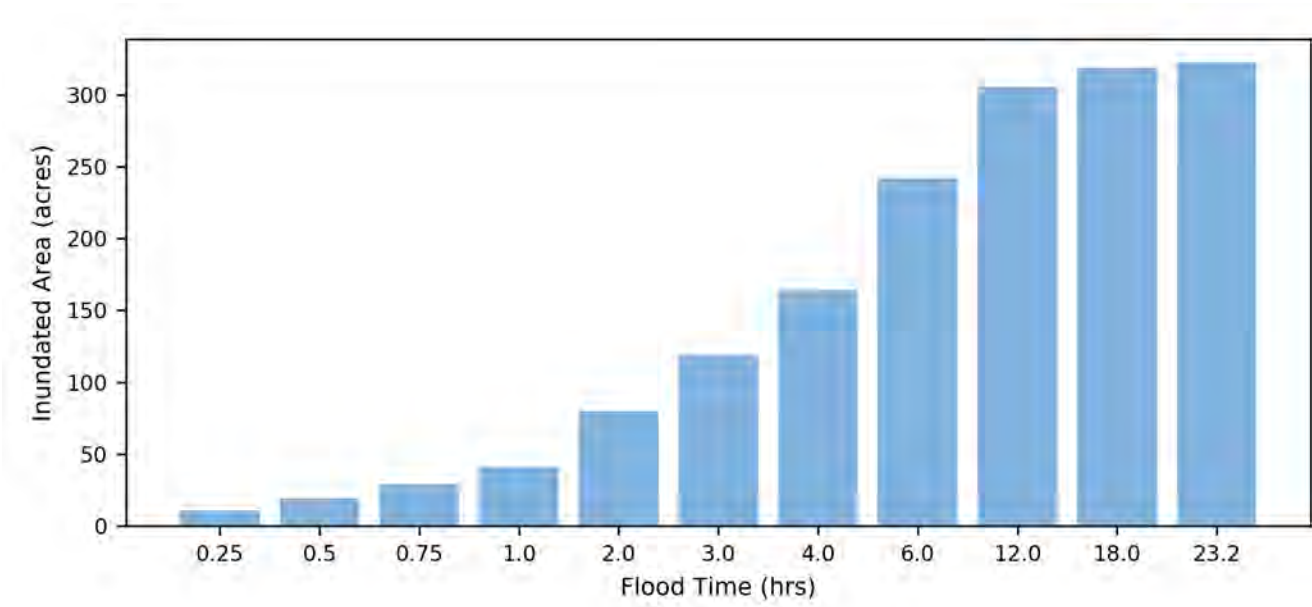


Figure 1. Evolution of total inundated area as a function of time.

ANALYSIS BASED ON CENSUS BLOCK DATA

Population in completely or partially inundated census blocks:	741
Housings in completely or partially inundated census blocks:	641
Number of states in inundated area:	1
Number of counties in inundated area:	1
Number of census blocks in inundated area:	44

ANALYSIS BASED ON GRIDDED LANDSCAN USA DATA

Total Nighttime PAR in inundated area (see figure 2):	7
Total Daytime PAR in inundated area (see figure 3):	47

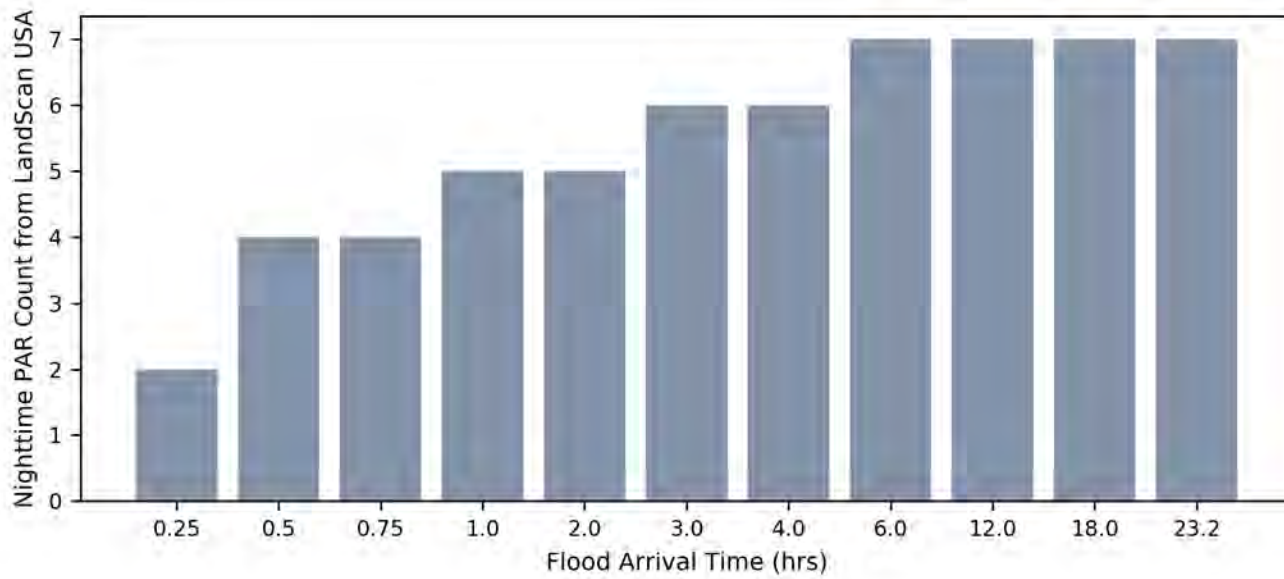


Figure 2. Evolution of nighttime PAR as a function of time.

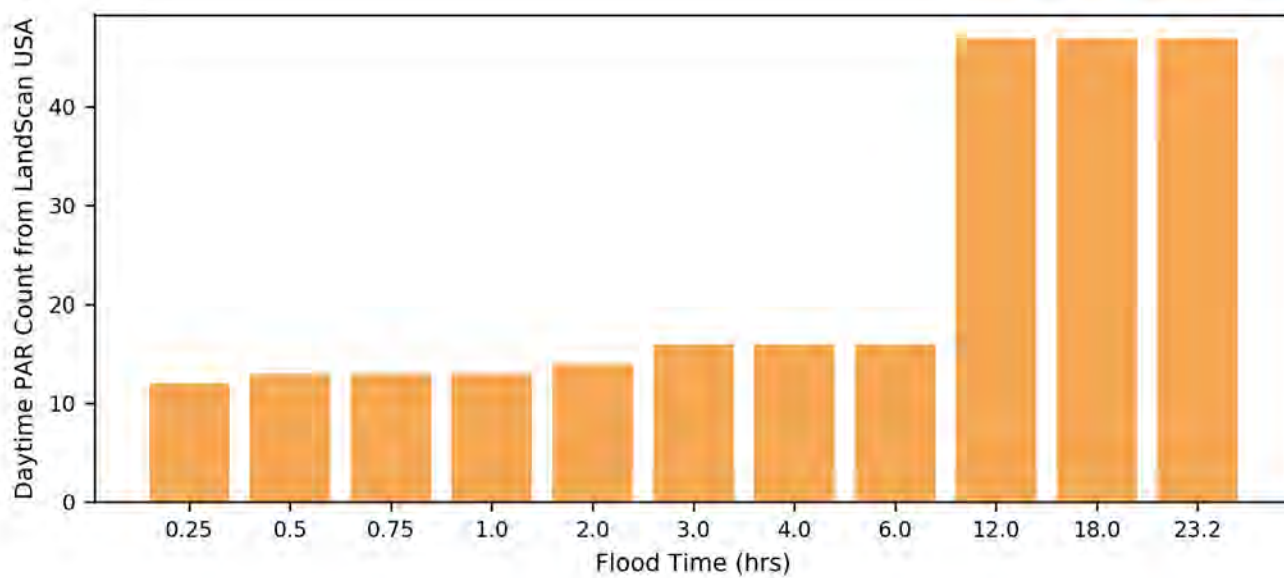


Figure 3. Evolution of daytime PAR as a function of time.

1.0 Overview

This report is produced DSS-WISE HCOM, which is part of the DSS-WISE Web system developed by the National Center for Computational Hydroscience and Engineering, at the University of Mississippi. Funding for DSS-WISE HCOM was provided by the U.S. Federal Emergency Management Agency (FEMA) through a contract with Argonne National Laboratory (ANL).

The results provided to the user by DSS-WISE HCOM include the following:

- the present report,
- a Microsoft Excel file containing data, results and plots, and
- a series of geospatial results files (in the form of polygon shapefiles).

These files can be used for further analysis and decision making for preparedness or during the response to an emergency. The files can also be used for hazard classification, risk prioritization preparing Emergency Actions Plans (EAPs).

DSS-WISE HCOM interfaces two-dimensional flood simulation results provided by DSS-WISE Lite with the population data provided by the U.S. Census Bureau and LandScan USA.

Please send any questions or suggestions to
admin@dsswiseweb.ncche.olemiss.edu

2.0 List of Abbreviations

ft	feet
hrs	hours
ft^2/s	Unit discharge, feet-squared per second
m^2/s	Unit discharge, meters squared per second
ft/s	feet per second
$ft.lb.$	foot-pounds
$m.kg.$	Meter-kilograms
D_{max}	Maximum depth
DV	Depth times velocity, unit discharge
DV_{max}	Maximum depth times velocity, maximum unit discharge
q_{max}	Maximum unit discharge, also called DV_{max}
DSS-WISE	Decision Support System for Water Infrastructural Security
DSS-WISE Web	Decision Support System for Water Infrastructural Security Web, the web-based system housing DSS-WISE Lite and other tools
DSS-WISE Lite	Decision Support System for Water Infrastructural Security Lite, the web-based version of DSS-WISE dam-break and flood modeling software
HCOM	Human Consequence Module
NCCHE	National Center for Computational Hydroscience and Engineering
PLFZ	Potentially Lethal Flood Zones
PAR	Population At Risk
EAP	Emergency Action Plan
NIDID	National Inventory of Dams (NID) Identifier
USCB	United States Census Bureau, or officially the Bureau of the Census
FEMA	Federal Emergency Management Agency
ANL	Argonne National Laboratory
ORNL	Oak Ridge National Laboratory
ESRI	Environmental Systems Research Institute
LSM	Life Safety Model

3.0 HCOM DATA SETS

3.1 DSS-WISE Lite Results Files

The human consequence analysis in this report are provided by DSS-WISE HCOM based on the raster results files for the following dam-break flood modeling simulation with DSS-WISE Lite:

DSS-WISE Lite simulation ID:	44667
Project Name:	Williams Dam
Scenario Name:	Storm Day (1146.0) Dam Breach (Froehlich Partial)
NIDID:	NXXXXXX
Scenario Description:	Storm Day (1146.0) Dam Breach Froehlich Partial Breach HEC-HMS Hydrograph 1624 cfs Baseflow 40 Bottom Breach Width 0.2 hr Fail- ure Time 8712.4 cfs Peak Discharge 7.5 sq. mi. 2 days 15 ft x 15 ft cell size
Simulation distance requested (<i>miles</i>):	7.5
Simulation cell size (<i>ft</i>):	15.0
Simulation duration requested (<i>days</i>):	2.0

Table 1. DSS-WISE Lite results files used by DSS-WISE HCOM.

File Name	Type	Units	Description
44667_Hmax_ft_upto_final.tif	Raster	<i>ft</i>	Maximum flood depth
44667_Arrival_Time_hr_upto_final.tif	Raster	<i>hrs</i>	Flood Arrival Time
44667_Vmax_ftps_upto_final.tif	Raster	<i>ft/s</i>	Maximum flood velocity
44667_DVmax_ft2ps_upto_final.tif	Raster	<i>ft²/s</i>	Magnitude of the maximum specific discharge
44667_DVmax_ft2ps_upto_final.tifArrivalTime	Raster	<i>hrs</i>	Arrival time of the maximum value of specific discharge

3.2 Population Data Sets Used by DSS-WISE HCOM

DSS-WISE HCOM uses two different sets of population data to estimate the Population at Risk (PAR) potentially affected by the flood:

1. 2010 Census Block data provided by the United States Census Bureau (USCB), which is federal government agency in charge of producing data about the people and economy of the U.S. A census block is the smallest geographic unit for which USCB collects data from all the houses in the unit (rather than a sample of houses). Census Blocks are bounded by visible features such as streets, roads, streams and nonvisible features such as property lines and limits of city, township, school district, and counties, etc. They are defined as polygons in a shapefile covering the entire territory of the U.S. including Puerto Rico and the Island areas. The attributes of the census block polygons include 2010 Census Housing Unit Count and 2010 Census Population Count. The latter should be considered as 2010 nighttime population data.
2. LandScan USA gridded population data developed and maintained by the Oak Ridge National Laboratory (ORNL) located in Oak Ridge, TN. LandScan USA (<https://landscan.ornl.gov/>) is a collection of gridded nighttime and daytime population datasets developed by the Oak Ridge National Laboratory (ORNL), Department of Energy. These gridded population datasets are available as raster files with a resolution of 3 arc-second (90m or 295.28ft.). They were developed by combining satellite remote sensing data, geospatial infrastructure datasets, and demographic data from USCB. Researchers at ORNL used “Intelligent” dasymetric modeling method to assign the population counts to the grid cells (Dobson et al. 2000 and Bhaduri et al. 2007) by defining a habitability index and by maintaining the total count of cells in a census block to be equal to the total population of the census block. The LandScan USA datasets used in this report are projections for 2016 (McKee et al. 2014). Daytime data is generated using specially developed techniques for population dynamics (Bhaduri 2007).

Detailed explanations on the methodologies used by DSS-WISE HCOM are provided in the technical manual, which can be downloaded from documentation page of the DSS-WISE Web website.

4.0 FLOOD HAZARD MAPPING

Flood-hazard mapping consists of partitioning the inundation extent into zones of pre-defined potential danger classes for humans. The resulting map is an ESRI shapefile of polygon type. The polygons correspond to different levels of potential danger for humans caught outdoors and indoors.

The potential danger classes are identified based on the ranges of the value of the maximum specific discharge, DV_{max} . The ranges of $q_{max} \equiv DV_{max}$ values are different for persons caught outdoors or indoors.

4.1 Potential Flood Hazard for Humans Caught Outdoors

For humans caught outdoors, the ranges of DV_{max} corresponding to five potential hazard (or danger) levels identified by different color codes are summarized in [Table 2](#), which is adapted from [Cox et al. \(2010\)](#). The potential hazard levels are:

1. “Very Low Hazard: Shallow flow or deep standing water”;
2. “Low Hazard: Dangerous to children”;
3. “Moderate Hazard: Dangerous to some adults”;
4. “Significant Hazard: Dangerous to most adults”; and
5. “Extreme Hazard: Dangerous to all”.

The three rightmost columns of [Table 2](#) correspond to the interpretation of five potential hazard levels by [Cox et al. \(2010\)](#) for three population categories defined by an index value corresponding to the product of height (H) and mass (M) of the individual as listed at the bottom of [Table 2](#).

1. “Infants and small Children”,
2. “Children”, and
3. “Adults”;

The five polygons corresponding to the five potential flood hazard levels for people caught outdoors as listed in [Table 2](#) are provided as an ESRI shapefile of polygon type.

Cox et al. (2010) notes that the limits of DV_{max} in Table 2 correspond loosely to the loss of stability of different population categories. However, it is important to note that the ranges of DV_{max} given in Table 2 should not be considered as strict limits. Various other factors may influence the stability of individuals caught outdoors by the flood, such as:

- Bottom conditions (uneven surface, slippery surface, visible or invisible obstacles);
- Flow conditions (floating debris, low temperature, poor visibility, unsteady flow and flow aeration);
- Human subject (standing or moving, experience and training, clothing and footwear, physical attributes, such as height, mass and muscular development, disabilities, and psychological factors); and
- Other factors (strong wind, poor lighting, feeling unsafe or complete loss of footing).

Table 2. Potential flood hazard levels for humans caught outdoors by the flood (adapted from Cox et al. 2010).

DV_{max}				Potential Hazard Category	Explanation		
m^2/s		ft^2/s			Adults	Children	Infants, Small Children and Frail/Older Persons
from	to	from	to				
0.0	0.4	0.0	4.3	HZ01 Very Low Hazard: Shallow flow or deep standing water	Low Hazard	Low Hazard	Extreme Hazard Dangerous to all Infants, small Children and Frail/Older Persons
0.4	0.6	4.3	6.5	HZ02 Low Hazard: Dangerous to Children		Significant Hazard; Dangerous to most Children	
0.6	0.8 ⁽²⁾	6.5	8.6 ⁽²⁾	HZ03 Moderate Hazard: Dangerous to some adults	Moderate Hazard: Dangerous to some adults		
0.8	1.2 ⁽³⁾	8.6	13 ⁽³⁾	HZ04 Significant Hazard: Dangerous to most adults	Significant Hazard: Dangerous to most adults	Extreme Hazard: Dangerous to all children	
1.2 ⁽³⁾		13 ⁽³⁾		HZ05 Extreme Hazard: Dangerous to all	Extreme Hazard: Dangerous to all		
1) Small children, children and adult categories are defined based on $height(H) \times mass(M)$ Small children: $H \times M \leq 25l(m.kg.)$ $H \times M \leq 181(ft.lb.)$ Children: $25 < H \times M(m.kg.) \leq 50$ $181 < H \times M(m.kg.) \leq 362$ Adult: $50 < H \times M(m.kg.)$ $362 < H \times M(ft.lb.)$							
2) Recommended upper limit of tolerable working flow regime for trained safety workers or experience and well-equipped persons							
3) Above this value, the hazard is extreme according to majority of the past studies.							

Results file package of DSS-WISE HCOM contains an ESRI shapefile of polygon type containing up to five polygons (see [Table 6](#)) corresponding to the five potential flood hazard levels for humans caught outdoors by the flood, which are listed in [Table 2](#). For convenience, [Map 09](#) of this report shows the inundation extent colored by the five potential flood hazard levels listed in [Table 2](#).

4.2 Flood Hazard for Humans Caught Indoors

For people caught indoors by the flood, it is assumed that the potential danger is associated with the collapses of the building (see [FEMA 2011, p.43](#)). This implicitly assumes that the people indoors are in potential danger of loss of life if the building collapses due to inundation by floodwaters.

[Table 3](#) list the DV_{max} values for the potential collapse of different types of buildings, which are taken from the technical report of the Life Safety Model (LSM) developed by British Columbia Hydro ([BCH 2006](#)).

Table 3. Potential flood hazard levels for humans caught indoors based on the BC Hydro LSM Building Stability Criteria.

DV_{max}		Color Code	Building Type
(m^2/s)	(ft^2/s)		
≥ 5	≥ 54		HZ06: Poorly constructed building
≥ 10	≥ 108		HZ07: Well-built timber building
≥ 15	≥ 161		HZ08: Well-built masonry building
≥ 20	≥ 215		HZ09: Concrete building
≥ 35	≥ 377		HZ10: Large concrete building

Results file package of DSS-WISE HCOM contains an ESRI shapefile of polygon containing up to five stacked polygons (see [Table 6](#)) corresponding to the five potential flood hazard levels for humans caught indoors by the flood, which are listed in [Table 3](#). For convenience, [Map 10](#) of this report shows the inundation extent colored by the five potential flood hazard levels listed in [Table 3](#).

5.0 MAPPING POTENTIALLY LETHAL FLOOD ZONES (PLFZs) FOR CHILDREN AND ADULTS

The mapping of potentially lethal flood zones (PLFZs) for humans consists of partitioning the inundation extent into zones of predefined potential lethality classes for humans. The resulting map is an ESRI shapefile of polygon type for each category. The polygons correspond to different levels of potential lethality that are defined based on the maximum depth, D_{max} , and maximum specific discharge, DV_{max} . The PLFZs for different categories of people caught outdoors, cars, mobile homes and typical residential structures are listed in [Table 4](#) ([Feinberg, 2017](#)).

Table 4. Definition of potentially lethal flood zones (PLFZs) for different categories ([Feinberg, 2017](#)).

Category	Color Code	D_{max} (<i>ft.</i>)		DV_{max} (<i>ft</i> ² / <i>s</i>)
Children caught outdoors (tent camping, fishing, hiking, etc.)		≥ 2	or	≥ 5.4
Adults caught outdoors (tent camping, fishing, hiking, etc.)		≥ 4	or	≥ 6.5
Motor vehicle (compact car) floating	None	≥ 1	or	≥ 4.3
Motor vehicle (compact car) sliding/toppling	None			≥ 5.4
Mobile homes	None	≥ 2	or	≥ 30
Typical residential structures	None	≥ 4	or	≥ 75

Results file package of DSS-WISE HCOM contains an ESRI shapefile of polygon type containing two stacked polygons corresponding to the first two categories in [Table 4](#). These two polygons were extracted using the maximum flow depth and maximum specific discharge files provided in the results package of DSS-WISE Lite simulation (see [Table 6](#)). For convenience, [Map 11](#) of this report shows the extents of these two PLFZ polygons.

The polygons for the remaining PLFZ zones can also be extracted from the D_{max} and DV_{max} raster files using a suitable GIS software.

6.0 POPULATION AT RISK (PAR) ANALYSIS

The population at risk (PAR) analysis aims to provide an estimate of the number of people that will be potentially affected by the propagation of the dam-break flood. DSS-WISE HCOM provides two different types of PAR analysis based on the two different population data sets that are available (see [Section 3.2](#)).

6.1 PAR Analysis Using Census Block Population Data

The results of the PAR analysis using 2010 census block population are given in two different forms:

- The list of the census blocks that are inundated (completely or partially) by the dam-break flood is provided in the “CensusBlock_Analysis” worksheet of the MS Excel file accompanying the present report.
- The polygons of the census blocks that are inundated (completely or partially) by the dam-break flood are provided in a shapefile accompanying the present report. The attributes of the census block polygons are the same as the data columns in the MS Excel file.

The polygons of census blocks included in the inundation extent (completely or partially) are provided as an ESRI shapefile (see [Table 6](#)) in the results package of DSS-WISE HCOM. The worksheet “CensusBlock_Analysis” lists all the census blocks and their attributes, which include various data extracted by DSS-WISE HCOM. The attributes of the census-block polygons are the same as the columns in the worksheet “CensusBlock_Analysis” of the MS Excel file accompanying the present report.

These attributes of the census blocks are listed and explained in [Table 5](#). [Map 06](#) in this report shows the census block polygon outlines overlaid on the flood extent.

Table 5. Attributes of the census block polygons in the shapefile and the corresponding columns in the worksheet “CensusBlock_Analysis” of the MS Excel file accompanying the present report.

ExcelFile		Shapefile	Unit	Description
Col	Title	Attributes		
A	State Name	STATE_NAME		Abbreviation of the state name
B	County Name	CNTY_NAME		County Name

C	State FIPS CODE	STATEFP10		2010 Census state FIPS code
D	County FIPS CODE	COUNTYFP10		2010 Census county FIPS code
E	Tract CODE	TRACTCE10		2010 Census tract code
F	Tabulation Block Number	BLOCKCE		2010 Census tabulation block number
G	Block ID Number	BLOCKID10		Census block identifier; A concatenation of 2010 Census state FIPS code, 2010 Census county FIPS code, 2010 Census tract code , and 2010 Census block number
H	Partial Block Indicator	PARTFLG		Y = partial block N = whole block
I	Total Number of Housing	HOUSING10	<i>Count</i>	2010 Census Housing Unit Count
J	Total Number of Population	POP10	<i>Count</i>	2010 Census Population Count
K	Total Area	AREATOT	<i>Acres</i>	Total area of the census block. This information is extracted from the geometry of the census block
L	Inundated Area	AREAINUND	<i>Acres</i>	Area of the census block inundated. This information is extracted by intersecting the inundation extent with the census block.
M	Percent Area Inundated	AINUND_PCT	%	This quantity is calculated in the MS Excel spreadsheet by the dividing the AREAINUND (column L) by the AREATOT (column K).

N	Flood Arrival Time (Avg)	FLDAT_AVG	<i>hrs</i>	This quantity is extracted from the arrival time raster. It corresponds to the average value of the arrival times of all computational cells within the extent of the census block.
O	Flood Arrival Time (Min)	FLDAT_MIN	<i>hrs</i>	This quantity is extracted from the arrival time raster. It corresponds to the minimum value of the arrival times of all computational cells within the extent of the census block.
P	Flood Arrival Time (Max)	FLDAT_MAX	<i>hrs</i>	This quantity is extracted from the arrival time raster. It corresponds to the maximum value of the arrival times of all computational cells within the extent of the census block.
Q	Flood Maximum Depth (Avg)	HMAX_AVG	<i>ft</i>	This quantity is extracted from the maximum flood depth raster. It corresponds to the average value of the maximum flood depths of all computational cells within the extent of the census block.
R	Flood Maximum Depth (Min)	HMAX_MIN	<i>ft</i>	This quantity is extracted from the maximum flood depth raster. It corresponds to the minimum value of the maximum flood depths of all computational cells within the extent of the census block.
S	Flood Maximum Depth (Max)	HMAX_MAX	<i>ft</i>	This quantity is extracted from the maximum flood depth raster. It corresponds to the maximum value of the maximum flood depth of all computational cells within the extent of the census block.

T	Flood Maximum DV Arrival Time (Avg)	DVMAXATAVG	<i>hrs</i>	This quantity is extracted from the arrival time of maximum specific discharge raster. It corresponds to the average value of the maximum specific discharge arrival times of all computational cells within the extent of the census block.
U	Flood Maximum DV Arrival Time (Min)	DVMAXATMIN	<i>hrs</i>	This quantity is extracted from the arrival time of maximum specific discharge raster. It corresponds to the minimum value of the maximum specific discharge arrival times of all the computational cells within the extent of the census block.
V	Flood Maximum DV Arrival Time (Max)	DVMAXATMAX	<i>hrs</i>	This quantity is extracted from the arrival time of maximum specific discharge raster. It corresponds to the maximum value of the maximum specific discharge arrival times of all the computational cells within the extent of the census block.
W	Flood Maximum DV (Avg)	DVMAX_AVG	ft^2/s	This quantity is extracted from the maximum specific discharge raster. It corresponds to the average value of the maximum specific discharge of all the computational cells within the extent of the census block.
X	Flood Maximum DV (Min)	DVMAX_MIN	ft^2/s	This quantity is extracted from the maximum specific discharge raster. It corresponds to the minimum value of the maximum specific discharge of all the computational cells within the extent of the census block.

Y	Flood Maximum DV (Max)	DVMAX_MAX	ft^2/s	This quantity is extracted from the maximum specific discharge raster. It corresponds to the maximum value of the maximum specific discharge of all the computational cells within the extent of the census block.
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6.2 PAR Analysis Using LandScan USA Gridded Population Data

The PAR analysis using LandScan USA 3 arc-second gridded population data provides three sets of tabular results classified in up to 17 flood times and 10 flood hazard categories based on DV_{max} :

- Tabular summary of inundation areas as a function of flood time is presented in the worksheet “InundatedArea” of the MS Excel file accompanying the present report. The inundation area values are presented as a stacked column plot in the same worksheet.
- Tabular summary of nighttime PAR counts as a function of flood time is presented in the worksheet “Nighttime_PAR” of the MS Excel file accompanying the present report. The nighttime PAR counts are plotted as a stacked column plot in the same worksheet.
- Tabular summary of daytime PAR counts as a function of flood time is presented in the worksheet “Daytime_PAR” of the MS Excel file accompanying the present report. The tabular data is also plotted as a stacked column plot.

The nighttime and daytime PAR counts were obtained from nighttime and daytime population densities, which were extracted from LandScan USA following the methodologies described in the technical manual for DSS-WISE HCOM. [Map 07](#) and [Map 08](#) in this report show the nighttime and daytime population densities over the inundation area.

7.0 RESULTS FILES GENERATED BY DSS-WISE HCOM

All the results files generated by DSS-WISE HCOM are listed [Table 6](#).

Table 6. List of results files generated by DSS-WISE HCOM.

No	Name	Type	Description
1	44667_HCOM_Final_Report.pdf	PDF	The present report.
2	44667_HCOM_Analysis.xlsx	Ms Excel	Ms Excel file accompanying this report. It contains four worksheets: 1. InundatedArea 2. Nighttime_PAR 3. Daytime_PAR 4. CensusBlock_Analysis
3	44667_HCOM_Census_Block_polygons.shp	ESRI Shapefile	This ESRI shapefile of polygon type contains the polygons of the census blocks completely or partially included in the inundation extent. The attributes of the polygons are the same as the columns in the worksheet “CensusBlock_Analysis”. They are listed in Table 5 .
4	44667_HCOM_Outdoor_Hazard_Categories_polygons.shp	ESRI Shapefile	This ESRI shapefile of polygon type contains up to five polygons corresponding to the five potential flood hazard levels for humans caught outdoors by the flood as listed in Table 2 (Section 4.1)
5	44667_HCOM_Indoor_Hazard_Categories_polygons.shp	ESRI Shapefile	This ESRI shapefile of polygon type contains up to five polygons corresponding to the five potential flood hazard levels for humans caught indoors by the flood as listed in Table 3 (Section 4.2)

6	44667_HCOM_PLFZ_ polygons.shp	ESRI Shapefile	This ESRI shapefile of polygon type contains up to two stacked polygons corresponding to the PLFZ areas as listed in the first two rows of Table 4 .
7	44667_HCOM_NT_PopDensity_ persqmi_polygons.shp	ESRI Shapefile	This ESRI shapefile of polygons type contains polygon of nighttime population density per square mile extracted from LandScan USA data. This file should be treated as FOUO
8	44667_HCOM_DT_PopDensity_ persqmi_polygons.shp	ESRI Shapefile	This ESRI shapefile of polygons type contains polygon of daytime population density per square mile extracted from LandScan USA data. This file should be treated as FOUO

8.0 REFERENCES

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Bhaduri, B., Bright, E., Coleman, Ph., Urban, M.L. (2007). LandScan USA: a high-resolution geospatial and temporal modeling approach for population distribution and dynamics. *Geojournal* 69:103-117. DOI 10.1007/s10708-007-9105-9

Bhaduri, B. (2007). Workshop Presentation.

<https://www.csm.ornl.gov/workshops/RAMSworkshop07/presentation/bhaduri.ppt>

Cox, R.J., Yee, M. and Ball, J.E. (2004). Safety of People in Flooded Streets and Floodways. 8th National Conference on Hydraulics in Water Engineering, Gold Coast. The Institution of Engineers, Australia.

Cox, R.J., Shand, T.D., and Blacka, M.J. (2010). Australian Rainfall and Runoff, Revision Project 10: Appropriate Criteria for People. AR&R Report Number P10/S1/006. Engineers Australia, Water Engineering. ISBN 978-085825-9454. <http://arr.ga.gov.au/revision-projects/project-list/projects/project-10>

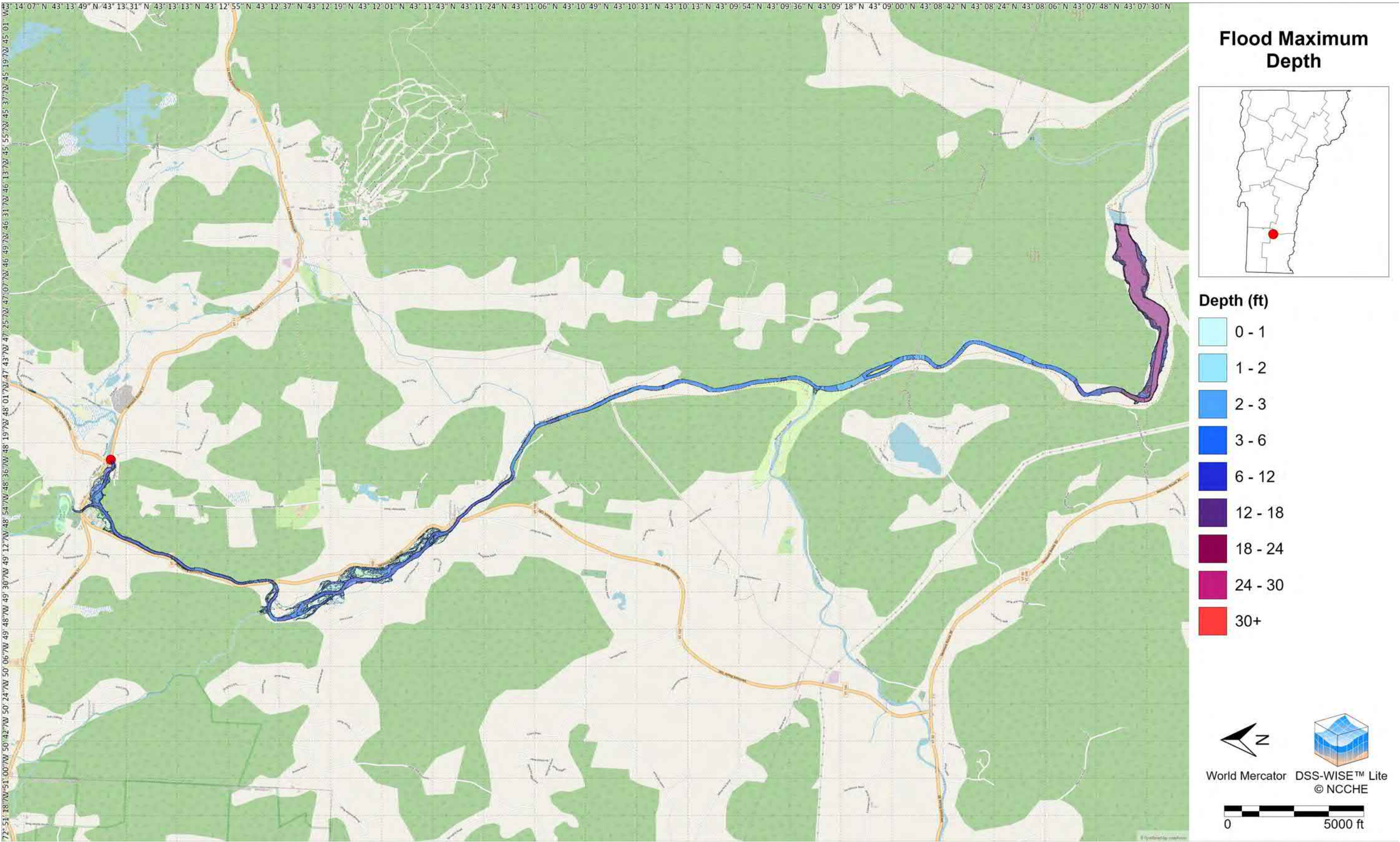
Dobson, J.E., Bright, E.A., Coleman, Ph.R., Durfee, R.C., and Worley, B.A. (2000). LandScan: A Global Population Database for Estimating Populations at Risk. *Photogrammetric Engineering & Remote Sensing*, Vol. 66, NO. 7, pp. 849-857. https://www.asprs.org/wp-content/uploads/pers/2000journal/july/2000_jul_849-857.pdf

Feinberg, B. (2017). Using Potentially Lethal Flood Zones to Assess Downstream Impacts from Dam Failure. Presentation at National Dam Safety Training Seminar.

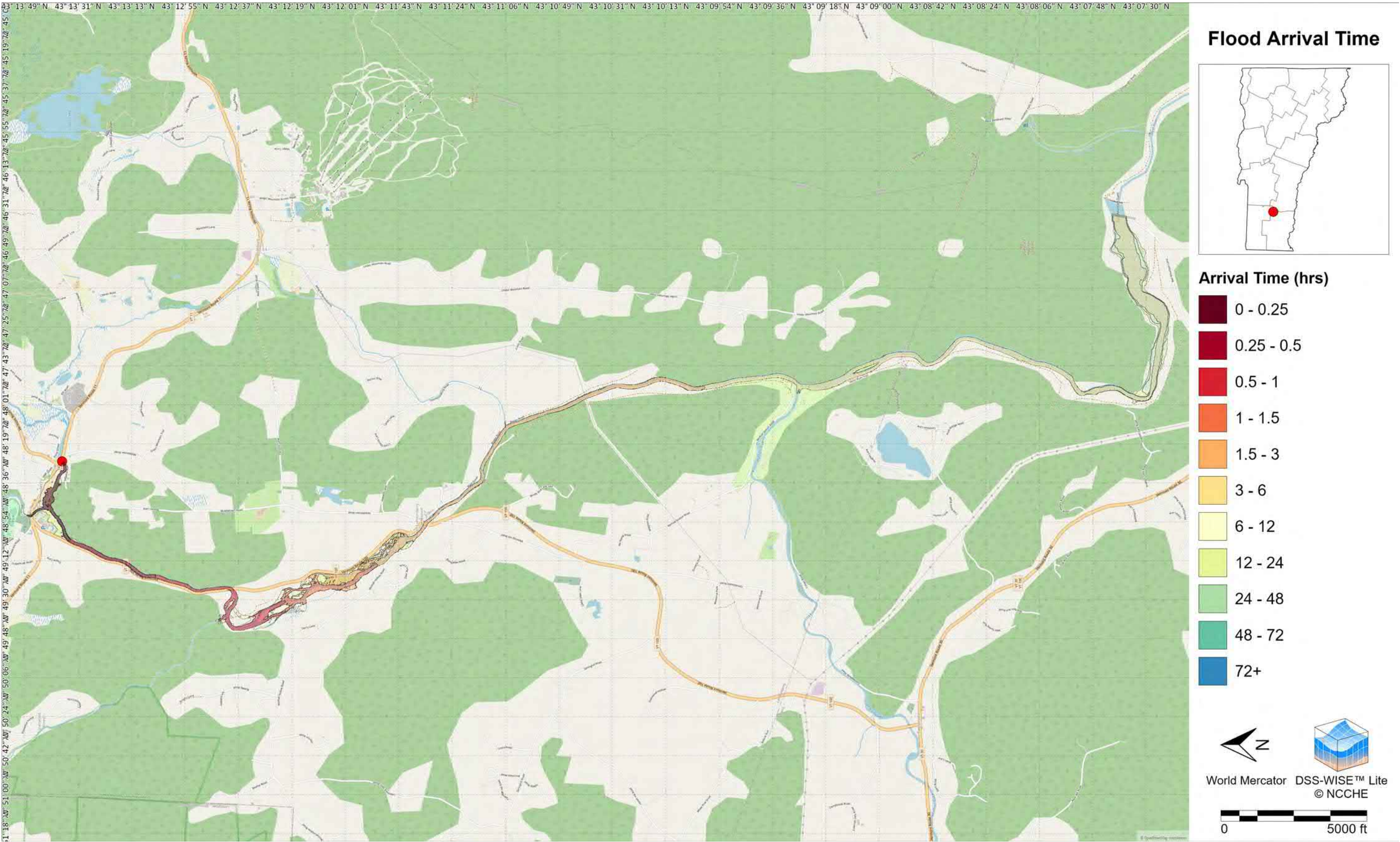
FEMA (2011). Estimating Loss of Life for Dam Failure Scenarios. Draft version.

McKee, J.J., Rose, A.N., Bright, E.A., Huynh, T., and Bhaduri, B.L. (2014). Locally adaptive, spatially explicit projection of US population for 2030 and 2050. *PNAS*, 112(5), 1344-1349. <http://www.pnas.org/content/pnas/112/5/1344.full.pdf>

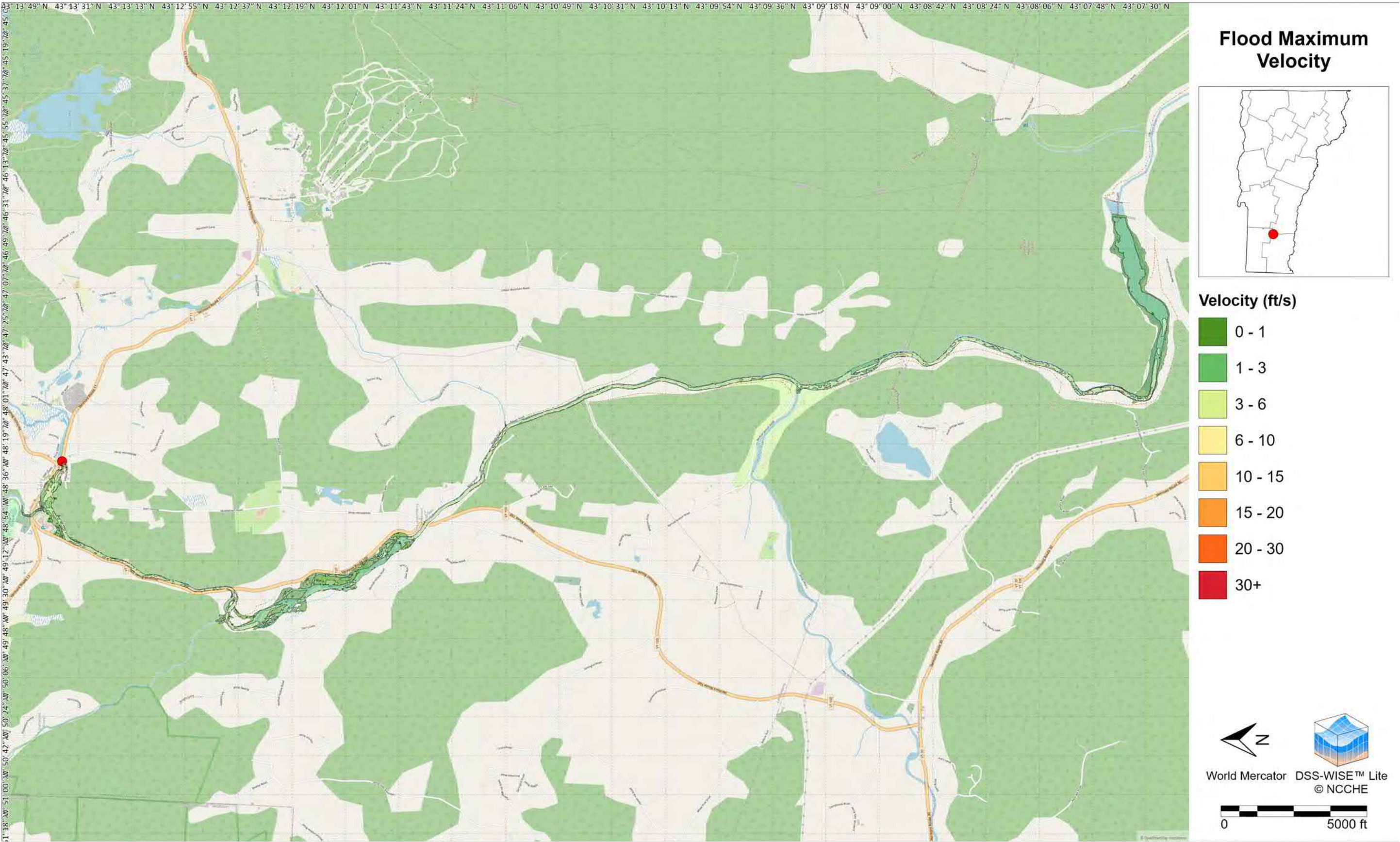
Map 01: Flood Maximum Depth



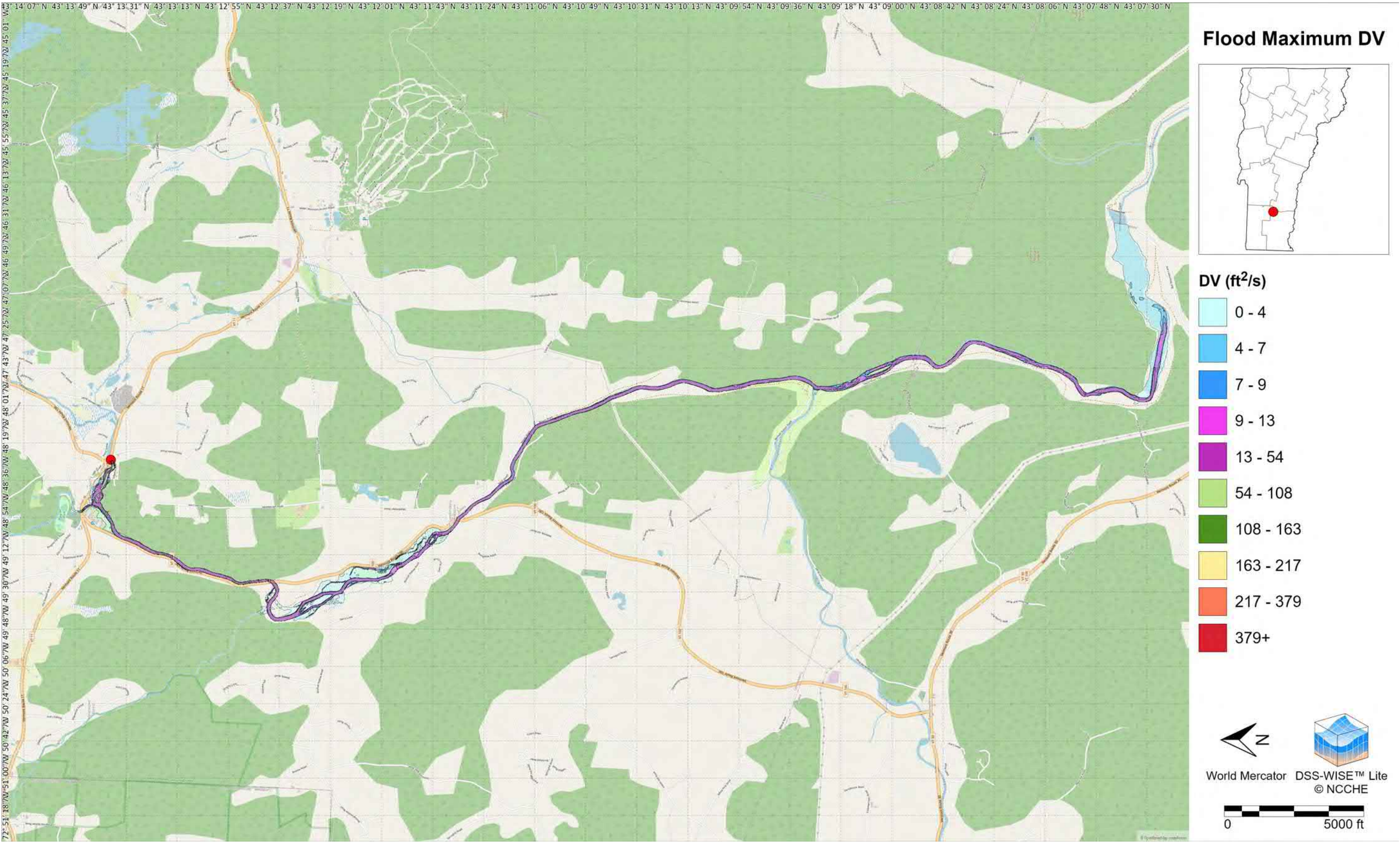
Map 02: Flood Arrival Time



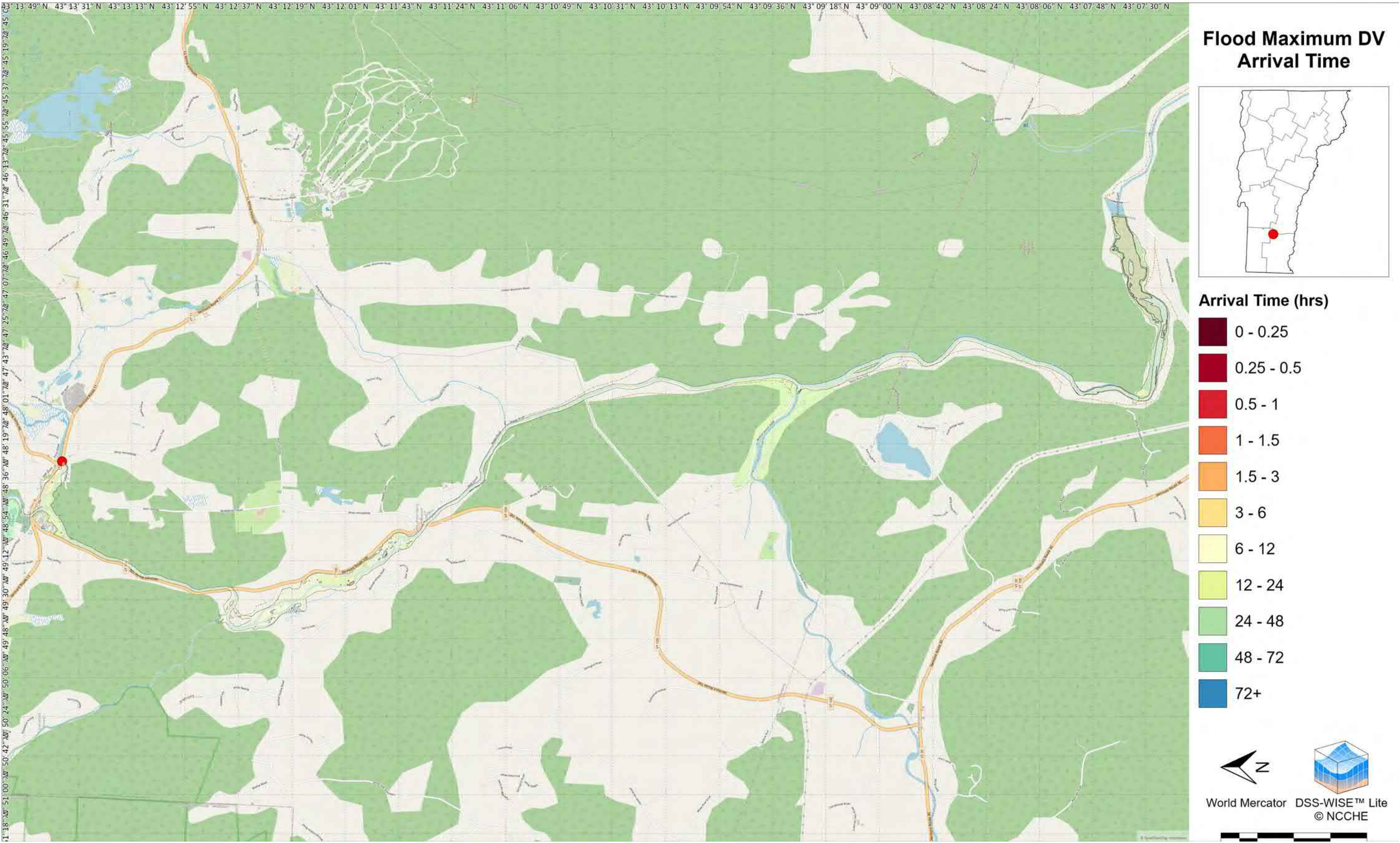
Map 03: Flood Maximum Velocity



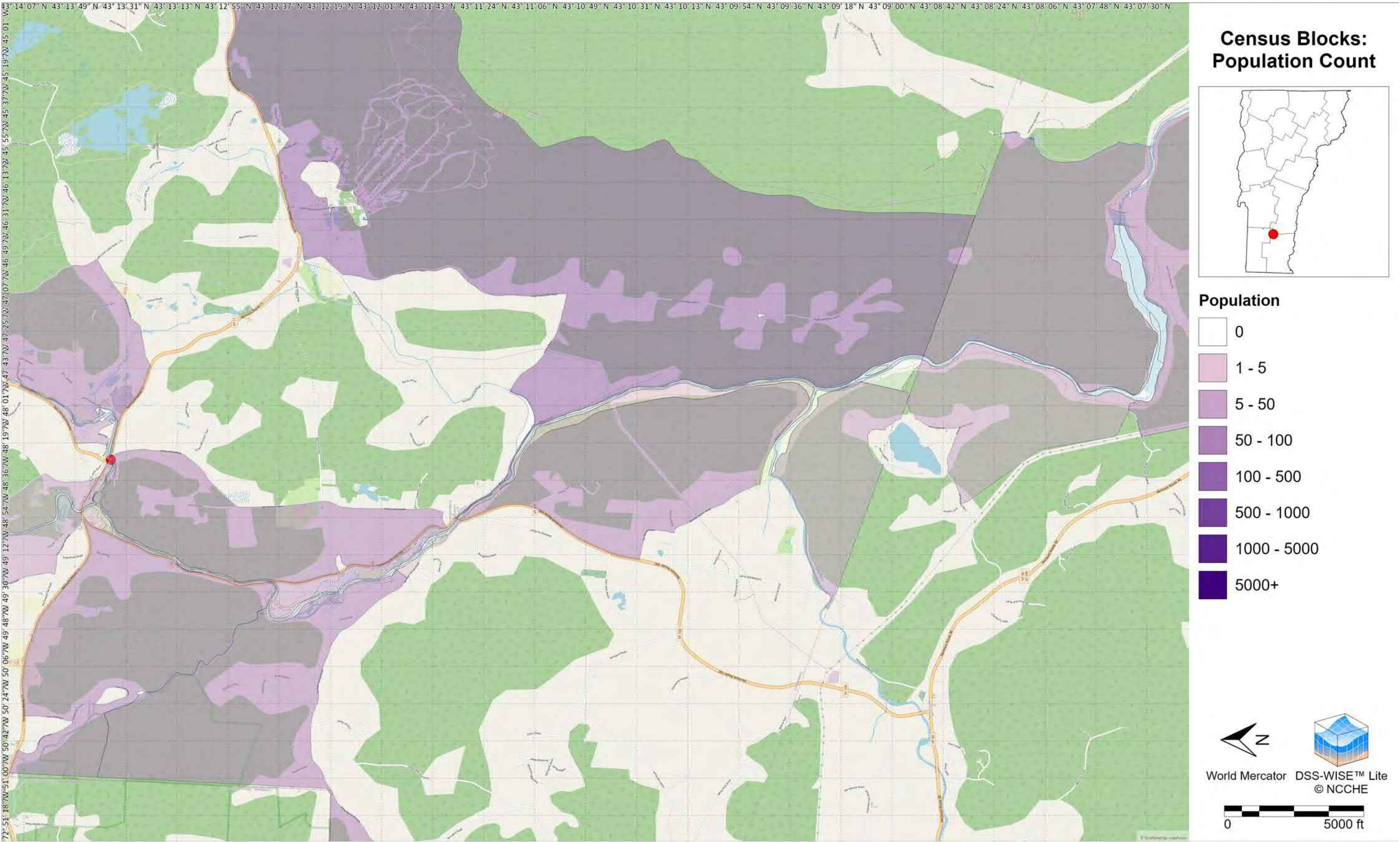
Map 04: Flood Maximum DV



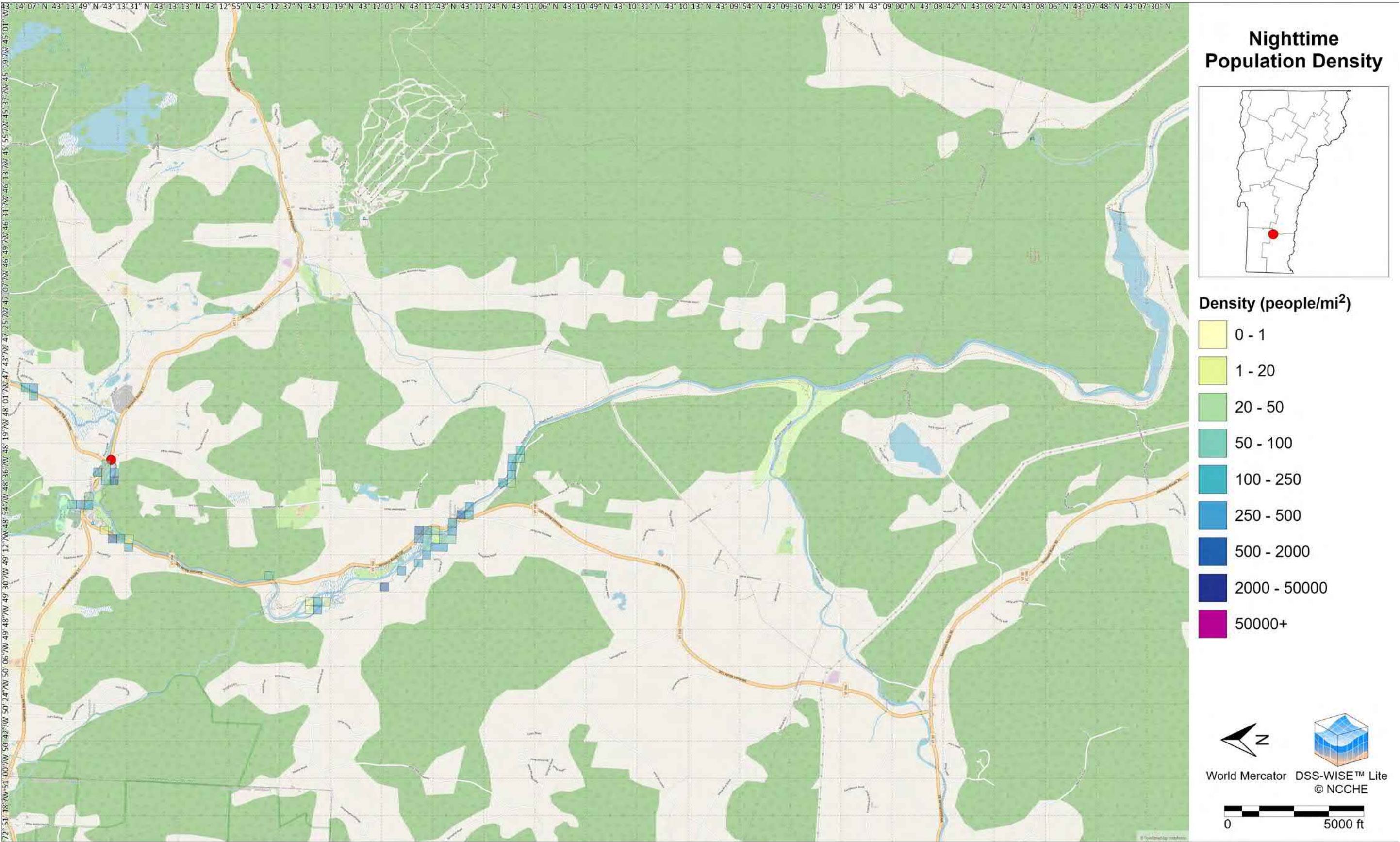
Map 05: Flood Maximum DV Arrival Time



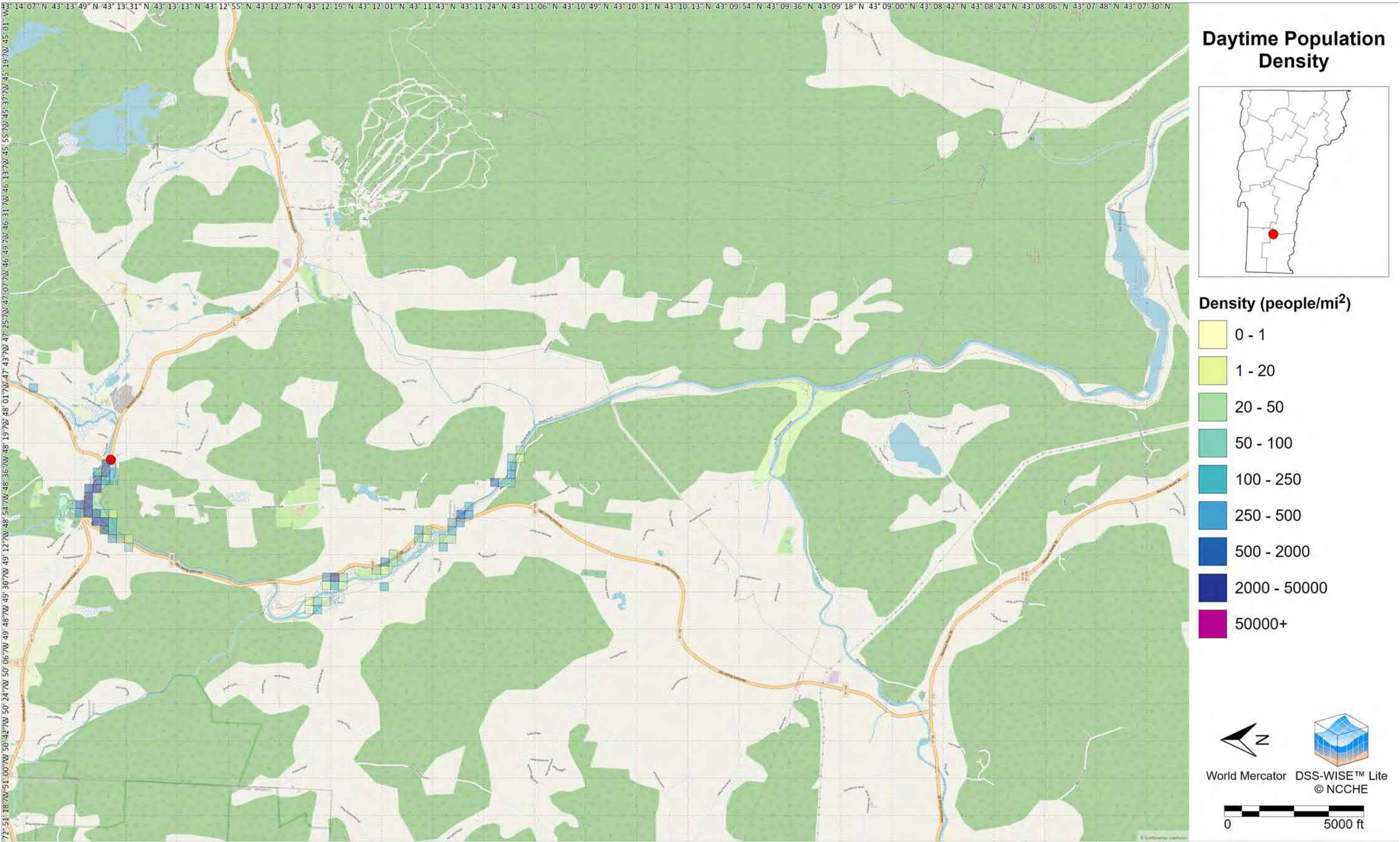
Map 06: Census Blocks: Population Count



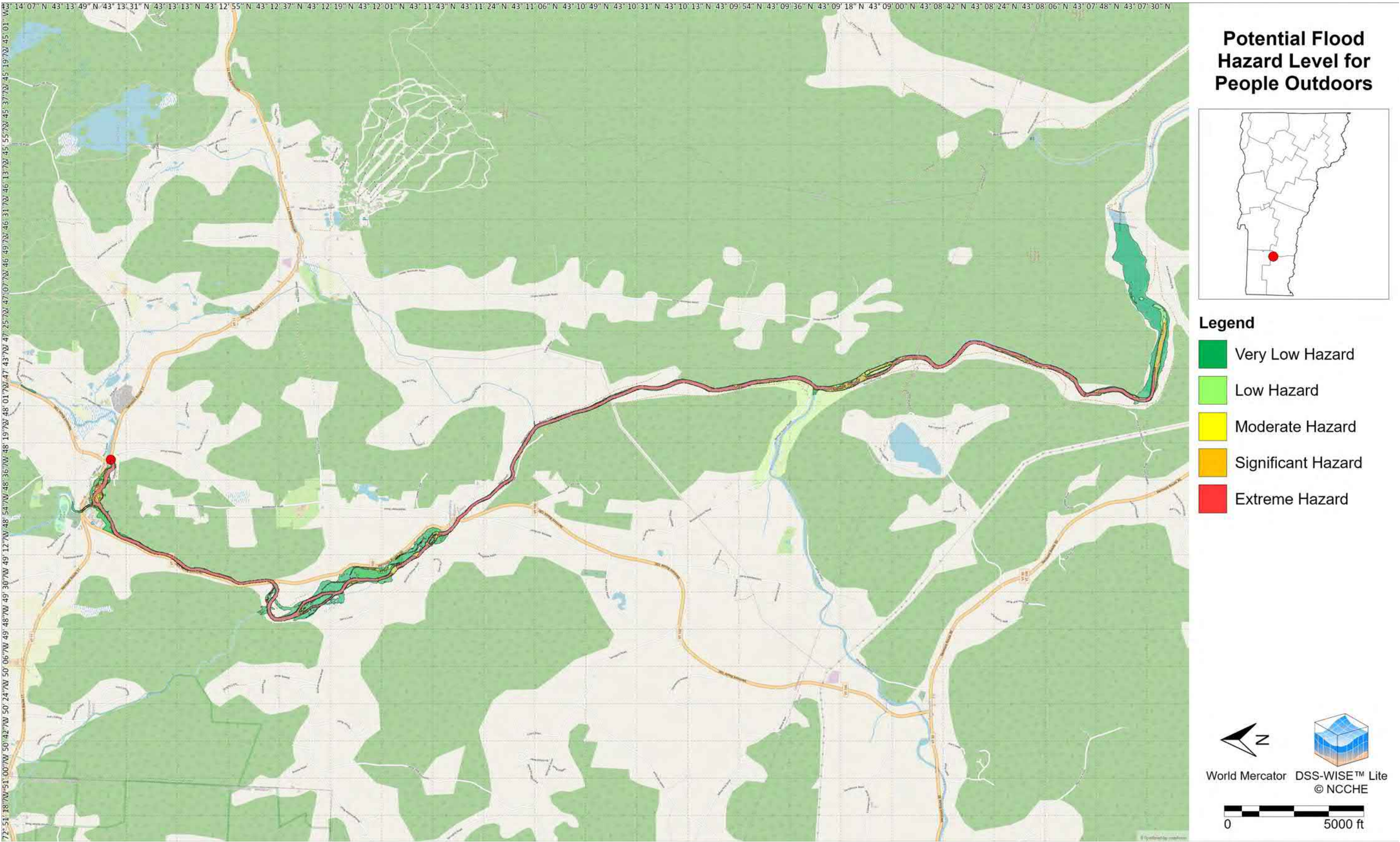
Map 07: Nighttime Population Density



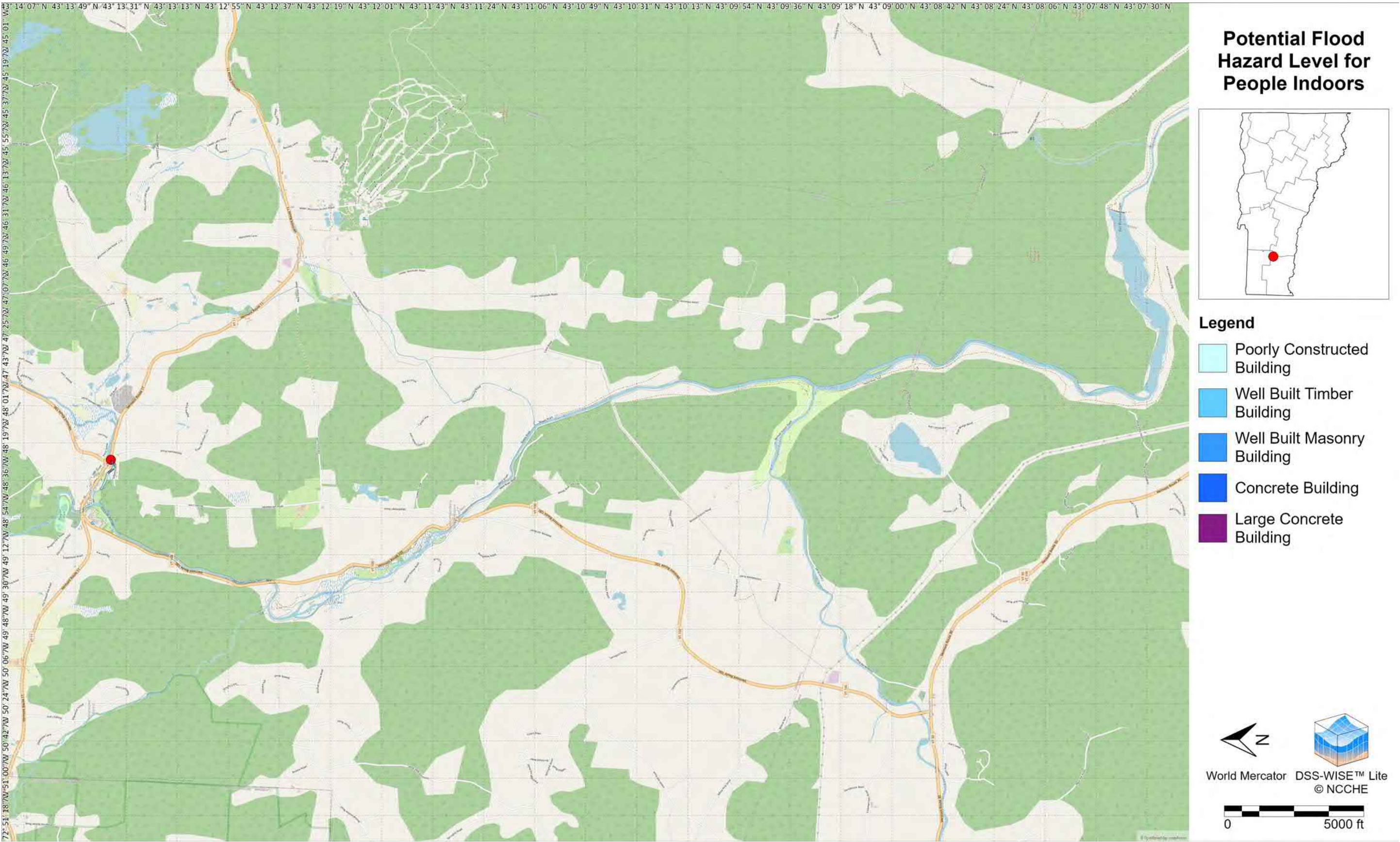
Map 08: Daytime Population Density



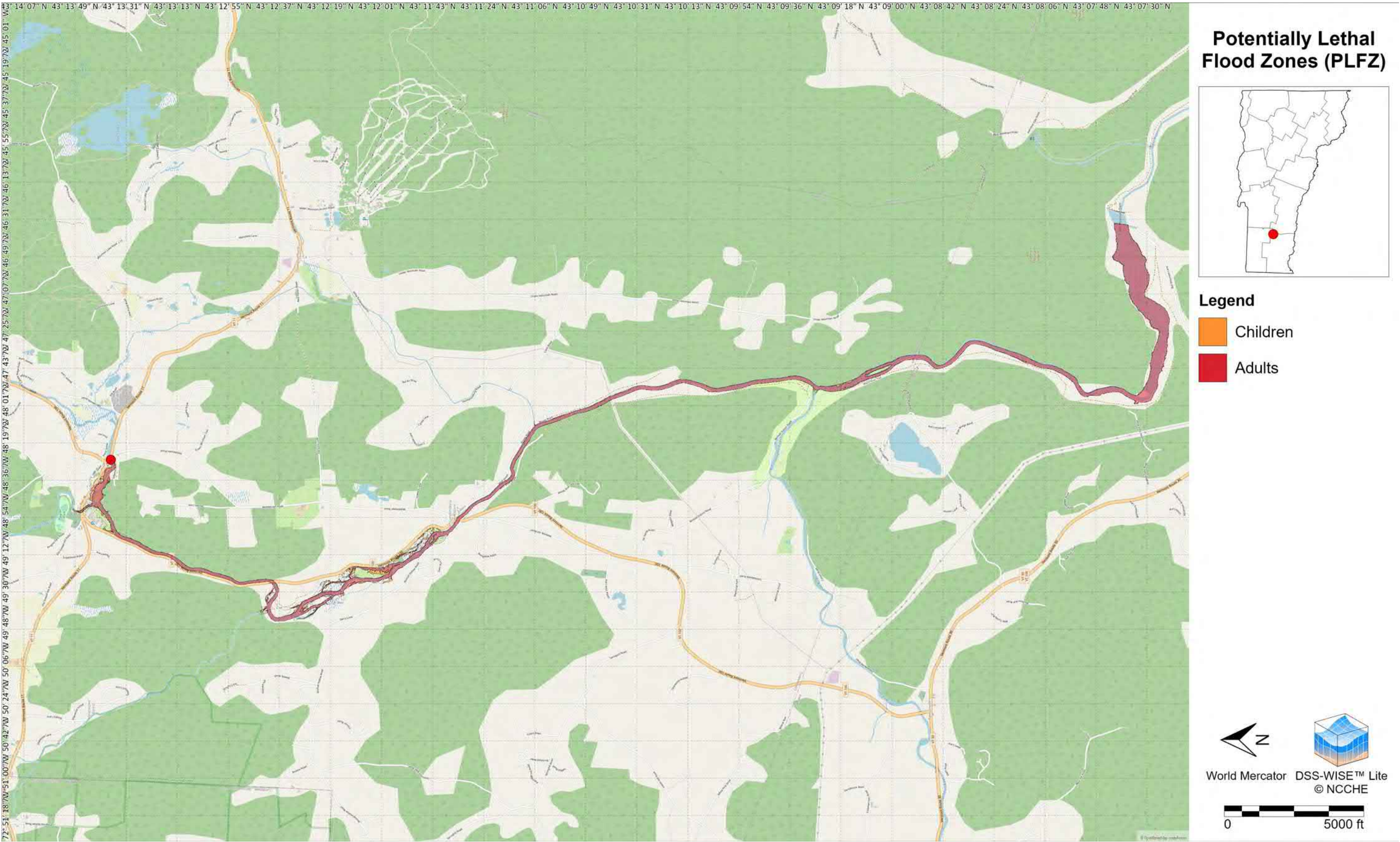
Map 09: Potential Flood Hazard Level for People Outdoors



Map 10: Potential Flood Hazard Level for People Indoors



Map 11: Potential Lethal Flood Zones (PLFZ)

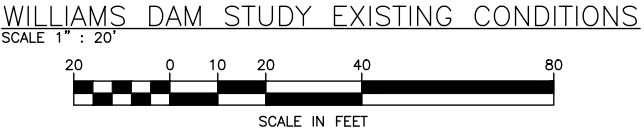


Appendix F

Alternative Conceptual Plans



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WILLIAMS DAM
STUDY (#115.01)
LONDONDERRY, VT

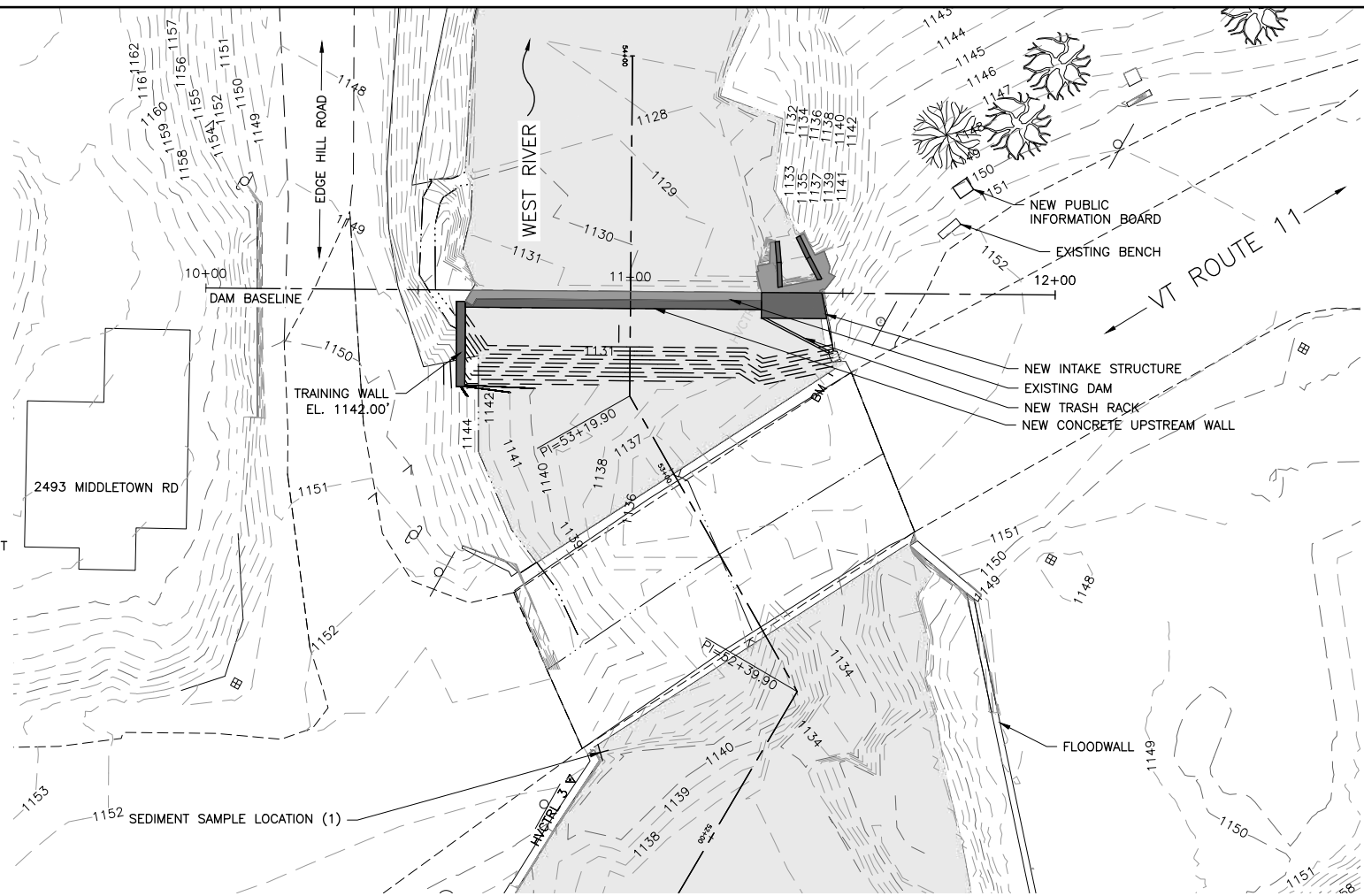
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EXISTING
CONDITIONS SITE
PLAN

DRAWN BY RJL	DATE PROGRESS
CHECKED BY CWJ	D&K PROJECT # 827442
PROJ. ENG. CWJ	

SHEET NUMBER

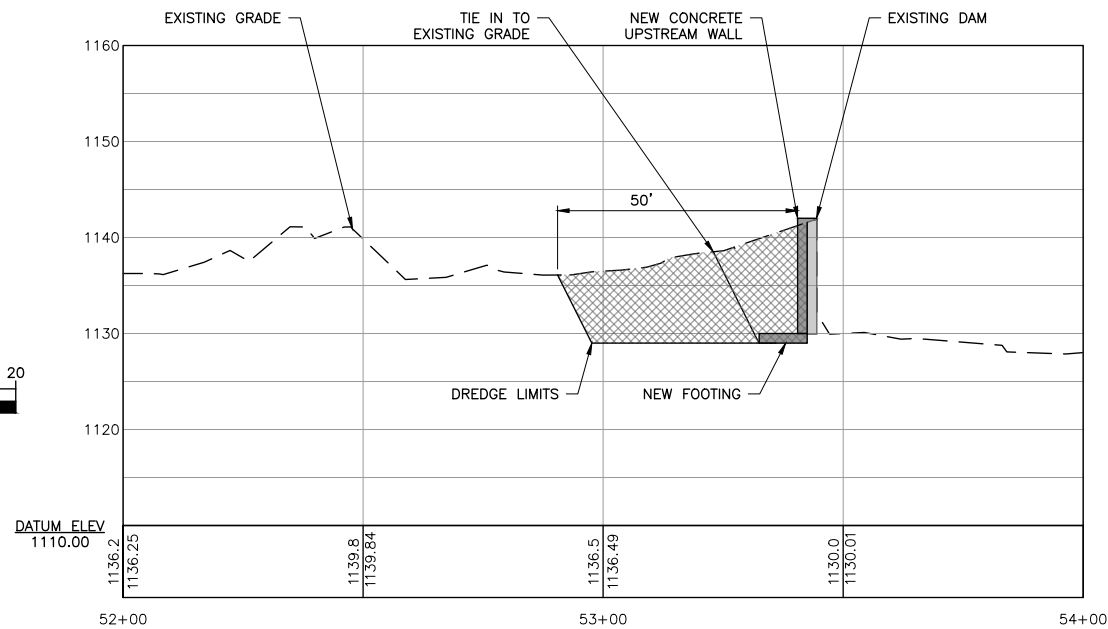
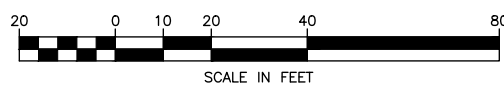
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SHEET 1 OF 9



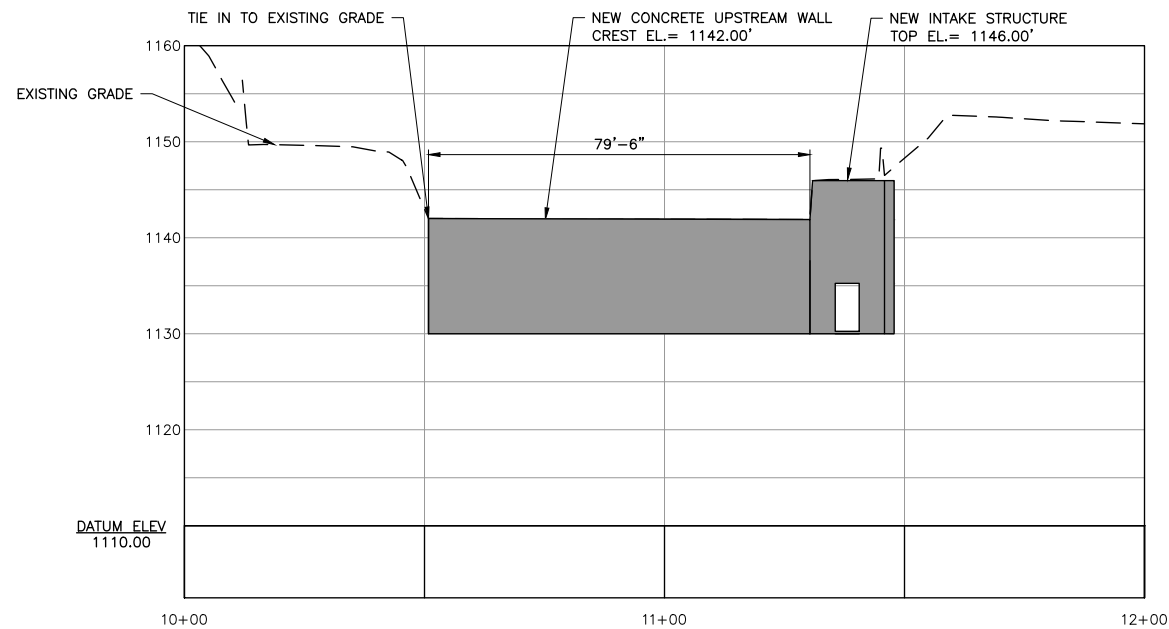
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2. LEAVE EXISTING DAM IN PLACE AND CONSTRUCT A PUBLIC INFORMATION BOARD.
3. NEW LOW LEVEL OUTLET WITH NEW PIPE AND HEADGATE.
4. NEW TRASHRACK/DEBRIS DIVERSION.
5. NEW ABUTMENT TRAINING WALLS AND STONE RIPRAP ALONG ABUTMENTS.
6. DREDGE ACCUMULATED SEDIMENT BEHIND EXISTING DAM AND EXISTING DRY HYDRANT LOCATION.

2493 MIDDLETOWN RD

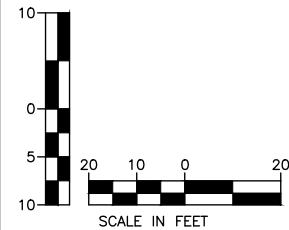
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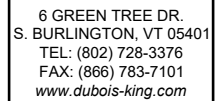
CHANNEL BASELINE PROFILE



DAM BASELINE PROFILE



DATUM:
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LONDONDERRY, VT

SHEET TITLE
CONCEPTUAL ALTERNATIVE DAM REHABILITATION

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PROJ. ENG. CWJ	

SHEET NUMBER	
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SHEET	2 OF 9

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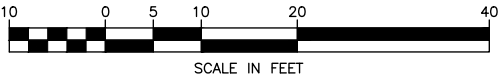
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2. LEAVE EXISTING DAM IN PLACE AND CONSTRUCT A PUBLIC INFORMATION BOARD.
3. NEW LOW LEVEL OUTLET WITH NEW PIPE AND HEADGATE.
4. NEW TRASHRACK/DEBRIS DIVERSION.
5. NEW ABUTMENT TRAINING WALLS AND STONE RIPRAP ALONG ABUTMENTS.
6. DREDGE ACCUMULATED SEDIMENT BEHIND EXISTING DAM AND EXISTING DRY HYDRANT LOCATION.



CONCEPTUAL ALTERNATIVE DAM REHABILITATION

SCALE 1" = 10'



DATUM:

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SHEET TITLE

DAM
REHABILITATION
ORTHOIMAGERY

DRAWN BY RJL	DATE PROGRESS
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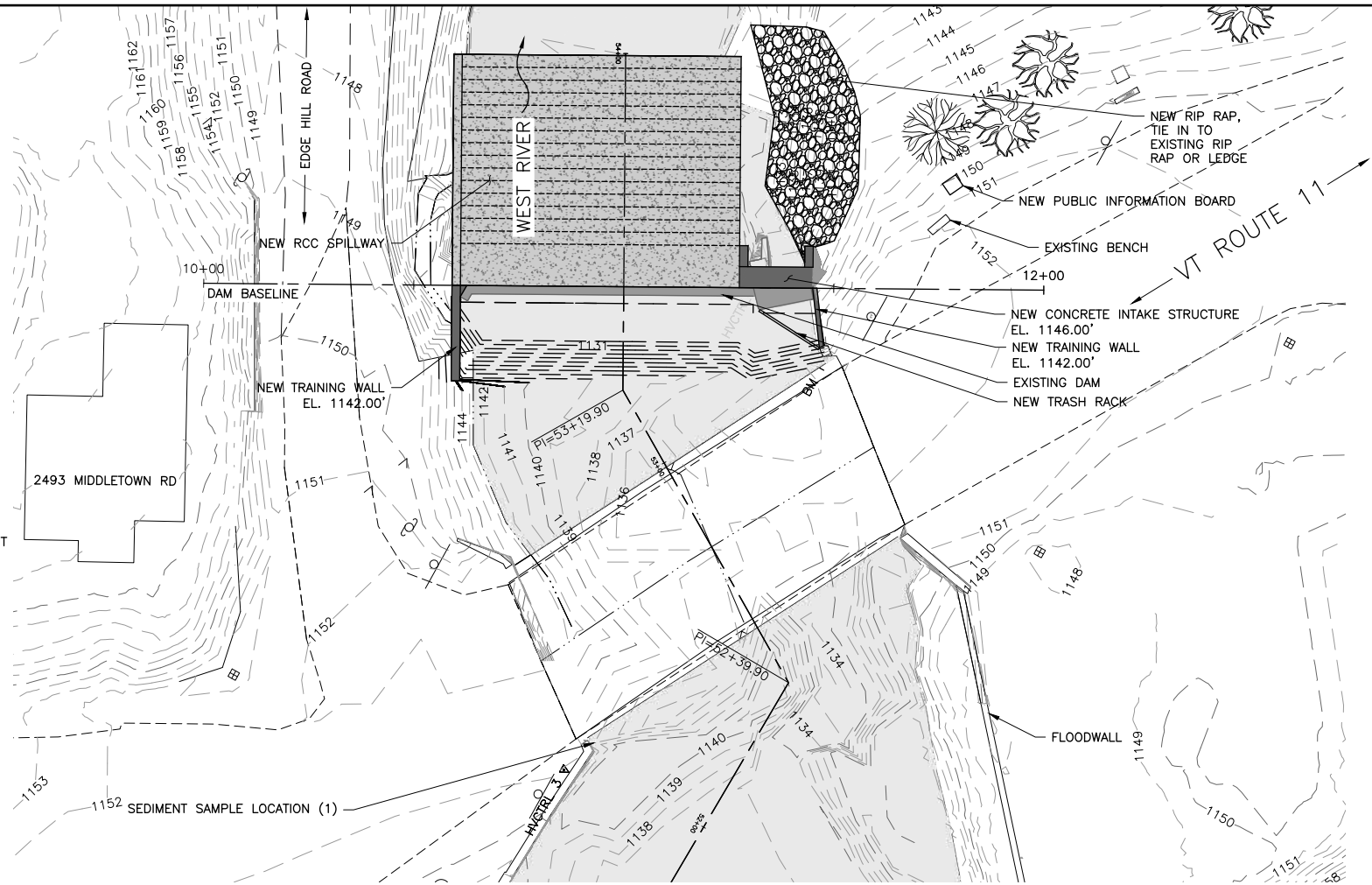
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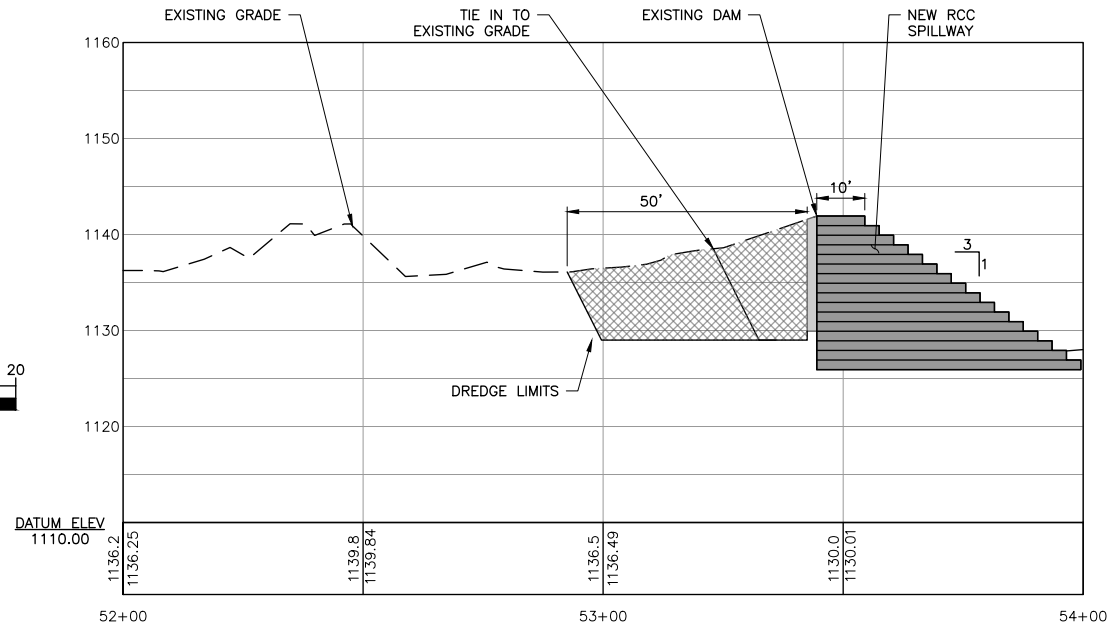
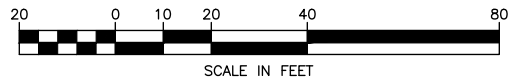
SHEET 3 OF 9

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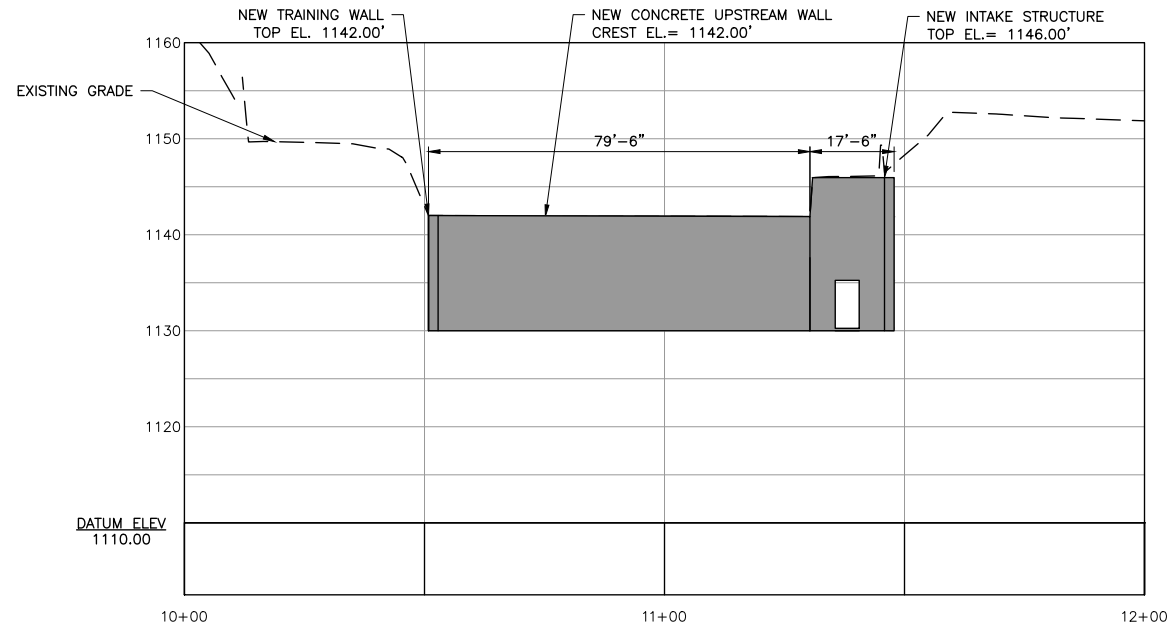
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2. LEAVE EXISTING DAM IN PLACE AND CONSTRUCT A PUBLIC INFORMATION BOARD.
3. NEW LOW LEVEL OUTLET WITH NEW PIPE AND HEADGATE.
4. NEW TRASHRACK/DEBRIS DIVERSION.
5. NEW ABUTMENT TRAINING WALLS AND STONE RIPRAP ALONG ABUTMENTS.
6. DREDGE ACCUMULATED SEDIMENT BEHIND EXISTING DAM AND EXISTING DRY HYDRANT LOCATION.



CONCEPTUAL ALTERNATIVE DAM REHABILITATION (B)
SCALE 1" = 20'



CHANNEL BASELINE PROFILE



DAM BASELINE PROFILE

DATUM:
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HORIZONTAL: NAD 83 GPS DERIVED

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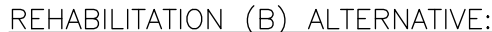
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WILLIAMS DAM
STUDY (#115.01)
LONDONDERRY, VT

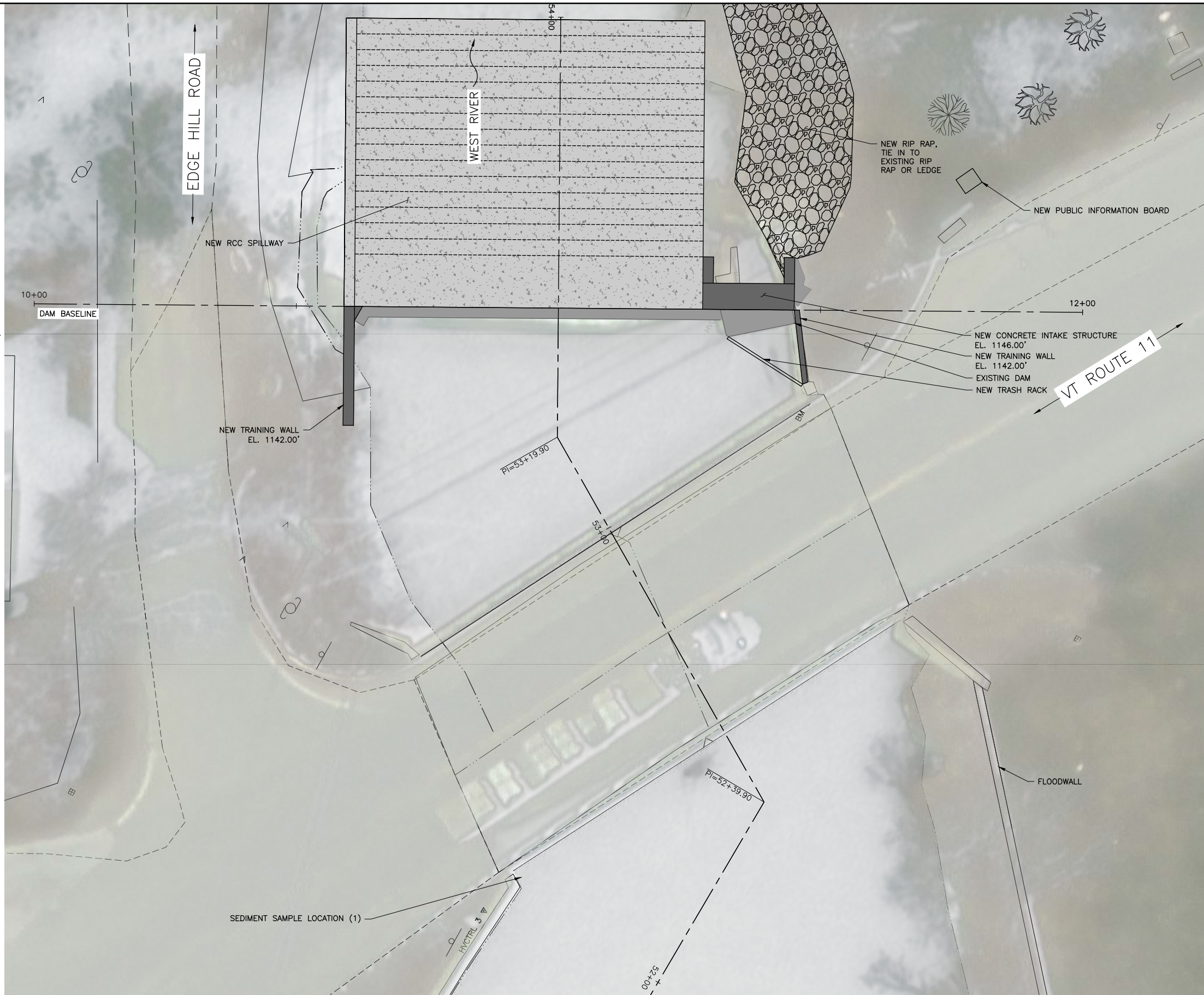
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CONCEPTUAL
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REHABILITATION (B)

DRAWN BY RJL	DATE PROGRESS
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PROJ. ENG. CWJ	

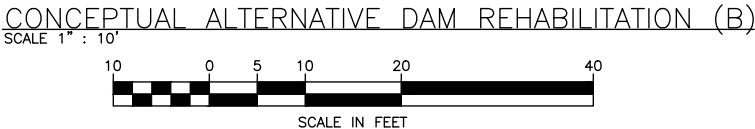
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SHEET 4 OF 9



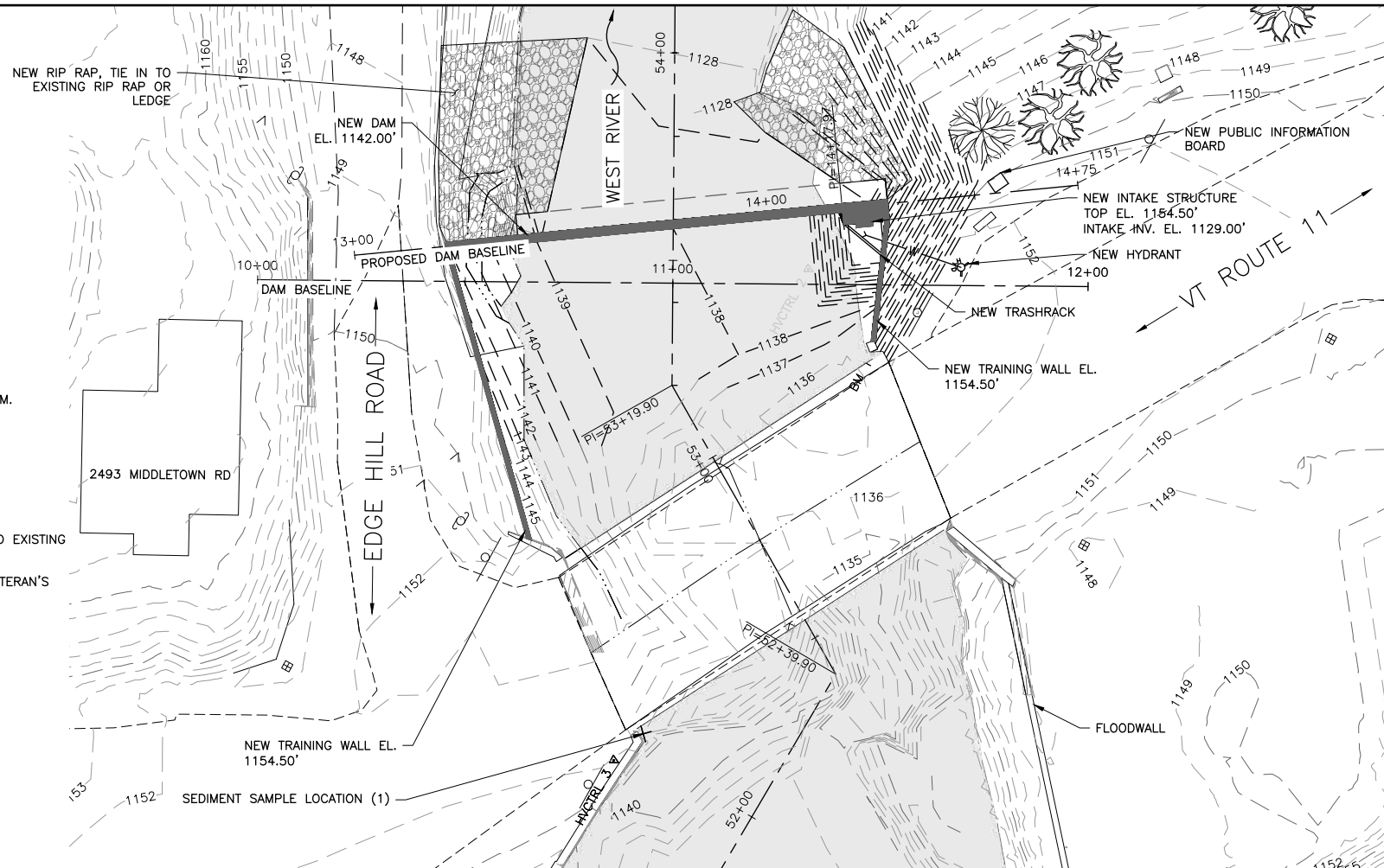
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2. LEAVE EXISTING DAM IN PLACE AND CONSTRUCT A PUBLIC INFORMATION BOARD.
3. NEW LOW LEVEL OUTLET WITH NEW PIPE AND HEADGATE.
4. NEW TRASHRACK/DEBRIS DIVERSION.
5. NEW ABUTMENT TRAINING WALLS AND STONE RIPRAP ALONG ABUTMENTS.
6. DREDGE ACCUMULATED SEDIMENT BEHIND EXISTING DAM AND EXISTING DRY HYDRANT LOCATION.



DATUM:
VERTICAL: NAVD 88 GPS DERIVED
HORIZONTAL: NAD 83 GPS DERIVED

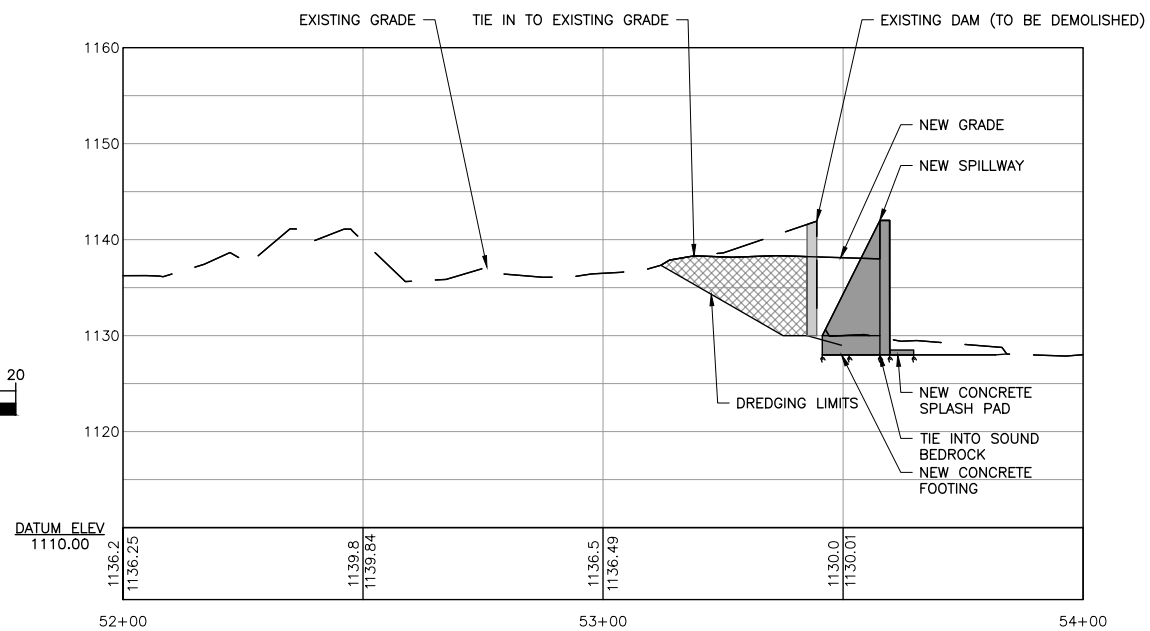
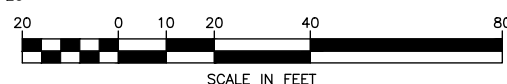


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WILLIAMS DAM STUDY (#115.01)									
LONDONDERRY, VT									
SHEET TITLE									
DAM REHABILITATION (B) ORTHOIMAGERY									
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PROJ. ENG. CWJ									
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SHEET 5 OF 9									

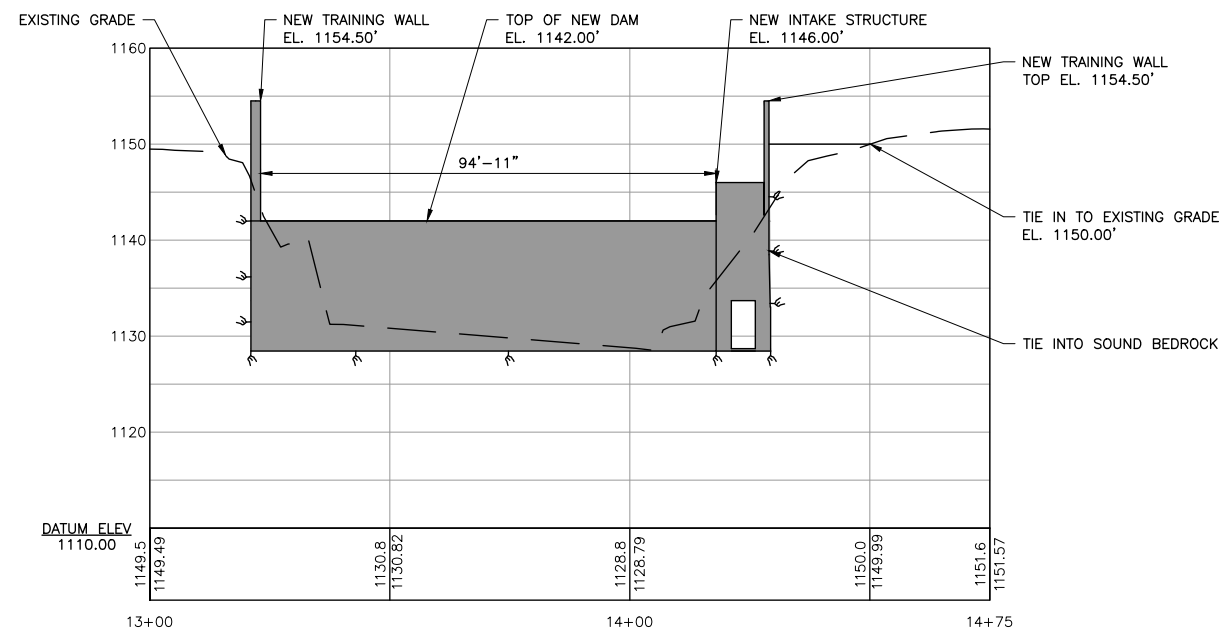


1. NEW CONCRETE DAM APPROXIMATELY 10—FT DOWNSTREAM OF EXISTING DAM.
2. DEMOLISH EXISTING DAM AND CONSTRUCT A PUBLIC INFORMATION BOARD.
3. NEW LOW LEVEL OUTLET WITH NEW PIPE AND HEADGATE.
4. NEW TRASHRACK/DEBRIS DIVERSION.
5. NEW ABUTMENT TRAINING WALLS AND STONE RIPRAP ALONG ABUTMENTS.
6. DREDGE ACCUMULATED SEDIMENT APPROXIMATELY 25—FT UPSTREAM BEHIND EXISTING DAM.
7. ABANDON EXISTING HYDRANT AND CONSTRUCT A NEW HYDRANT AT THE VETERAN'S PARK.

SCALE 1" : 20'



CHANNEL BASELINE PROFILE



PROPOSED DAM BASELINE PROFILE

<u>DATUM:</u>	
VERTICAL:	NAVD 88 GPS DERIVED
HORIZONTAL:	NAD 83 GPS DERIVED



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STUDY (#115.01)
LONDONDERRY, VT

SHEET TITLE

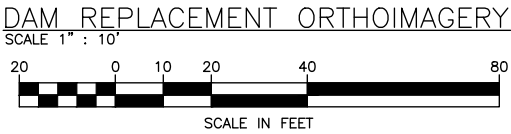
CONCEPTUAL
ALTERNATIVE
DAM
REPLACEMENT

DRAWN BY RJL	DATE PROGRESS
CHECKED BY	D&K PROJECT # 827442
PROJ. ENG. CWJ	

SHEET NUMBER
6
SHEET 6 OF 9



- DATUM:
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HORIZONTAL: NAD 83 GPS DERIVED



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WILLIAMS DAM
STUDY (#115.01)

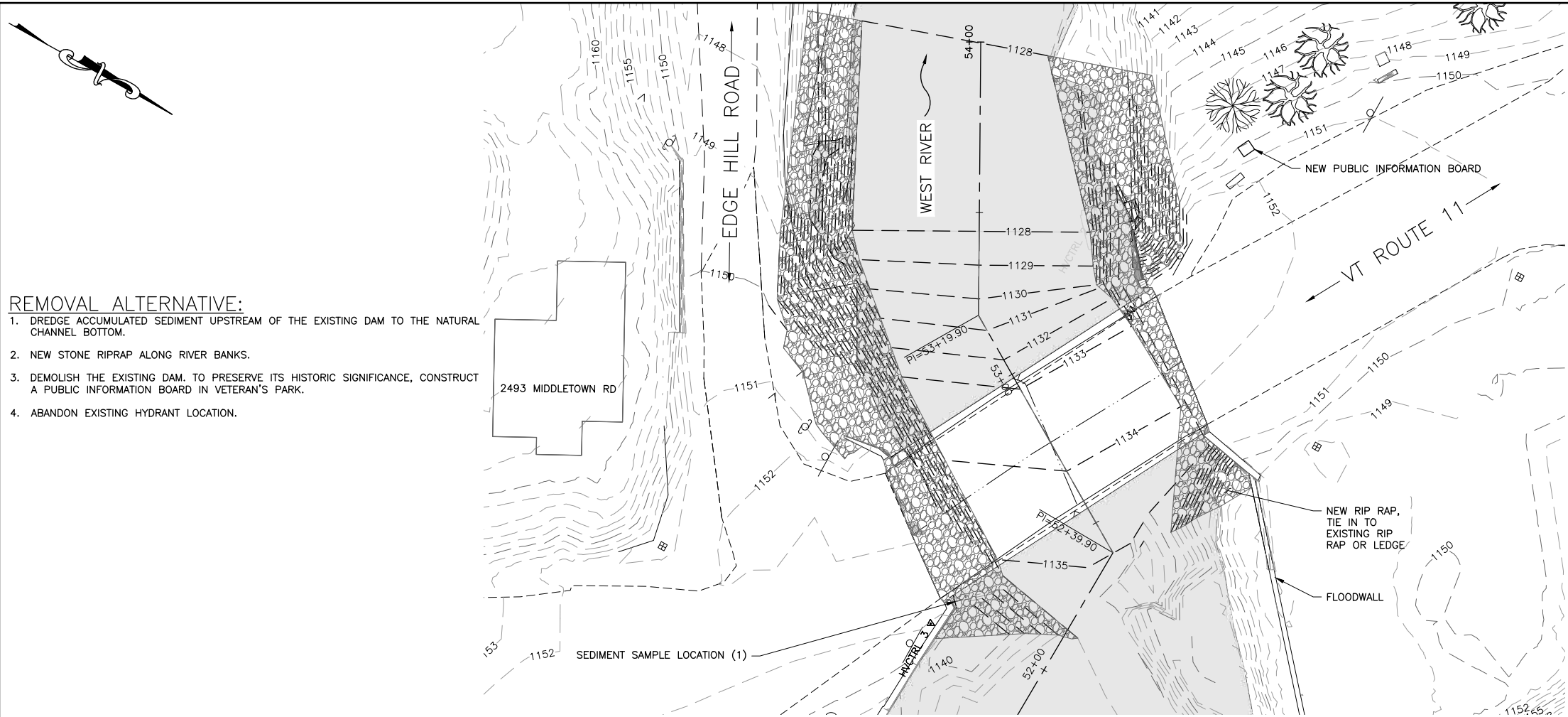
LONDONDERRY, VT

SHEET TITLE

DAM
REPLACEMENT
ORTHOIMAGERY

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CHECKED BY	D&K PROJECT # 827442
PROJ. ENG. CWJ	

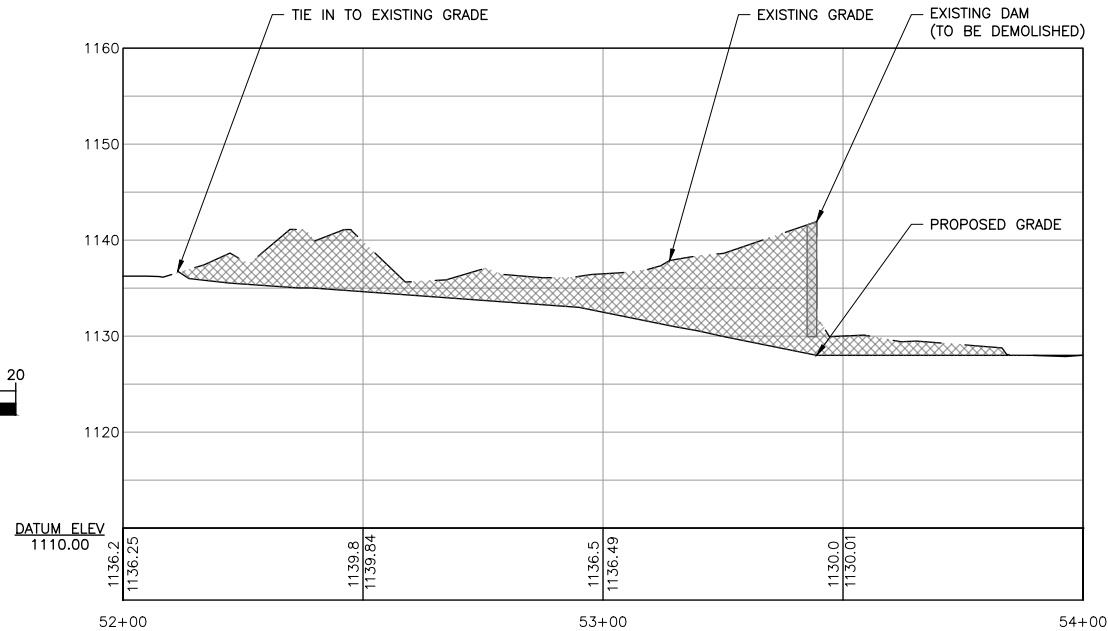
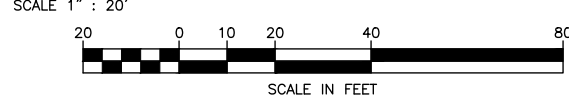
SHEET NUMBER
7
SHEET 7 OF 9



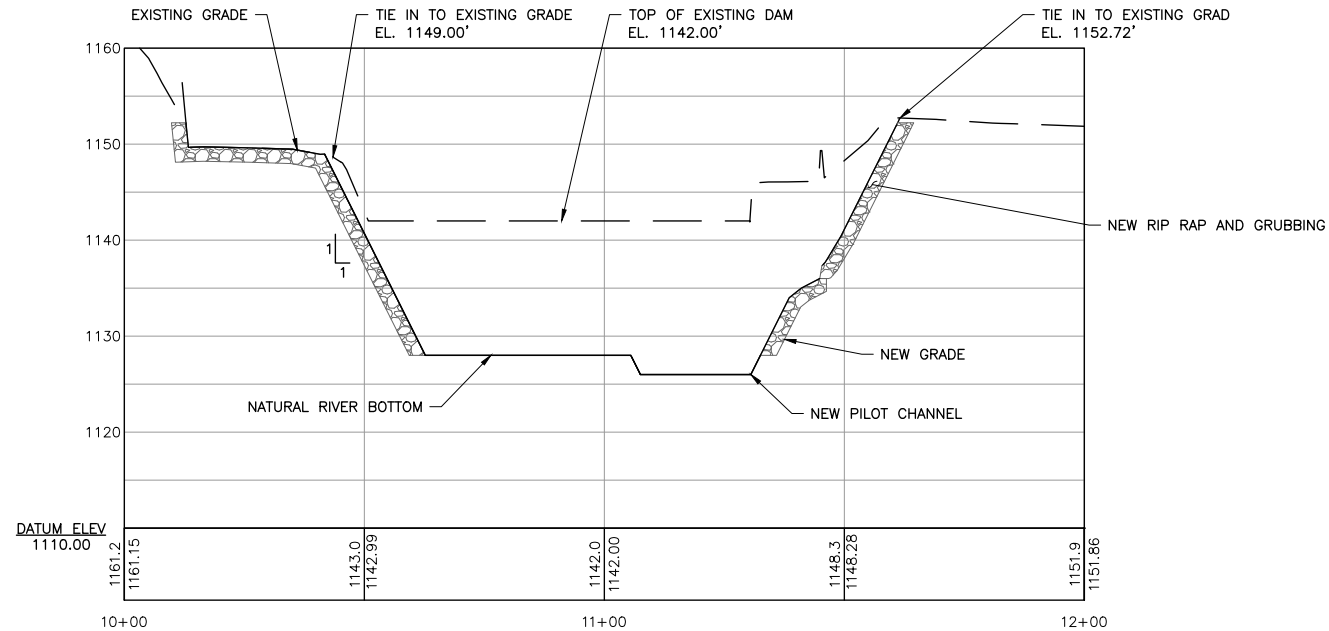
REMOVAL ALTERNATIVE:

1. DREDGE ACCUMULATED SEDIMENT UPSTREAM OF THE EXISTING DAM TO THE NATURAL CHANNEL BOTTOM.
2. NEW STONE RIPRAP ALONG RIVER BANKS.
3. DEMOLISH THE EXISTING DAM. TO PRESERVE ITS HISTORIC SIGNIFICANCE, CONSTRUCT A PUBLIC INFORMATION BOARD IN VETERAN'S PARK.
4. ABANDON EXISTING HYDRANT LOCATION.

CONCEPTUAL ALTERNATIVE DAM REMOVAL



CHANNEL BASELINE PROFILE



RIVER CHANNEL SECTION

DATUM:
VERTICAL: NAVD 88 GPS DERIVED
HORIZONTAL: NAD 83 GPS DERIVED

DuBois & King

6 GREEN TREE DR.
S. BURLINGTON, VT 05401
TEL: (802) 728-3376
FAX: (866) 783-7101
www.dubois-king.com

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PROFESSIONAL SEAL

NOT FOR
CONSTRUCTION

NO.	DATE	DESCRIPTION	BY	CK'D

TOWN OF
LONDONDERRY
100 OLD SCHOOL
STREET
S. LONDONDERRY,
VT 05155

WILLIAMS DAM
STUDY (#115.01)
LONDONDERRY, VT

SHEET TITLE
CONCEPTUAL
ALTERNATIVE
DAM REMOVAL

DRAWN BY RJL	DATE PROGRESS
CHECKED BY CWJ	D&K PROJECT # 827442
PROJ. ENG. CWJ	

SHEET NUMBER
8
SHEET 8 OF 9



1. DREDGE ACCUMULATED SEDIMENT UPSTREAM OF THE EXISTING DAM TO THE NATURAL CHANNEL BOTTOM.
2. NEW STONE RIPRAP ALONG RIVER BANKS.
3. DEMOLISH THE EXISTING DAM. TO PRESERVE ITS HISTORIC SIGNIFICANCE, CONSTRUCT A PUBLIC INFORMATION BOARD IN VETERAN'S PARK.
4. ABANDON EXISTING HYDRANT LOCATION.

DATUM:
VERTICAL: NAVD 88 GPS DERIVED
HORIZONTAL: NAD 83 GPS DERIVED



CONCEPTUAL ALTERNATIVE DAM REMOVAL

SCALE 1" : 20'



SCALE IN FEET



6 GREEN TREE DR.
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FAX: (866) 783-7101
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PROFESSIONAL SEAL

**NOT FOR
CONSTRUCTION**

[illegible]

TOWN OF
LONDONDERRY
100 OLD SCHOOL
STREET
S. LONDONDERRY,
VT 05155

WILLIAMS DAM
STUDY (#115.01)

LONDONDERRY, VT

SHEET TITLE

DAM REMOVAL ORTHOIMAGERY

DRAWN BY RJL	DATE PROGRESS
CHECKED BY	D&K PROJECT # 827442
PROJ. ENG. CWJ	

SHEET NUMBER

9

SHEET 9 OF 9

Appendix G

Alternative Opinion of Probable Construction Costs



**Town of Londonderry
William's Dam Study**

**Conceptual Alternative: Dam Rehabilitation
Opinion of Probable Construction Costs**

ITEM NO.	DESCRIPTION	UNITS	ESTIMATED QUANTITY	UNIT COST	TOTAL
DAM REHABILITATION					
1	Upstream CIP Concrete Wall	CY	200	\$ 1,800.00	\$ 360,000.00
2	Sediment Excavation	CY	950	\$ 18.00	\$ 17,100.00
3	Sediment Haul	CY	950	\$ 22.00	\$ 20,900.00
DAM REPLACEMENT SUBTOTAL					\$ 398,000
CHANNEL RESTORATION					
4	Silt Fencing	LF	120	\$ 4.10	\$ 492.00
5	Engineered Log Jams	EA	3	\$ 5,000.00	\$ 15,000.00
6	Channel Vegetation (Seed/mulch)	LS	1	\$ 5,000.00	\$ 5,000.00
7	Topsoil	CY	25	\$ 35.40	\$ 885.00
8	Seed	LB	5	\$ 8.73	\$ 43.65
9	Fertilizer	LB	10	\$ 3.83	\$ 38.30
10	Hay Mulch	TON	1	\$ 857.35	\$ 857.35
11	Grubbing Material	SY	20	\$ 3.83	\$ 76.60
CHANNEL RESTORATION SUBTOTAL					\$ 22,392.90
ADDITIONAL ITEMS					
13	Survey Layout	DAY	1	\$ 2,000.00	\$ 2,000.00
14	Stabilized Construction Entrance	CY	50	\$ 52.52	\$ 2,626.00
15	Inlet Protection Device, Type 1	EA	3	\$ 171.67	\$ 515.01
16	Rolled Erosion Control Product	SY	100	\$ 1.66	\$ 166.00
17	Reset Roadway Signs	EA	1	\$ 27.14	\$ 27.14
18	Remove and Reset Roadway Lighting	EA	1	\$ 1,000.00	\$ 1,000.00
	ADDITIONAL ITEMS SUBTOTAL				\$ 6,334
GENERAL					
19	Mobilization (10% of Construction Costs)	LS	1	\$ 43,000.00	\$ 43,000.00
20	EPSC (5% of Construction Costs)	LS	1	\$ 22,000.00	\$ 22,000.00
21	Traffic Control (10% of Construction Costs)	LS	1	\$ 43,000.00	\$ 43,000.00
22	Control of Water (20% of Construction Costs)	LS	1	\$ 86,000.00	\$ 86,000.00
GENERAL SUBTOTAL					\$ 194,000.00
CONSTRUCTION ITEMS SUB-TOTAL (rounded to nearest \$1,000) = \$621,000					
30% CONTINGENCY = \$187,000					
TOTAL CONSTRUCTION COST = \$808,000					



Town of Londonderry
William's Dam Study

Conceptual Alternative: Dam Rehabilitation (B)
Opinion of Probable Construction Costs

ITEM NO.	DESCRIPTION	UNITS	ESTIMATED QUANTITY	UNIT COST	TOTAL
DAM REHABILITATION					
1	ROLLER COMPACTED CONCRETE	CY	740	\$ 200	\$ 148,000
2	STRUCTURAL CONCRETE	CY	90	\$ 1,800	\$ 162,000
2	Sediment Excavation	CY	600	\$ 10	\$ 6,000
3	Sediment Haul	CY	600	\$ 20	\$ 12,000
DAM REPLACEMENT SUBTOTAL					\$ 328,000
CHANNEL RESTORATION					
4	Silt Fencing	LF	12	\$ 4	\$ 49
5	Engineered Log Jams	EA	3	\$ 5,000	\$ 15,000
6	Channel Vegetation (Seed/mulch)	LS	1	\$ 5,000	\$ 5,000
7	Topsoil	CY	25	\$ 35	\$ 885
8	Seed	LB	5	\$ 9	\$ 44
9	Fertilizer	LB	10	\$ 4	\$ 38
10	Hay Mulch	TON	1	\$ 857	\$ 857
11	Grubbing Material	SY	20	\$ 4	\$ 77
CHANNEL RESTORATION SUBTOTAL					\$ 21,950
ADDITIONAL ITEMS					
13	Survey Layout	DAY	1	\$ 2,000	\$ 2,000
14	Stabilized Construction Entrance	CY	30	\$ 53	\$ 1,576
15	Inlet Protection Device, Type 1	EA	3	\$ 172	\$ 515
16	Rolled Erosion Control Product	SY	200	\$ 2	\$ 332
17	Reset Roadway Signs	EA	2	\$ 27	\$ 54
18	Remove and Reset Roadway Lighting	EA	2	\$ 1,000	\$ 2,000
ADDITIONAL ITEMS SUBTOTAL					\$ 6,477
GENERAL					
19	Mobilization (Assume 10% of Construction Costs)	LS	1	\$ 36,000	\$ 36,000
20	EPSC (5% of Construction Costs)	LS	1	\$ 18,000	\$ 18,000
21	Traffic Control (10% of Construction Costs)	LS	1	\$ 36,000	\$ 36,000
22	Control of Water (20% of Construction Costs)	LS	1	\$ 72,000	\$ 72,000
GENERAL SUBTOTAL					\$ 162,000
CONSTRUCTION ITEMS SUB-TOTAL (rounded to nearest \$1,000)					= \$ 519,000
30% CONTINGENCY					= \$ 156,000
TOTAL CONSTRUCTION COST					= \$ 675,000



**Town of Londonderry
William's Dam Study**

**Conceptual Alternative: Dam Replacement
Opinion of Probable Construction Costs**

ITEM NO.	DESCRIPTION	UNITS	ESTIMATED QUANTITY	UNIT COST	TOTAL
DAM REPLACEMENT					
1	CONCRETE CLASS A	CY	290	\$ 1,800.00	\$ 522,000
2	Sediment Excavation	CY	950	\$ 18.00	\$ 17,100
3	Sediment Haul	CY	950	\$ 22.00	\$ 20,900
DAM REPLACEMENT SUBTOTAL					\$ 560,000
DAM REMOVAL					
4	Concrete Demolition	CY	175	\$ 23.82	\$ 4,169
5	Rock Excavation	CY	225	\$ 40.68	\$ 9,153
DAM REMOVAL SUBTOTAL					\$ 13,322
CHANNEL RESTORATION					
6	Silt Fencing	LF	310	\$ 4.10	\$ 1,271
7	Engineered Log Jams	EA	3	\$ 5,000.00	\$ 15,000
8	Riprap, Heavy Type	CY	260	\$ 63.13	\$ 16,414
9	Channel Vegetation (Seed/mulch)	LS	1	\$ 5,000.00	\$ 5,000
10	Topsoil	CY	70	\$ 35.40	\$ 2,478
11	Seed	LB	10	\$ 8.73	\$ 87
12	Fertilizer	LB	20	\$ 3.83	\$ 77
13	Hay Mulch	TON	1	\$ 857.35	\$ 857
14	Grubbing Material	SY	130	\$ 3.83	\$ 498
CHANNEL RESTORATION SUBTOTAL					\$ 41,682
ADDITIONAL ITEMS					
15	Survey Layout	DAY	1	\$ 2,000.00	\$ 2,000
16	Stabilized Construction Entrance	CY	50	\$ 52.52	\$ 2,626
17	Inlet Protection Device, Type 1	EA	3	\$ 171.67	\$ 515
18	Rolled Erosion Control Product	SY	200	\$ 1.66	\$ 332
19	Reset Roadway Signs	EA	2	\$ 27.14	\$ 54
20	Dry Hydrant System	LS	1	\$ 5,000.00	\$ 5,000
20	Remove and Reset Roadway Lighting	EA	2	\$ 1,000.00	\$ 2,000
ADDITIONAL ITEMS SUBTOTAL					\$ 12,527
GENERAL					
21	Mobilization (10% of Construction Costs)	LS	1	\$ 63,000.00	\$ 63,000
22	EPSC (5% of Construction Costs)	LS	1	\$ 32,000.00	\$ 32,000
23	Traffic Control (10% of Construction Costs)	LS	1	\$ 63,000.00	\$ 63,000
24	Control of Water (20% of Construction Costs)	LS	1	\$ 126,000.00	\$ 126,000
GENERAL SUBTOTAL					\$ 284,000
CONSTRUCTION ITEMS SUB-TOTAL (rounded to nearest \$1,000)				=	\$ 912,000
30% CONTINGENCY				=	\$ 274,000
TOTAL CONSTRUCTION COST				=	\$ 1,186,000



**Town of Londonderry
William's Dam Study**

**Conceptual Alternative: Dam Removal
Opinion of Probable Construction Costs**

ITEM NO.	DESCRIPTION	UNITS	ESTIMATED QUANTITY	UNIT COST	TOTAL
DAM REMOVAL					
1	Concrete Demolition	CY	170	\$ 23.82	\$ 4,049.40
2	Rock Excavation	CY	210	\$ 40.68	\$ 8,542.80
DAM REMOVAL SUBTOTAL					\$ 12,592
CHANNEL RESTORATION					
3	Sediment Excavation	CY	3,000	\$ 18.00	\$ 54,000.00
4	Sediment Haul	CY	3,000	\$ 22.00	\$ 66,000.00
5	Silt Fence	LF	420	\$ 4.10	\$ 1,722.00
6	Riprap, Heavy Type	CY	260	\$ 63.13	\$ 16,413.80
7	Engineered Log Jams	EA	3	\$ 5,000.00	\$ 15,000.00
8	Channel Vegetation (Seed/mulch)	LS	1	\$ 5,000.00	\$ 5,000.00
9	Topsoil	CY	40	\$ 35.40	\$ 1,416.00
10	Seed	LB	10	\$ 8.73	\$ 87.30
11	Fertilizer	LB	30	\$ 3.83	\$ 114.90
12	Hay Mulch	TON	1	\$ 857.35	\$ 857.35
13	Grubbing Material	SY	400	\$ 3.83	\$ 1,532.00
CHANNEL RESTORATION SUBTOTAL					\$ 162,143.35
ADDITIONAL ITEMS					
14	Survey Layout	DAY	1	\$ 2,000.00	\$ 2,000.00
15	Stabilized Construction Entrance	SY	110	\$ 52.52	\$ 5,777.20
16	Stabilized Construction Entrance	CY	110	\$ 52.52	\$ 5,777.20
17	Rolled Erosion Control Product	SY	250	\$ 1.66	\$ 415.00
18	Reset Roadway Signs	EA	3	\$ 27.14	\$ 81.42
19	Remove and Reset Roadway Lighting	EA	2	\$ 1,000.00	\$ 2,000.00
ADDITIONAL ITEMS SUBTOTAL					\$ 16,051
GENERAL					
20	Mobilization (10% of Construction Costs)	LS	1	\$ 20,000.00	\$ 20,000.00
21	EPSC (5% of Construction Costs)	LS	1	\$ 10,000.00	\$ 10,000.00
22	Traffic Control (10% of Construction Costs)	LS	1	\$ 20,000.00	\$ 20,000.00
23	Control of Water (20% of Construction Costs)	LS	1	\$ 39,000.00	\$ 39,000.00
GENERAL SUBTOTAL					\$ 89,000.00

CONSTRUCTION ITEMS SUB-TOTAL (rounded to nearest \$1,000)	=	\$280,000
30% CONTINGENCY	=	\$84,000
TOTAL CONSTRUCTION COST	=	\$364,000

Appendix H

Alternative Permitting Information Sheets



State of Vermont
PERMIT AND LICENSE INFORMATION

DAMS

**SUMMARY
DESCRIPTION
OF PERMIT**

A permit is required to ensure that the construction, reconstruction, alteration or removal of dams is carried out to serve the public good and provide adequately for the public safety.

Owners of dams capable of impounding more than 500,000 cubic feet of water are responsible for the payment of the **annual fee**, based on the hazard class of the dam: low hazard dams \$200/year, significant hazard dams \$350/year, and high hazard dams \$1,000/year.

**EXAMPLE OF
REGULATED
ACTIVITY**

Construction, enlargement, raising, lowering, remodeling, reconstruction, breaching or otherwise altering any dam, pond or impoundment not related to generation of electric energy for public use or part of a public utility system which is or will be capable of impounding more than 500,000 cubic feet of water or other liquid, as measured to the top of the dam.

**INFORMATION
REQUIRED**

Requires submittal of completed application form, fee, plans and specifications and design data. May require public information meeting [10 VSA Chapter 170](#).

WEB ADDRESS

<http://dec.vermont.gov/facilities-engineering/dam-safety/dam-ownership-and-responsibility/dam-orders>

**ADMINISTERING
AGENCY**

**AGENCY OF NATURAL RESOURCES
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
FACILITIES ENGINEERING DIVISION**

CONTACT: Ben Green, P.E. Dam Safety Engineer
802-622-4093 benjamin.green@vermont.gov
Steven Hanna, Dam Safety Engineer
802-490-6123 steven.hanna@vermont.gov

ADDRESS: Facilities Engineering Division
1 National Life Drive
Montpelier, Vermont 05620-3510

AUTHORITY

[10 VSA Chapter 43](#)

**APPLICABLE
RULES**

If dam impounds less than 500,000 cubic feet it may require a [Stream Alteration Permit](#) (10 VSA Chapter 41, Subchapter 2), or [Stream Obstruction Permit](#) (10 VSA Chapter 111, § 4607) (Issued by the Commissioner of Fish and Wildlife). If hydroelectric project, it is regulated under 10 VSA Chapter 43 of the Public Utility Commission. May also require a [Conditional Use Determination](#) under Wetlands Rules and US Army Corps of Engineers permit. See general information about pond construction on [Sheet 32.1](#).

**APPEAL
PROCESS**

Within 30 days of the date of an act or decision, any person aggrieved by an act or decision of the secretary, or any party by right, may appeal to the environmental court in accordance with the provisions of [10 VSA Chapter 220](#).



State of Vermont
PERMIT AND LICENSE INFORMATION

WETLANDS PERMIT

**SUMMARY
DESCRIPTION
OF PROGRAM**

The purpose of this program is to protect significant wetlands in Vermont. The Vermont Wetland Rules establish a three-tier classification system for wetlands.

**EXAMPLE OF
REGULATED
ACTIVITY**

Placement of fill for an access road, land clearing, excavation of ponds. Any activity within the wetland or 50-foot buffer zone.

**CRITERIA FOR
JURISDICTION**

Class I and Class II wetlands are designated significant wetlands based on the function and value they provide. The [Vermont Wetland Rules](#) (VWR) refer to criteria for presuming a wetland is significant under Section 4.6 of the VWR which includes connection to other surface waters, size of a half-acre or more, and mapped wetlands. Classification can be assigned by the Secretary for mapped or unmapped wetlands through a Wetland Determination. Activities that are allowed within the significant wetlands and their adjacent buffer zones are listed in Section 6 of the VWR, provided there is no draining, dredging, filling, grading or alteration of the water flow. All uses that are not allowed uses require either an Individual Wetland Permit or a Vermont Wetland General Permit. If an individual is unsure whether a permit is required, they should contact their District Wetland Ecologist.

**INFORMATION
REQUIRED**

Application forms for permits and determinations are available from the Vermont Wetlands Office, website, and from our website.

WEB ADDRESS

<http://dec.vermont.gov/watershed/wetlands>

FEES

Minimum Application Fee \$240.00 PLUS:

- (A) \$0.75 per square foot of proposed impact to Class I or II wetlands;
- (B) \$0.25 per square foot of proposed impact to Class I or II wetland buffers;
- (C) Maximum fee, for the conversion of Class II wetlands or wetland buffers to cropland use, \$200.00 per application. "Cropland" means land that is used for the production of agricultural crops, including row crops, fibrous plants, pasture, fruit-bearing bushes, trees or vines and the production of Christmas trees;
- (D) Clearing and maintenance of forested wetland corridors for utility lines, pipelines and ski trails: \$0.25 per square foot of proposed impact.

**APPLICATION
TIME FRAME**

The performance standard for processing a complete application is 90 days without a meeting and 120 days with a meeting.

**ADMINISTERING
AGENCY****AGENCY OF NATURAL RESOURCES
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION**

CONTACT: Contact your regional [District Wetlands Ecologist](#)
for site-specific questions
(802) 490-6195
ANR.WSMDWetlands@vermont.gov

ADDRESS: Watershed Management Division
1 National Life Drive, Davis 3
Montpelier, VT 05620-3522

AUTHORITY

10 V.S.A. § 905(a)(7-9) & V.S.A. § 2822(j)(26)

**APPLICABLE
RULES**

[Vermont Wetland Rules](#)
Effective February 23, 1990, and amended April 1, 2017

**APPEAL
PROCESS**

Any person aggrieved by an act or decision of the Secretary may appeal to the Environmental Court within 30 days of the date of the act or decision in accordance with [10 VSA Chapter 220](#) and the Vermont Rules of Environmental Court Proceedings.

**OTHER PERMITS
AND APPROVALS**

Contact a Permit Specialist for a Project Review Sheet, see:
<http://dec.vermont.gov/environmental-assistance/permits>.



State of Vermont
PERMIT AND LICENSE INFORMATION

STREAM ALTERATIONS & CROSSINGS

**SUMMARY
DESCRIPTION
OF PERMIT**

This permit regulates the alteration of streams. Regulated activities may be covered under either an individual or general permit. Permit review protects against creation of flood hazards and damage to fish life; protects rights of neighboring landowners; and, with respect to the stream alteration activity, assures compliance with Vermont Water Quality Standards.

**EXAMPLE OF
REGULATED
ACTIVITY**

Streambank stabilization, mineral prospecting, municipal roadway improvements requiring instream work, utility crossings under streambeds, municipal or private bridge construction or repair.

**CRITERIA FOR
JURISDICTION**

Movement, excavation or fill of 10 or more cubic yards annually in any perennial stream, or construction or maintenance of a berm in a flood hazard area or river corridor. No person may remove gravel from any watercourse primarily for construction or sale. Exemptions for: emergency protective measures with municipal authorization and reporting and implementation requirements, removal of 50 cubic yards or up to 10 cubic yards in Outstanding Resource Waters annually for riparian landowners with reporting requirements, and Required Agricultural Practices as defined by the Commissioner of Agriculture. Approval required for municipal or private stream crossings on perennial streams.

**INFORMATION
REQUIRED**

Requires specific information regarding project location and extent, adjacent and opposite landowners, working dates, maps/drawings, plans and notification of application to adjoining landowners and the municipality.

WEB ADDRESS

<http://dec.vermont.gov/watershed/rivers/river-management>

FEES

Individual Permit: \$350.00 (municipalities are not exempt)
 General Permit: New, repair, or replacement culverts and bridges and restoration projects: \$200.00 (municipalities are not exempt)
 General Permit: Next flood or emergency protective measures: No Fee

**APPLICATION
TIME FRAME**

The performance standard for processing a complete application is 40 days.

**ADMINISTERING
AGENCY**

**AGENCY OF NATURAL RESOURCES
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION**

Map of the regions served by the River Management Engineers:
http://dec.vermont.gov/sites/dec/files/wsm/rivers/docs/RME_districts.pdf

For Northwestern Vermont:

Chris Brunelle, River Management Engineer
 Essex Regional Office
 Work Cell 802-777-5328: Fax: 802 879-3871
 Email: chris.brunelle@vermont.gov

For Northeastern Vermont:

Patrick Ross, P.E. River Management Engineer
 St. Johnsbury Regional Office
 Work Cell: 802-279-1143 Fax: 802-748-6687
 Email: patrick.ross@vermont.gov

For Central Vermont:

Jaron Borg, River Management Engineer
 Central Montpelier Office
 Work Cell: 802-371-8342 Fax: 802-828-1544
 Email: jaron.borg@vermont.gov

For Southwestern Vermont:

Josh Carvajal, River Management Engineer
 Rutland Regional Office
 Work Cell: 802-490-6163 Fax: 802-786-5915
 Email: joshua.carvajal@vermont.gov

For Southeastern Vermont:

Scott Jensen, River Management Engineer
 Springfield Regional Office
 Work Cell: 802-490-6962 Fax: 802-885-8890
 Email: scott.jensen@vermont.gov

AUTHORITY

10 VSA Chapter 41

**APPEAL
PROCESS**

Effective January 31, 2005, within 30 days of the date of an act or decision, any person aggrieved by an act or decision of the secretary, or any party by right, may appeal to the environmental court in accordance with the provisions of [10 VSA Chapter 220](#).

OTHER PERMITS

Local Flood Hazard Area permits, U.S. Army Corps of Engineers permits, 401 Water Quality Certification, ANR Flood Hazard Area & River Corridor General Permit may apply. For further information, contact a [Permit Specialist](#) for a Project Review Sheet.

<http://dec.vermont.gov/environmental-assistance/permits>



State of Vermont
PERMIT AND LICENSE INFORMATION

**FEDERAL PERMIT REQUIREMENTS
 FOR WORK IN WETLANDS**

**SUMMARY
 DESCRIPTION
 OF PERMIT**

Permits required for the discharge of dredged or fill material or mechanized land clearing in all waters of the United States, including wetlands, under Section 404 of the Clean Water Act. Impacts subject to Federal review include not only the area of wetland directly filled, but also any inundation or drainage of wetlands caused by the placement of fill or mechanized land clearing.

**EXAMPLE OF
 ACTIVITY**

Filling a wetland adjacent to Lake Champlain; construction of a pond in wetland.

**CRITERIA FOR
 JURISDICTION**

Projects or activities, which involve the placement of fill, excavation, or mechanized land clearing in jurisdictional wetlands. Certain small projects may be eligible for authorization under abbreviated procedures.

DEFINITION OF "WETLAND": The term "wetland" is defined by Federal regulations to mean "...those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions..." (33 CFR Part 328.3 (b), as published in the November 13, 1986 Federal Register). Wetlands generally include swamps, marshes, bogs and similar areas.

DEFINITION OF "FILL": The term "fill material" is defined by Federal regulations to mean "...any material used for the primary purpose of replacing an aquatic area with dry land or of changing the bottom elevation of a waterbody. The term does not include any pollutant discharged into the water primarily to dispose of waste..." (33 CFR Part 323.2 (b), as published in the November 13, 1986 Federal Register).

**INFORMATION
 REQUIRED**

Requires submission of completed application form, vicinity map, site plan and cross-sections of proposed activity. A wetland delineation using the [1987 Corps of Engineers Wetlands Delineation Manual](#) and [Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region](#) is required. The Natural Resources Conservation Service should be contacted for delineation of agricultural lands. Plans should be drawn to scale and include the wetland boundary, dimensions of the proposed work, and extent of wetland encroachment. Waterways and wetlands are vital areas that constitute productive and valuable public resources, the unnecessary alteration or destruction of which is to be discouraged. Therefore, Federal regulations state that filling of these resources shall not be permitted unless the applicant clearly demonstrates the following:

- a. that the activity associated with the fill must have direct access or proximity to or be located in the water resources in order to fulfill its basic purpose, and that other site or construction alternatives are not practicable; or
- b. if the activity associated with the fill does not have to have direct access to the water resources, you must provide information on the need to place fill in the waterway and/or wetlands and the feasibility of alternative sites or methods to accomplish the objective of the project.

In addition to a and b above, the possibilities for mitigation of any unavoidable damages to the resources must be discussed. If mitigation is possible, it should be included as part of the application. The applicant must submit information that thoroughly and clearly documents the need for the fill, alternatives, and mitigation possibilities.

WEB ADDRESS

<http://www.nae.usace.army.mil/Missions/Regulatory/>

FEES

\$0 - \$100; dependent upon type of permit to be processed.

**APPLICATION
TIMEFRAME**

Dependent upon type and complexity of project. Small, non-controversial projects can be processed in 15-90 days; large, controversial projects can take considerably longer.

**ADMINISTERING
AGENCY****U.S. ARMY CORPS OF ENGINEERS**

CONTACT: U.S. Army Corps of Engineers
Vermont Project Office
802-872-2893

ADDRESS: 11 Lincoln St, Room 210
Essex Junction, Vermont 05452

AUTHORITY

33 USC 1344 (Clean Water Act)

**APPLICABLE
RULES**

33 CFR Part 323 as published in the November 13, 1986 Federal Register

APPEAL PROCESS

None



State of Vermont
PERMIT AND LICENSE INFORMATION

**FEDERAL PERMIT REQUIREMENTS FOR WORK IN
 RIVERS AND STREAMS**

**SUMMARY
 DESCRIPTION
 OF PERMIT**

Permits required for all structures or work beyond the ordinary high-water mark in navigable waters of the United States under Section 10 of the Rivers and Harbors Act. Permits required for the discharge of dredged or fill material or mechanized land clearing in all waters of the United States under Section 404 of the Clean Water Act.

**EXAMPLE OF
 ACTIVITY**

Rip-rap river bank below ordinary high water; filling of streambed for bridge abutments.

**CRITERIA FOR
 JURISDICTION**

Projects or activities which encroach beyond the ordinary high watermark of the Batten Kill, Black River, Connecticut River, Lamoille River, Missisquoi River, Moose River, Nulhegan River, Nulhegan River - Black Branch, Nulhegan River - East Branch, Nulhegan - Yellow Branch, Ompompanoosuc River, Otter Creek, Paul Stream, Passumpsic River, Passumpsic River - East Branch, Waits River, Wells River, White River, and Winooski River, including (but not limited to) dredging, shoreline stabilization, and water intakes. Projects or activities, which involve the discharge of, dredged or fill material or mechanized clearing beyond the ordinary high-water mark in all other rivers and streams within the State. Certain small projects may be eligible for authorization under abbreviated procedures.

**INFORMATION
 REQUIRED**

Requires submission of completed application form, vicinity map, site plan and cross-sections of proposed activity. Plans should be drawn to scale and include the ordinary high-water mark, dimensions of the proposed work, and extent of encroachment beyond the ordinary high water mark.

WEB ADDRESS

<http://www.nae.usace.army.mil/Missions/Regulatory/>

FEES

\$0 - \$100; dependent upon type of permit to be processed.

**APPLICATION
 TIMEFRAME**

Dependent upon type and complexity of project. Small, non-controversial projects can be processed in 15-90 days; large, controversial projects can take considerably longer.

**ADMINISTERING
AGENCY****U.S. ARMY CORPS OF ENGINEERS**

CONTACT: U.S. Army Corps of Engineers
Vermont Project Office
802-872-2893

ADDRESS: 11 Lincoln St, Room 210
Essex Junction, Vermont 05452

AUTHORITY

33 USC 403 (Rivers and Harbors Act of 1899) and
33 USC 1344 (Clean Water Act).

**APPLICABLE
RULES**

33 CFR 322-323 as published in the November 13, 1986 Federal Register.

APPEAL PROCESS

None



State of Vermont
PERMIT AND LICENSE INFORMATION

WORK IN A STATE HIGHWAY RIGHT OF WAY

**SUMMARY
DESCRIPTION
OF PERMIT**

Prior to performing any work or installing any utility facility within the State highway right-of-way, a Title 19, § 1111 permit is required from the Agency of Transportation.

**EXAMPLE OF
REGULATED
ACTIVITY**

Work within the limits of a State highway right-of-way (for example, construction of a driveway, installation of a culvert, excavation of a ditch or re-grading, paving or re-paving) requires a permit from the Agency.

**CRITERIA FOR
JURISDICTION**

A permit is needed for nearly any activity in or directly affecting the highway right-of-way, including (but not necessarily limited to) creation or modification of a driveway, repaving a portion of a driveway within the right-of-way, placement of structures, placement or grading of earthen material, discharge of water, or nearly anything else that would affect the right-of-way. The full scope of this permit process is beyond the scope of the general information handout.

**INFORMATION
REQUIRED**

Includes the applicant's and/or owner's name, address, phone number(s); location and description of the work to be performed; when the work is planned to begin and be completed; if Act 250 or local zoning permit is required; and, if filing for such permits, has the process been initiated. Other information includes a plan or sketch, providing a clear showing of the proposed work, including all appropriate details. Requests for residential access permits are to be submitted to the Agency's District Transportation Administrator.

FEES

A processing fee may be required. The applicant will be responsible for any mitigation improvements needed to the State highway because of the applicant's work; and for any inspection services deemed necessary to ensure the work is performed to State requirements. In the case of a permit for access (driveway), the applicant is also responsible for the land records recording fee, paid to the municipality, to record "Notice of Permit Action".

**APPLICATION
TIME FRAME**

One – two months

**ADMINISTERING
AGENCY**

AGENCY OF TRANSPORTATION

CONTACT: Craig Keller, Chief of Permitting Services
Phone: 802-279-1152 Office: 802-828-2653
craig.keller@vermont.gov
<http://vtrans.vermont.gov/planning/permitting>

ADDRESS: 219 N. Main St.
Barre, VT 05641

AUTHORITY

19 V.S.A. § 1111

APPEAL PROCESS

Administrative Hearing, Transportation Board, Superior Court



State of Vermont

PERMIT AND LICENSE INFORMATION**PROTECTION OF HISTORIC SITES UNDER CRITERION 8 OF ACT 250****SUMMARY**

The Vermont Division for Historic Preservation is considered under state law (22 V.S.A. Chapter 14) the state's expert on historic and archeological resources. The Division provides District Commissions with comments and the necessary information for them to make a positive finding under the historic sites aspect of Criterion 8. Project review by the Division consists of identifying the project's potential impacts to historic buildings, structures, historic districts, historic landscapes and settings, and known or potential archeological resources. Under 10 V.S.A. Chapter 151 (Act 250), section 6001 (9), the Vermont Advisory Council on Historic Preservation is responsible for providing testimony about the significance of historic and archeological resources.

NOTE: In some cases, an Act 250 project also has federal funding or requires a federal permit. In such cases, the project is also subject to the provisions of Section 106 of the National Historic Preservation Act (see [Sheet #101](#)). Compliance with Section 106 generally satisfies the needs of the Act 250 process. However, because of the very specific Section 106 review procedures, satisfying Act 250 may not ensure compliance with Section 106 requirements.

EXAMPLES OF ACTIVITY

Including but not limited to: ground disturbing projects (i.e. subdivisions, golf courses, ski area improvements, radio towers, etc.), whole or partial demolition of buildings or structures, new construction in an historic district or historic landscape, rehabilitation of buildings or structures.

INFORMATION REQUIRED

Copy of USGS topographic map showing project location; detailed project description; site plan, if available; information about past and current land use; clearly labeled photographs of any buildings or structures that are 50 years old or older within the project area and photos of their surroundings and adjacent landscape; building's dates of construction and any significant alterations; building elevations, if rehabilitation of an historic building is proposed. The Division or Advisory Council may require additional information as the review process proceeds. **The review process works best when early planning and consideration of historic and archeological resources allows adequate time for thoughtful and careful decision making, thereby avoiding last minute surprises, tight turnaround times, and delays.**

WEB ADDRESSES

<http://accd.vermont.gov/historic-preservation/review-compliance>

FEES

None. However, Act 250 applicants may find it necessary to hire qualified consultants such as professional archeologists, professional architectural historians, and architects to assist resource identification and review of potential project effects.

**APPLICATION
TIME FRAME**

Depends on size and complexity of project and degree of potential impacts. Consultation with Division as early as possible in planning stage will ensure a more efficient process and may reduce potential development conflicts with resources through a "least impact" project design. If field inspection by Division staff and Advisory Council review are necessary, process may require several months. Field inspections (or archeological field investigations) cannot be undertaken under conditions of frozen ground or snow cover. This seasonal limitation to field activities requires appropriate, advanced planning during the review process to take maximum advantage of frost-free/snow free ground (mid-late April to early-mid November).

**ADMINISTERING
AGENCY**

**AGENCY OF COMMERCE AND COMMUNITY DEVELOPMENT
VERMONT DIVISION FOR HISTORIC PRESERVATION
Serving as the STATE HISTORIC PRESERVATION OFFICE**

CONTACT: Jamie Duggan, Historic Preservation Review Coordinator
James.Duggan@vermont.gov
(802) 477-2288

ADDRESS: One National Life Dr, Davis Bldg 6th Floor
Montpelier, Vermont 05620-0501
ACCD.ProjectReview@vermont.gov

AUTHORITY

10 VSA Chapter 151 (Act 250);
22 VSA Chapter 14 (VT Historic Preservation Act).

APPEAL PROCESS

See [Sheet #47](#) relating to Act 250



State of Vermont
PERMIT AND LICENSE INFORMATION

OBSTRUCTING STREAMS

SUMMARY DESCRIPTION OF PERMIT	Commissioner approval required for permanent or temporary stream obstructions to fish passage. Permit form is a letter from Commissioner authorizing obstruction.
EXAMPLE OF REGULATED ACTIVITY	Dam or weir repair and construction; culvert installation.
CRITERIA FOR JURISDICTION	Impact of proposed activity on fish passage.
INFORMATION REQUIRED	Description and location of proposed activity, name of waterbody.
FEES	None.
WEB ADDRESS	http://vtfishandwildlife.com/conservation/development-review
APPLICATION TIME FRAME	30-60 days from receipt of request. Review may include on-site inspection by fisheries biologist.
ADMINISTERING AGENCY	VERMONT FISH & WILDLIFE DEPARTMENT CONTACT: Local fisheries biologist in district office closest to site.
AUTHORITY	10 V.S.A. Section 4607
APPEAL PROCESS	None
OTHER PERMITS	Ponds Fact Sheet # 32.1 , Dams Sheet # 45 , Stream Alteration Sheet # 32 , Water Quality Certificate Sheet # 27 , Wetlands Sheet # 29 , Corps. of Engineer Sheets # 98 & 99 .

Appendix I

Alternative Funding Sources

Dam Rehabilitation Alternative

Historic Preservation Grants Frequently Asked Questions

Do I qualify for a Historic Preservation Grant?

Properties owned by non-profit organizations or municipalities are eligible for funding through the state grant program. A building must also be either listed or determined eligible for listing in the *National Register of Historic Places* to qualify. You may contact the Division for Historic Preservation to learn if your building is listed or has been determined eligible for listing. Privately owned businesses or homes are not eligible for funding.

How much funding is available?

Grants of up to \$20,000 are available on a 1 to 1 matching basis. This is a reimbursement program, which means that if you are awarded a grant, you are responsible for paying for the full amount of the project and the State will then reimburse you once the project and required paperwork are complete. Annually, and pending legislative approval, the program has \$200,000 available in grant funds.

Can I start my project before I get a grant?

No. You may not apply for funding to support projects that have already been completed or are in progress. If your project is large with many components, you may be able to do work on your building before you get a grant, if the portion of the project to be funded with a grant has NOT started.

What work is eligible for funding?

Projects to repair and/or restore historic building features are eligible. Work must meet the Secretary of the Interior's *Standards for Rehabilitation* to qualify for funding. This could include but is not limited to:

- Work on a failed structural component, such as the building's frame, foundation or roof;
- Repairs to damaged or deteriorated components of the historic building, such as windows, doors, porches, and siding; and
- Preservation or restoration of significant historic features of a building, including historic plaster or decorative painting restoration

Ineligible work includes new construction, additions, electrical, plumbing or heating projects and weatherization or code improvements. Work that is generally considered maintenance such as cleaning or painting, will not be funded. Planning projects are also not eligible for funding.

What information must be provided with an application?

In addition to completing a Historic Preservation Application, all applicants must provide the following information to the Division for Historic Preservation in order to be considered for grant funding:

- Estimate – a detailed, written estimate from a qualified contractor for your project
- Photographs – digital photographs documenting your building and the issues you are trying to resolve
- Proof of non-profit status

When can I apply?

Applications for funding are generally made available during August annually and the deadline for applications is the first Monday of October each year. To receive notification regarding the next round of Grants and be added to our mailing list, contact Caitlin Corkins at 802-828-3047.

Caitlin Corkins, Tax Credits & Grants Coordinator 802-828-3047

Dam Removal Alternative

<https://dec.vermont.gov/watershed/rivers/streamflow-protection/dam-removal#:~:text=Dam%20removal%20has%20in%20recent,financial%20burdens%20on%20their%20owners>.

https://dec.vermont.gov/sites/dec/files/wsm/rivers/docs/drw_funding.pdf

<https://www.ctriver.org/our-work/reconnecting-habitat-for-fish/>

<https://www.americanrivers.org/river-restoration-funding-sources/>

<https://www.federalgrants.com/National-Fish-Passage-Program-19005.html>

<https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/equip/>

Appendix B Williams Dam, Londonderry, VT (NRCS, 2022)

Williams Dam Flooding Analysis

Londonderry, Vermont

SLR Project No.: 20433.00002

January 5, 2024



December 16, 2022

Town of Londonderry
Shane O'Keefe
Town Administrator
100 Old School Street
South Londonderry, VT 05155

Dear Shane,

Please find attached/enclosed a Preliminary Investigation and Feasibility Report (PIFR) for Williams Dam, which was completed by RJH Consultants, Inc. Based in the information in this PIFR, we do not believe that renovation or replacement of this dam would be eligible for USDA-Natural Resources Conservation Service's Watershed and Flood Prevention Operations (WFPO) program. The "Pie-in-the-Sky" alternative #4 on page 8 states:

"Alternative 4 represents a "pie-in-the-sky" solution. This alternative includes the replacement of Williams Dam as described in Alternative 2 and the construction of floodwalls on both sides of the West River floodplain boundary upstream of Williams Dam to provide 10-year flood protection to Londonderry. The floodwalls will have an average height of approximately 10 feet and a total length of approximately 8,500 feet. Additionally, approximately 2,000 feet of Route 100 will be raised an average of 6 feet to intersect the required crest elevation of the western floodwall and contain 10-year flood flows in the West River floodplain."

A "run of the river" dam in this location, at best, will only provide protection from a 10 year flood event. Under WFPO, dams must meet the flood prevention criteria stated in TR-60 which requires a minimum protection from a 100 year flood event. We do not feel it is feasible for this dam in this location to provide the necessary flood protection and storage. However, the program could provide funding for the removal of this dam for the purpose of enhancing fish and wildlife migration and habitat.

It is our understanding that you have already been contacted by the Connecticut River Conservancy regarding removal of this dam and they offered to provide the necessary technical and financial assistance to properly remove the dam. Unless you can find other sources of money to renovate this dam, NRCS recommends the removal of the Dam through the Connecticut River Conservancy.

If you have any question regarding the attached/enclosed PIFR or the project in general, please contact Bob Thompson, State Conservation Engineer (802)951-6796 x232.



TRAVIS L. THOMASON
State Conservationist

Attachment/Enclosure: Preliminary Investigation Findings Report, Williams Dam, Londonderry, VT

Natural Resources Conservation Service
(NRCS) Watershed Operations Program
*Preliminary Investigation
Findings Report (PIFR)*

Williams Dam, Londonderry, VT

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Abbreviations

BCC	Birds of Conservation Concern
CFS	Cubic Feet Per Second
D&K	DuBois & King Engineering
EA	Environmental Assessment
EE	Environmental Evaluation
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
MOU	Memorandum of Understanding
N/A	Not Applicable
NRCS	Natural Resources Conservation Service
NWPM	National Watershed Program Manual
PIFR	Preliminary Investigation Feasibility Report
STC	State Conservationist
SWAPA	Soil, Water, Air, Plants, and Animals
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VT DSP	Vermont Dam Safety Program
VTDEC	Vermont Department of Environmental Conservation
VTFWD	Vermont Fish and Wildlife Department
WSP	WSP USA Environment & Infrastructure

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Summary

The Town of Londonderry, Vermont (Londonderry) is requesting assistance with the Williams Dam Rehabilitation Project. The project area is within Londonderry and includes the dam site and the reaches of the West River upstream and downstream of the dam structure. Londonderry will be involved with the project through its completion and will take responsibility for operation and maintenance of the project area.

The primary PL-566 project purpose is flood prevention, with secondary purposes including public recreation, public fish and wildlife, and maintenance of a water supply for fire protection. Williams Dam is currently in poor condition. The State of Vermont Dam Safety Program (VT DSP) has required action from Londonderry to address the dam safety deficiencies by either replacing, rehabilitating, or removing Williams Dam. In 2022, VT DSP increased the hazard classification of Williams Dam from low to significant hazard. The flooding that would result from the failure of Williams Dam is a threat to the public health and safety of Londonderry.

Londonderry has primary interest in rehabilitating or rebuilding Williams Dam for the aesthetic and socio-economic value it provides. The impoundment also provides recreational opportunities and is a source of water for firefighting.

NRCS considered four alternatives: 1) a “No Action/Future Without Project” alternative, 2) a structural alternative, 3) a non-structural alternative, and 4) a pie-in-the-sky alternative. Each alternative is briefly summarized below:

1. Alternative 1 represents the “No Action/Future Without Project” alternative. This alternative would postpone the project indefinitely while other sources of funding were secured. During the delay, the public will remain at risk of the flooding associated with the failure of Williams Dam. Temporary rehabilitation measures or dam removal may be required to address dam safety deficiencies and reduce the public risk.
2. Alternative 2 represents a structural solution. This alternative includes demolition and removal of the existing dam and construction of a new concrete gravity dam approximately 20 feet downstream of the existing structure. The new dam will also be a run-of-the-river dam and consist of a principal spillway and a low-level outlet structure. The crest elevation of the new dam will be the same as the existing dam and the extents of the impoundment will be unchanged. Approximately 66 feet of the length of the dam crest will serve as a straight-drop overfall principal spillway to maintain the aesthetics of the existing dam.
3. Alternative 3 represents a non-structural solution. This concept includes purchasing 11 structures located in the area inundated by a breach of Williams Dam, demolishing and removing the structures and utilities, and rezoning the land areas to prevent future development. This concept addresses human safety but does not address the deficiencies at Williams Dam.
4. Alternative 4 represents a “pie-in-the-sky” solution. This alternative includes the replacement of Williams Dam as described in Alternative 2 and the construction of floodwalls on both sides of the West River floodplain boundary upstream of Williams Dam to provide 10-year flood protection to Londonderry. The floodwalls will have an average height of approximately 10 feet and a total length of approximately 8,500 feet. Additionally, approximately 2,000 feet of Route 100 will be raised an average of 6 feet to intersect the required crest elevation of the western floodwall and contain 10-year flood flows in the West River floodplain.

Applicable Agency Authority and Authorized Purposes

The table below provides documentation that the project is eligible for federal assistance and will meet statutory requirements.

Describe the potential project watershed area; how does the area meet the requirements outlined in NRCS's National Watershed Program Manual [22].									
Response: The potential project watershed is primarily comprised of northern hardwood forest, comprised of steep slopes, and contains West River. The watershed area is sparsely populated.									
Will the project area exceed 250,000 acres in size? ^{1,2}								☐ YES	☒ NO
If over 250,000 acres will it be divided into sub-watersheds in one plan?								☐ YES	☐ NO
Potential Project Area Size: 100 acres									
Will any single structure provide more than 12,500 acre-feet of floodwater detention capacity, or have a 25,000 acre-feet of total capacity?								☐ YES ³	☒ NO
How many recreational developments will be included in the project area?									
• One development in a project area less than 75,000 acres								☒ YES	☐ NO
• Two developments in a project area between 75,000 and 150,000 acres								☐ YES	☒ NO
• Three developments in a project area greater than 150,000 acres								☐ YES	☒ NO
Which authorized purposes will the project address? (Indicate only one purpose as primary):									
								Primary	Other
• Flood prevention								☒	☐
• Watershed Protection								☐	☐
• Public Recreation								☐	☒
• Public Fish and Wildlife								☐	☒
• Agricultural Water Management								☐	☐
• Municipal or Industrial Water Supply								☐	☒
• Water Quality Management								☐	☐
Will the project produce substantial benefits to the general public, to communities, and to groups of landowners?								☒ YES	☐ NO ³
Can the project be installed by individual or collective landowners under alternative cost-sharing assistance?								☐ YES ³	☒ NO
Will the project have strong local citizen and sponsor support through agreements to obtain land rights, permits, contribute the local cost of construction, and carry out operation and maintenance.								☒ YES	☐ NO ³
Will the project take place in a Special Designated Area? (if yes, check applicable area below.)								YES	☒ NO
Appalachia	☐	Delaware River Basin	☐	Susquehanna River Basin	☐	Tennessee Valley	☐		

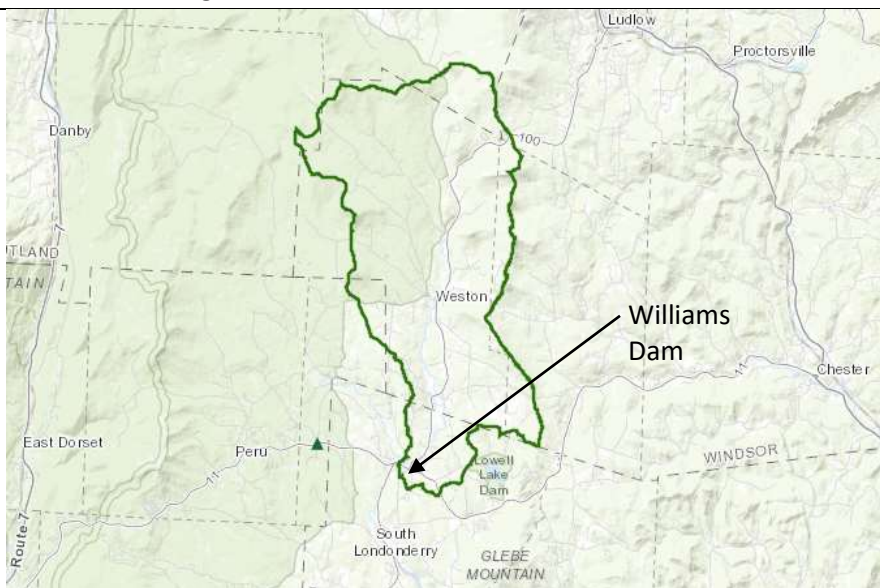
1- For specific appropriations, the 250,000 acres is waived except for watershed projects with the flood prevention purpose.

2- Watersheds exceeding 250,000 acres can be broken up into smaller sub-watersheds.

3- The project will not meet the statutory requirements.

Potential for 20 Percent Agricultural (Rural) Benefits

The Williams Dam Rehabilitation Project will have the authorized purpose of flood prevention. The other identified purposes of the project include public recreation, public fish and wildlife, and maintenance of a water supply for fire protection. The loss of the Williams Dam impoundment would have a negative impact to the local community and visitors to the area. The Town of Londonderry, Vermont had a recorded population of 180 during the 2020 U.S. census and qualifies as a rural area. Rural benefits associated with the project are estimated to include community recreation and wildlife habitat.

Project Overview							
Proposed Project Name	Description: Williams Dam Rehabilitation Project						
State	Vermont						
County/Parish	Windham						
Congressional District	Vermont: At-large						
USGS Hydrologic Unit Code (HUC) and Watershed Name	 Map of the Headwaters West River Watershed, Windham County, VT Williams Dam is located within the Headwaters West River Watershed (010801070301), which is a sub-watershed to the Headwaters West River Watershed (0108010703). <table><tr><td>Headwaters West River</td><td>010801070301</td><td>40.8 sq. mi.</td></tr><tr><td>Total Watershed Drainage Area</td><td></td><td>26,122 acres</td></tr></table>	Headwaters West River	010801070301	40.8 sq. mi.	Total Watershed Drainage Area		26,122 acres
Headwaters West River	010801070301	40.8 sq. mi.					
Total Watershed Drainage Area		26,122 acres					
General Coordinates of the Watershed	Approximate center of watershed: 43°14'48"N, 72°50'06"W						

Project Setting	Williams Dam is located in Windham County, Vermont, about 18 miles west of Rockingham, VT. Newfane is the County seat of Windham County. Williams Dam is a run-of-the-river dam constructed across West River consisting of a stone masonry primary spillway with a concrete cap and low-level outlet at the right abutment. The dam was originally constructed in 1883 for a machine shop. The dam is approximately 13 feet in height and impounds approximately 24.2 acre-feet of water at the principal spillway crest elevation [2]. The watershed is situated on the Green Mountain massif. Regional bedrock primarily consists of Middle and Early Mesoproterozoic era biotite-quartz-plagioclase and other aluminous schist and gneisses of the Washington Genesis and Wilcox formations and related rocks. Middle and early Mesoproterozoic South Londonderry Igneous Suit and Stratton Mountain Intrusive Suit gneisses are also commonly observed within the watershed. Bedrock transitions to Lower Cambrian and Neoproterozoic Tyson Formation near the western and eastern edges of the watershed. A thrust fault is mapped approximately at the location of Williams Dam; however, the fault is inactive [32,33]. South-central Vermont has a cold and temperate climate. High temperatures in the area in July average in the 70s °F; high temperatures in January average in the 20s °F, while the average low is around 10 °F. The majority of the West River Basin upstream of Williams Dam is undeveloped and composed of northern hardwood forest. Residential houses are sparsely spaced along and adjacent to West River upstream of the dam. The Town of Weston is located approximately 5 miles north of the dam along West River.
Potential Project Area - Size	The West River Basin upstream of Williams Dam has an area of approximately 40.8 square miles (about 26,122 acres) and lies within the Headwaters of West River Watershed (HUC 010801070301).

Resource Information	
Soils	A variety of soil types have been identified around the project site. Mundal fine sandy loam is very stony, moderately to well drained, and is found on 8 to 15 percent slopes. Houghtonville fine sandy loam is very stony, well-drained, and found on 8 to 15 percent slopes. Worden loam contains boulders, is poorly drained, and is found on 8 to 15 percent slopes. Colton gravelly sandy loam is excessively drained and found on 8 to 15 percent slopes. Ondoawa fine sandy loam is well drained, found on 0 to 3 percent slopes, and is occasionally flooded. Rumney fine sandy loam is poorly drained and found on 0 to 3 percent slopes. The sediment built up behind the Williams dam has been sampled in two locations for contaminants. Samples were collected upstream of the dam, tested, and then compared to the “Vermont Watershed Management Division’s Recommended Guidelines for Evaluating Contaminant Concentrations in Freshwater Sediments and the Potential for those Contaminant Concentrations to Adversely Affect Aquatic Biota”. The samples did not reflect the presence of contaminants above Vermont thresholds. [1,2]
Water	The Williams Dam is a run-of-the-river dam that obstructs the West River in Londonderry, VT. The drainage area to the dam is 40.8 square miles. The basin gets an average of 53.6 inches of rain per year. The inundation area at the principal spillway crest elevation is 9.3 surface acres with a total storage volume of 24.2 acre-feet [2]. The total storage volume at the dam crest elevation is 97.1 acre-feet [2]. The maximum discharge at the dam is estimated to be 1600 cubic feet per second (cfs). The hazard class of this dam was upgraded to significant in 2022. [3,4]
Air	Based on 2021 data, air quality in the region is good 84.7 percent of the time, moderate 15.0 percent of the time, and unhealthy for sensitive groups 0.3 percent of the time. [5]
Plants	American Ginseng, Northeastern Bulrush, Butternut, Ornamental Hemlocks, and Spotted Wintergreens are likely found in the area. No endangered plant species are known to be in the area. Vermont has 71 state-endangered and 93 state-threatened plants. A complete list of these species can be found through the Vermont Natural Heritage Inventory and Vermont Fish and Wildlife Department. These species are protected under Vermont’s Endangered Species Law (10 V.S.A. Chap. 123). These listed plant species should continue to be considered and monitored throughout the project. [11,29]

Animals	Three other dams are located downstream of the Williams Dam before the West River discharges into the Connecticut River. These dams inhibit fish passage from the Connecticut River to the project area. Fish are present in the project area but are generally confined between the reaches of rivers between dams. The project area includes Brook Trout Waters and used to be a prime area for Rainbow Trout fishing. Mussel species and Wood Turtles are also found upstream of the dam. Additionally, a deer wintering area is located 1.1 miles away from the project site. The dam is located in an urbanized area of a small town and is not expected to have a lot of wildlife habitat in the direct vicinity. Other animals that could likely be in the surrounding area and are not endangered, or threatened species include West Virginia Whites and the Common Loon. The forested area on the left overbanks 0.4 miles downstream of the dam is the most likely area for wildlife activity in close proximity to the project site. [6, 29]

Energy	Windham county has eight powerplants that supply around 43,300 people with power. Of the 8 power plants, 5 are hydroelectric power plants, 2 are nuclear power plants, and 1 is a solar power plant. Londonderry is located in Windham County but does not have any power plants within its borders. [10]
Human	Based on the census of 2020, the population of Londonderry, VT is 180 people. Ninety-four percent of people identify as white, four percent as multi-ethnic, one percent as Asian, and one percent as another race. One and a half percent of these people are Hispanic or Latino people of any race. Twelve percent of the population in Londonderry is over the age of 65, and the median age is 27.8 years old. The employment rate is 65.2 percent, and the median household income is \$28,125. [9] Route 11 (Main St) is a major road in the area. Construction at the dam could increase traffic on this road and Veteran's Bridge (the Route 11 Bridge over the West River). Additionally, the left overbank adjacent to the dam consists of residential houses. Noise from the project would likely cause a temporary disturbance to the folks who live here during construction. Similarly, upstream of the dam on both overbanks are residential houses that could be within earshot of construction noise. Overhead power lines are located on Route 11 near the dam. These power lines would need to be considered when determining site access. The impounded water behind the dam (known as Mill Pond) was formerly a popular recreation spot. It was used by residents for fishing, swimming, and paddling. After years of sediment deposition behind the dam, Mill Pond has nearly lost all of its recreational use. A project at the Williams Dam would likely include dredging and could restore many of these recreational activities in Mill Pond. Additional water accesses would potentially be included in the project. A dry hydrant used for fire protection is located upstream of the dam in Mill Pond. It is very important that the functionality of this hydrant be maintained. This dry hydrant is currently used by the Londonderry fire department and would likely be used by the South Londonderry fire department if the intake was cleared of sediment.

Resources of Special Concern	
Clean Water Act	Vermont started the National Clean Watershed Needs Survey in March of 2022. The survey is scheduled to be completed in February 2023. The state will work with the Environmental Protection Agency (EPA) to complete this survey and evaluate what needs to be done to comply with the Clean Water Act. After this survey is completed, the results should be scanned for any information pertaining to the West River. Starting three miles downstream of the dam, a 1.5-mile reach of the West River has been identified as having elevated bacteria levels. This section of river has been placed on the 303(d) list as an impaired river. Based on previous studies, this is a point source issue within that 1.5-mile reach of the West River. In 2011 a (TMDL) for E. Coli was established for this reach of the river. The TMDLs are 33, 77, and 126 organisms/100 ml for VT Class A, VT Class B, and the National Recommended Water Quality Criteria respectfully. [12,13] The Vermont Department of Environmental Conservation - Rivers Program requires certain permits related to river work. For alternatives that involve construction or excavation in the river, are exempt from municipal regulation in flood hazard areas and river corridors, or involve water withdrawals, dam removal, or hydroelectric power, permits may be required. [15] For project alternatives that require earth disturbance within or adjacent to waterways, a Section 404 permit will need to be acquired before beginning construction. [14]
Clean Air Act	Air quality is generally good in the proposed project area. Air quality only reaches moderate to unhealthy levels for sensitive groups a few days out of the year. The primary source of air pollution associated with the proposed project area is likely traffic on nearby roadways. Activities associated with the proposed project are unlikely to require a Title V permit. [5]
Coastal Zone Management	The West River drains into the Connecticut River and eventually into Long Island Sound. Long Island Sound has a Coastal Management Program, but due to the scale of the project and its distance from the mouth of the Connecticut River, this project will not likely have an impact on this coastal zone. [16]
Coral Reefs	N/A

Cultural Resources	Historically, Londonderry was occupied by Native American tribes. Some archeological sites have been found in the western and eastern valleys. Native American relics have been found close to Under Mountain Road in Londonderry. Those artifacts are now located in the Londonderry Historic Society Museum. Three other areas have been archeologically studied in Londonderry, and no archeologically significant findings were made in any of the three. Even though this area has already experienced construction and ground disturbance, this historic background should still be considered during the project. [18] The area around the project is not a historic zoning district. Additionally, there are no identified registered historic places in the area. The Vermont Division for Historic Preservation should be contacted during the planning process. [19, 20]
Endangered & Threatened Species	Northern Long-eared Bats may potentially be located near or within the proposed project area, and this species is currently listed as threatened under the U.S. Endangered Species Act. Monarch Butterflies may also be located near or within the proposed project area and are currently considered a candidate species for protection under the U.S. Endangered Species Act. The Little Brown Bat and the Tricolored Bat could also be in this area and are listed state endangered species. The Yellow-banded Bumble Bee is found in the area and is a listed state-threatened species. [17, 29] Vermont has 37 state-endangered and 16 state-threatened species. They are protected by the Vermont Protection of Endangered Species law (10 V.S.A. Chap. 123). These listed animal species should continue to be considered and monitored throughout the project.[11] According to local residents in Londonderry, there is at least one rare, threatened, or endangered mussel species upstream of the dam; however, this could not be confirmed based on available state Geographic Information System (GIS) data.
Environmental Justice	In 2009 the non-profit organization Neighborhood Connection was formed. This group provides underserved people in the area resources such as preventative health care, health education, and social services. The group helps individuals work through social service systems, counseling, and crisis management. [21] In Londonderry, minority groups represent 6 percent of the population. 19.6 percent and 12 percent of the population are under the age of 5 and over the age of 65, respectively. There are no individuals living below the poverty line in Londonderry.

Essential Fish Habitat	About nine miles downstream of the project site, the West River gains an Essential Fish Habitat designation. Given the distance downstream and the additional dam between the Williams Dam and the designated Essential Fish Habitat, this project is unlikely to have a significant impact on Essential Fish Habitat. [6, 22]
Floodplain Management	The project site is located within the 100-year Federal Emergency Management Agency (FEMA) Zone AE floodplain. Water surface elevation above sea level during a 100-year flood event is predicted to reach 1153 feet at the project site. Flooding over the banks of the West River occurs both upstream and downstream of the Williams Dam during this event. Residential and commercial structures on the right overbanks of the West River are within the 100-year floodplain near the project site. There has been historic flooding around the dam documented during large storms. For example, during Hurricane Irene in 2011, parking areas on the right overbank near the dam were under multiple feet of water following the storm. Hydraulic analysis by both FEMA and DuBois & King shows that the dam and the Route 11 bridge impede the flow of the West River, leading to increased flooding upstream. [23] Hydraulic analysis showed that structures upstream and downstream of the dam are impacted by the 10-year flood event, which has a peak flow of approximately 5,400 cfs [2]; inundation mapping for more frequent flood events is not available.
Invasive Species	No aquatic invasive species have been detected in the project area. The U.S. Department of Agriculture had warnings of Lanternflies, Spongy Moths, and the relationship of firewood and invasive pests in Vermont. The projects plans should consider these warnings and follow guidance to ensure no invasive species are introduced during the project. [24, 25]
Migratory Birds/Bald & Golden Eagle Protection Act	Bald Eagles are known to inhabit the proposed project area and typically breed between mid-October and the end of August. Other Birds of Conservation Concern (BCC) that may breed within the proposed project area include Black-billed Cuckoo, Bobolink, Canada Warbler, Chimney Swift, and Wood Thrush. Other birds in the BCC designation that could pass through the project area before or after breeding season include Cape May Warbler, Evening Grosbeak, and Olive-sided Flycatcher. [17]

Natural Areas	Two official Natural areas in Vermont are near the project. Terrible Mountain is 12 miles north of the site, and Jamaica State Park is 12 miles south. Neither of these designated Natural areas are close enough to the site to be affected. [30] Veterans Park is located next to the project site. This park has been proposed as a location for a historical plaque in the event that the dam is removed or replaced. This park will be affected during construction, but no negative long-term effects are expected. Lowell Lake State Park is the closest state park to the Williams Dam and is 3.3 miles away. This project will have no impact on this park. However, if the Route 11 bridge had to close for any reason during the project, people who live on the north side of the West River would need to take an alternate and less direct route to get to the State Park. The West River Trail is a popular natural area in Londonderry. The nearest trailhead to the project site is 4.4 miles downstream. This project is not expected to have any adverse impacts on this trail. [27]
Prime and Unique Farmlands	Soils that have been identified as prime Farmland and Farmland of statewide importance have been found in the area around the project site. Ondoawa fine sandy loam is considered Prime Farmland. Rumney fine sandy loam is considered Farmland of statewide importance. These soils are located along the right overbank of the West River upstream and downstream of the project site. Areas with these soils have already been developed, so this project is unlikely to have any further impact. [1]
Riparian Area	The riparian area downstream of the dam is mostly forest on the left overbank with some neighborhood development present. For about 500 feet downstream of the dam, Edge Hill Road runs parallel to the West River at a 30-foot offset on average until only forest is present in the riparian zone. The left overbank upstream of the dam is paralleled by Route 11 and Derry Woods Road. This imperviousness in the riparian zone could lead to increased stormwater runoff directly into the river. The right overbank of the West River is more developed both upstream and downstream of the dam. Urbanization is not overly intense and consists of homes, stores, and open space. Starting 2,600 feet upstream of the dam, the riparian area on both overbanks is made up mostly of wetlands and shrublands. [6]
Scenic Beauty	The Williams Dam has been in place since 1883. Due to its long history, members of the public have grown an emotional connection to it and the dam feels like part of the town. The aesthetics and sounds of the dam and water are important to many members of the community. However, not all residents share these views.

Wetlands	32.5 acres of wetlands are located beginning 1,400 feet upstream of the dam and extend upstream in the floodplain corridor. Wetlands are of great ecological importance, so considerations of these sensitive areas must be factored into design and construction. Wetlands near the construction area should be flagged by a qualified consultant and applicable construction permits should be secured through the Vermont Department of Environmental Conservation. A Wetland Permit is expected to be needed for this project. [6,8]
Wild and Scenic Rivers	The National Rivers Inventory lists the West River as having an outstandingly remarkable value in the recreational and scenic categories. The Williams Dam is located nearly in the middle of the 21 miles of the West River, holding this designation. However, the West River does not hold a federal Wild and Scenic River designation. [26]

Proposed Project Purpose and Need Statement

Description:

Project Purpose:

The purpose of the proposed project is to improve flood safety in the Town of Londonderry by addressing the dam safety deficiencies at Williams Dam.

Project Need:

The project is needed because the existing dam was identified as being in poor condition by VT DSP in their 2015 inspection. Flood inundation of surrounding structures begins with the 10-year flood event. The dam is on the state's list of priority dams for removal and must be rehabilitated or removed.

Background:

Recent evaluations of Williams Dam by VT DSP concluded that the hazard potential classification of Williams Dam be increased from Low to Significant. Williams Dam is a run-of-the-river dam constructed in the mid to late 1800s to provide power for a machine shop. The dam is stone masonry and concrete and is about 13-feet tall and 90-feet wide. The existing low-level outlet is a 6-foot diameter corrugated metal pipe that is delaminating from the concrete encasement. Pressurized seepage through the dam and significant flows through the left abutment were observed in the inspection.

Sediment build-up reduces upstream flood capacity for the town of Londonderry. Portions of Londonderry are currently within the 100-year floodplain. Recent hydraulic analysis showed that structures upstream and downstream of the dam are impacted by the 10-year flood event, and that the Route 11 bridge over West River, directly upstream of Williams Dam, constricts flood flows and overtops during the 50-year storm event. The dam hazard classification report by VT DSP concluded that five structures in Londonderry would be impacted by a sunny-day breach of Williams Dam.

The impounded portion of the West River upstream of the dam is used as a water source by the fire department. The significant amount of accumulated sediment currently impounded behind Williams Dam restricts the use of the dry hydrant.

Two wetland areas have been identified upstream of the dam.

Resource Concerns and Opportunities

Potential Effects of Proposed Alternatives on Soil, Water, Air, Plants, and Animals (SWAPA) + E + H Resources and Resources of Special Concern

Use: + - Positive Impact - - Negative Impact 0 - No Impact

Resource Concerns: SWAPA + Energy + Human				
	Alt 1 - No Action/ Future Without Project Description: The Sponsor does not implement flood protection measures using Federal funds. Temporary rehabilitation measures or dam removal may be required. Ratings below assume no action.	Alt 2 - Structural Description: Replace the existing dam with a new concrete dam.	Alt 3 - Nonstructural Description: Purchase 11 properties, demolish structures, and rezone land in the downstream breach inundation area.	Alt 4 - Pie in the Sky Description: Replace the dam, construct floodwalls on both sides of the floodplain upstream, raise Route 100.
Soil	0	-/0	-/+	-
Water	-	-/+	-/+	-/+
Air	0	-/0	-/0	-/0
Plants	0	-/0	-/+	-/0
Animals	-	-/0	-/+	-/0
Energy	0	0	0	0
Human	-	+	-	+
Resources of Special Concern				
Clean Air Act	0	-/0	-/0	-/0
Clean Water Act/Waters of the U.S.	0	-/0	-/0	-/0
Coastal Zone Management	0	0	0	0
Coral Reefs	0	0	0	0
Cultural Resources/Historic Properties	0	0	0	0
Endangered & Threatened Species	0	-/0	-/+	-/0
Environmental Justice	0	0	-/+	0
Essential Fish Habitat	0	0	0	0
Floodplain Management	0	+	+	+
Invasive Species	0	-/0	-/+	-/0
Migratory Birds/Bald and Golden Eagle Protection Act	0	-/0	-/0	-/0
Natural Areas	0	0	0	0

Prime and Unique Farmland	0	0	0	0
Riparian Area	0	-/0	+	-/0
Scenic Beauty	0	-/0	-/0	-
Wetlands	+	0	0	-
Wild and Scenic Rivers	0	0	0	0
* Dual ratings indicate temporary impacts and permanent impacts. Temporary impacts are listed first, and permanent impacts are listed second. For example, negative impacts to air quality will occur during construction, but after completion of construction there will be no impacts on air quality. These impacts would receive a rating of -/0.				

Opportunities

Potential opportunities for each of the resource concerns are summarized below.

Soil

There were no opportunities identified to improve soil conditions.

Water

Alternatives 2 and 4 provide an opportunity to improve water quality by removing sediment upstream of the existing dam.

Air

There were no opportunities identified to improve air quality.

Plants

There were no opportunities identified to improve plant life.

Animals

There may be an opportunity to work with Vermont Fish and Wildlife Department (VTFWD) to maintain the ponded area for recreational fishing and aquatic habitat. The opportunities are located on lands owned by the Sponsor.

Energy

There were no opportunities identified to provide energy. Hydropower was considered as a component of Alternative 4 but was eliminated because a hydropower facility at Williams Dam is not anticipated to provide substantial benefit.

Human

The local community is very supportive of Williams Dam and the efforts to rehabilitate or replace the dam. The local fire department also uses the ponded area behind the dam to supply a dry hydrant. Dam replacement alternatives may allow for recreational opportunities. The opportunities are located on lands owned by the Sponsor.

State, Tribal, Federal Stakeholder Engagement

NRCS and the Sponsor, the Town of Londonderry, met virtually on September 15, 2022, to discuss the proposed PL-566 watershed project. The group discussed the current state of the dam, the dry hydrant, the public attachment to the dam, and potential alternatives for the project. On October 20, 2022 representatives of WSP USA Environment & Infrastructure (WSP), NRCS, and the Town of Londonderry met at the Williams Dam for a site visit. The group discussed historical and current dam conditions, including flooding history, dry hydrant usage, ecology, recreation, resident opinions, and proposed project alternatives. Town of Londonderry officials reiterated the importance of analyzing all possible alternatives to perform proper due diligence on behalf of the Londonderry community.

NRCS and the Sponsor will schedule a future meeting with the U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service (USFWS), VTFWD, and/or Vermont Department of Environmental Conservation (VTDEC), the Vermont Division for Historic Preservation as well as any other local, state, and/or federal agencies that may have an interest in this proposed project to recount the discussion of the September 15 meeting and to provide each agency/office represented the opportunity to ask questions about the potential project and to discuss any perceived controversies surrounding the project from their organization's perspective.

Potential Alternatives

General Discussion of Alternatives

Alternatives were evaluated to address the dam safety deficiencies noted by VT DSP in 2015. Only structural deficiencies were identified in this inspection because a detailed hydrologic study has not been performed for Williams Dam, and hydrologic and hydraulic criteria for the dam has not been established. The deficiencies are summarized as follows:

- The concrete sluiceway is deteriorated. Pressurized water flows through the structure and below the outlet pipe.
- Water flows through the main section of the dam and dam face.
- Water flows through and erodes the left abutment.
- The outlet stem is damaged, and the operator cannot drain the impoundment in an emergency.

NRCS TR210-60 requirements were considered in the development of these alternatives, although the requirements are intended for earthen embankments with the primary purpose of flood control and are generally not applicable to Williams Dam. Williams Dam is a significant hazard structure according to NRCS criteria and would be required to safely route a 10-day-duration, 100-year precipitation hydrograph through the principal spillway. The principal spillway in NRCS criteria is generally an ungated pipe structure, but this structure is not applicable to Williams Dam and does not meet the Sponsor's purpose and need for the structure. The uncontrolled principal spillway structure at Williams Dam is a straight-drop overfall weir structure in the dam crest, and there is no auxiliary spillway structure at the dam. It is estimated that the flow over the Williams Dam principal spillway structure is restricted by the low chord of the Route 11 bridge over West River, located approximately 15 feet upstream of the existing Williams Dam. FEMA FIS 100-year floodplain modeling shows that the 100-year flows exit the stream channel, flow over and around the Route 11 bridge and Williams Dam, and cause flooding in surrounding areas [2]. Flood mapping performed by D&K in 2022 confirms that flow is restricted and flooding occurs for the 100-year event even when Williams Dam is removed. The model information from FEMA and Dubois & King Inc. (D&K) confirm that the dam crest elevation required to safely attenuate and pass the 100-year storm event through a principal spillway pipe is unachievable because of topographic restraints in the West River channel. Williams Dam generally is not compatible with NRCS TR-210-60 requirements and, even with rehabilitation, is unlikely to meet the requirements.

Williams Dam was evaluated in these alternatives primarily based on dam engineering best practices and the criteria suggested for the dam in the VT DSP hazard classification, which include the following considerations:

- Stability for ice loading conditions
- Stability for the design controlling storm event identified by VT DSP, which approximates the 100-year storm event
- Industry-standard engineering design for concrete gravity dams
- Ability to lower the water surface elevation in the impoundment through a low-level outlet structure

Alternative 1:

Alternative 1 would postpone the project indefinitely while other sources of funding were secured. During the delay, the public will remain at risk of the flooding associated with the failure of Williams Dam. Temporary rehabilitation measures or dam removal may be required to address dam safety deficiencies and reduce public risk.

Alternative 2:

Alternative 2 represents a structural solution. This alternative includes demolition and removal of the existing dam and construction of a new concrete gravity dam approximately 20 feet downstream of the existing structure. The new dam will also be a run-of-the-river dam and consist of a principal spillway weir and a low-level outlet structure. The spillway crest elevation of the new dam will be the same as the existing dam and the extents of the impoundment will be unchanged.

The maximum section of the dam will be approximately 13 feet high. The total dam crest length will be approximately 140 feet, consisting of a 66-foot-long principal spillway and abutments. The principal spillway weir will be a straight-drop overfall weir in the dam crest with a control elevation of 1,142 feet and provide similar flow appearance as the existing structure. The abutments will have a top elevation of 1,149 feet and connect with bedrock. The low-level outlet works will consist of a 30-inch-diameter steel pipe, trash rack, manually operated slide gate. Access to the hand wheel will be provided from the top of the right abutment. The dam will be founded on bedrock and key into component bedrock at both abutments, which is shallow according to available inspection data [31]. **A properly designed concrete gravity dam with these characteristics will sustain being fully overtopped by extreme storm events without failure.**

The construction of the new gravity dam will address the dam safety deficiencies identified by VT DSP by providing a new structure that is stable during normal and extreme loading events and allows the safe evacuation of the impoundment through a low-level outlet structure.

In 2021, the Sponsor retained D&K to evaluate the existing condition of the dam and analyze different alternatives for addressing dam deficiencies, one of which was replacing the dam. **Criteria used in developing the replacement design was not documented in the report, but the design generally consisted of a vertical concrete wall similar to the existing dam rather than a structure with a traditional gravity dam cross-section. The design evaluated in this report is similar in functionality to the structure proposed in the D&K report, but instead considers a structure with a traditional gravity dam cross-section to conservatively account for stability and feasibility at this stage of planning.** In further levels of design, the structure proposed by D&K or other configurations could be evaluated to provide adequate stability, which could reduce cost.

The use of the existing dry hydrant is currently restricted by the accumulation of sediment upstream of the existing Williams Dam. Alternative 2 also includes the dredging of sediment to increase hydraulic capacity in the impoundment and installation of a new dry hydrant adjacent to the new dam that has an intake located behind the trash rack for the low-level outlet.

Alternative 3:

Alternative 3 represents a non-structural solution. This concept includes purchasing 11 structures located in the area inundated by a breach of Williams Dam, demolishing and removing the structures and utilities, and rezoning the land areas to prevent future development. The 11 impacted structures were identified in the controlling failure scenario for the Williams Dam hazard classification [2]. This concept addresses human safety but does not address the deficiencies at Williams Dam.

Alternative 4:

Alternative 4 represents a “pie-in-the-sky” solution. **This alternative includes the replacement of Williams Dam as described in Alternative 2 and the construction of floodwalls on both sides of the West River floodplain boundary upstream of Williams Dam to provide 10-year flood protection to Londonderry. The floodwalls will have an average height of approximately 10 feet above existing ground and a total length of approximately 8,500 feet. The floodwalls would consist of sheet pile (below ground) and concrete (above ground). The sheet pile would be about 15 feet deep to manage under-seepage and maintain seepage stability. Additionally, approximately 2,000 feet of Vermont Route 100 will be raised an average of 6 feet to**

intersect the required crest elevation of the western floodwall and contain 10-year flood flows in the West River floodplain. The floodwalls and raised road will extend north of Williams Dam to approximately the intersection of Route 100 and Evergreen Lane.

Alternatives	Possible Positive Impacts and Effects	Possible Adverse Impacts and Effects
Alternative 1 - No Action/Future Without Project. Description: The Sponsor does not implement flood protection measures using Federal funds. Estimated Cost: \$75,000	• No Federal cost.	• Condition of the dam will continue to deteriorate over time. • Sponsor will still need to invest funds to temporarily address deficiencies and lower water level. • Likely need to lower the pond water level to reduce risk. Reduction in recreational area. Lower water level will negatively impact existing wetlands. • Lower water and impounded sediment will continue to negatively impact flood fighting.
Alternative 2 - Structural. Description: Replace the existing dam with a new concrete dam. Estimated Cost: \$3,900,000	• Reduces the likelihood of dam failure and addresses dam breach flooding risk. • Maintains impoundment behind reservoir for recreation, habitat (including possible Class II wetlands), and dry hydrant tap for the Town of Londonderry. • Quasi-preserves aesthetics of the existing dam. • Improved ability to manage and release sediment impounded by Williams Dam.	• Temporary damage to the environment during construction. • Increased heavy traffic on area roadways during construction. • Historical and aesthetic significance of original Williams Dam is lost. • Does not provide additional flood protection beyond that provided by a structurally intact Williams Dam.

Alternative 3 - Non-Structural. Description: Purchase properties, demolish structures, and rezone land in the downstream breach inundation area. Estimated Cost: \$7,200,000	• Prevents damage to structures and reduces threat to public health and safety. • Potential for zoning to include recreational areas and trails.	• Capital cost that doesn't benefit residents. • Williams Dam may fail and the historical and aesthetic significance will be lost. • Negative environmental impacts associated with a breach and uncontrolled release of sediment downstream. • Relocating residents and businesses that may not want to move.
Alternative 4 - Pie in the Sky, if money was no object, all rules, regulations and permitting were approved (may be an action outside of NRCS program authority). Description: Replace the dam, construct floodwalls on both sides of the floodplain upstream, raise Route 100 Estimated Cost: \$30,600,000	• Reduces the likelihood of dam failure. • Maintains impoundment behind reservoir for recreation, habitat (including possible Class II wetlands), and dry hydrant tap for the Londonderry. • Quasi-preserves aesthetics of the existing dam. • Improved ability to manage and release sediment impounded by Williams Dam. • Provides 10-year flood protection for approximately 25 structures upstream of Williams Dam.	• Temporary damage to the environment during construction. • Increased heavy traffic on area roadways during construction. • Historical and aesthetic significance of original Williams Dam is lost. • Londonderry will be required to fund maintenance of the floodwalls. • The floodwall will have a negative visual impact by blocking the view of West River.

Facilitating Factors

Facilitating factors are those which ease implementation of the alternative and/or which improve the desired result.

Facilitating factors of Alternative 1:

- The alternative has the lowest capital cost of the evaluated alternatives.
- Removal of the dam addresses the dam safety deficiencies that have been identified by VT DSP.

Facilitating factors of Alternative 2:

- The proposed project has support from local residents.
- The proposed project addresses the dam safety deficiencies that have been identified by VT DSP.
- The proposed dam will have a low-level outlet works to allow evacuation of the impoundment and improve flood safety.
- The Sponsor will regain the ability to use the impoundment as a water supply for fire protection.
- The Sponsor will be responsible for the operation and maintenance of the new facility.

Facilitating factors of Alternative 3:

- The flood risk is reduced in Londonderry by vacating the breach inundation area.
- The rezoning of the land could include recreational areas and trails.

Facilitating factors of Alternative 4:

- The proposed project addresses the dam safety deficiencies that have been identified by VT DSP.
- The proposed dam will have a low-level outlet works to allow evacuation of the impoundment and improve flood safety.
- The Sponsor will regain the ability to use the impoundment as a water supply for fire protection.
- The Sponsor will be responsible for the operation and maintenance of the new dam facility and maintenance of the floodwalls.
- Provides 10-year flood protection for approximately 25 structures upstream of Williams Dam.

Obstructing Factors

Obstructing factors defined as those that make it more difficult for an alternative to happen and/or decreases the ability to attain a specified goal.

Obstructing factors for Alternative 1 include:

- Temporary rehabilitation measures will be difficult to implement in the existing structure and will not fully address dam safety deficiencies.
- There will be strong opposition from local residents to the removal of Williams Dam.
- VT DSP may require the lowering of the water surface elevation of the impoundment to reduce risk, which will negatively affect portions of the existing wetlands and public utility of the pond.
- The Sponsor will remain unable to use the impoundment as a water supply for fire protection.
- Removal of Williams Dam would not significantly reduce flooding in Londonderry.

Obstructing factors for Alternative 2 include:

- Construction of this alternative will have short-term impacts to the environment in areas adjacent to the dam.
- Construction staging area adjacent to the dam site is minimal.
- It is unlikely that the proposed dam structure will conform with NRCS TR210-60 requirements.
- The historical and aesthetic significance of the original Williams Dam will be lost.
- Construction will require a Section 404 Permit.
- Portions of Londonderry will still flood at approximately the 10-year event.

Obstructing factors for Alternative 3 include:

- There will be strong opposition from the community.
- VT DSP may require the lowering of the water surface elevation of the impoundment to reduce risk, which will negatively affect portions of the existing wetlands and public utility of the pond.
- The Sponsor will remain unable to use the impoundment as a water supply for fire protection.

Obstructing factors for Alternative 4 include:

- Construction of this alternative will have short-term impacts to the environment in areas adjacent to the dam.
- Construction staging area adjacent to the dam site is minimal.
- Route 100 will require closure during construction and disrupt traffic patterns.
- The construction of the floodwalls will have temporary environmental impacts during construction and likely some permanent environmental impacts.
- It is unlikely that the proposed dam structure will conform with NRCS TR210-60 requirements.
- The historical and aesthetic significance of the original Williams Dam will be lost.
- Portions of Londonderry will still flood at approximately the 10-year event.
- This alternative is more costly than Alternative 2 and the additional cost may not be justified by the benefits.
- The Sponsor may not be able to fund their cost-share portion.
- Increased maintenance costs for the floodwalls.
- Construction will require a Section 404 Permit.
- Permitting of the floodwall may be challenging because of the likely impact to wetlands.

Environmental Document

A potentially viable alternative for the proposed watershed project is to replace the existing significant hazard Williams Dam (Alternative 2). The existing Williams Dam hazard classification was revised from low to significant in 2022. By replacing the existing dam with a new structure, the likelihood of dam failure will drop significantly. Replacing the dam will likely improve the functionality of the dry hydrant and maintain the visual and audible aesthetic of the dam that is enjoyed by residents of the community. However, this alternative will not improve the flood protection either upstream or downstream of the dam. At this point in the planning process, the interdisciplinary team has determined that the appropriate Plan - Environmental Document for Alternative 2 will likely be a Plan-Environmental Assessment (Plan-EA). However, if any of the NRCS categorical exclusions are deemed to apply to the proposed alternative then the Environmental Document for Alternative 2 would be a Plan Environmental Evaluation (Plan-EE).

Alternative 4 is very similar to Alternative 2 but includes construction of floodwalls on both sides of the West River floodplain boundary upstream of Williams Dam to provide 10-year flood protection to Londonderry. The floodwalls will have an average height of approximately 10 feet and a total length of approximately 8,500 feet. Additionally, approximately 2,000 feet of Route 100 will be raised an average of 6 feet to intersect the required crest elevation of the western floodwall and contain 10-year flood flows in the West River floodplain. This Alternative has been determined by the interdisciplinary team to require an Environmental Impact Statement.

Alternative 3 involves purchasing 11 structures located in the area inundated by a breach of Williams Dam, demolishing and removing the structures and utilities, and rezoning the land areas to prevent future development. This concept addresses human safety but does not address the deficiencies at Williams Dam. The interdisciplinary team has determined that a Plan-EA is the required environmental document for Alternative 3. **However, the proposed non-structural alternative may qualify for a categorical exclusion due to the removal of buildings from the breach inundation area of the dam.** The potentially applicable NRCS categorical exclusion under CFR § 650.6 is listed as the following: (6) Removing or relocating residential, commercial, and other public and private buildings and associated structures constructed in the 100-year floodplain or within the breach inundation area of an existing dam or other flood control structure in order to restore natural hydrologic conditions of inundation or saturation, vegetation, or reduce hazards posed to public safety. With this categorical exclusion, the Environmental Document would be a Plan-EE assuming that the hazard classification of the existing dam does not justify a Plan-EA.

Alternative 1 represents a “No Action/Future Without Project” alternative. This alternative would postpone the project indefinitely while other sources of funding were secured. During the delay, the public will remain at risk of the flooding associated with the failure of Williams Dam. Temporary rehabilitation measures or dam removal may be required to address dam safety deficiencies. No Environmental Document would be needed until a course of action is selected.

Sponsors

<i>Sponsor Will:</i>	Assist in Planning	Land Rights / Eminent Doman	Local Cost Share	O/M Funds	Permits	Land Treatment	In-Kind MOU
The Town of Londonderry, VT	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Sponsor will:

- Assist in the locally led planning effort.
- Obtain needed land rights including the use of power of eminent domain, if necessary.
- Provide local cost-share funds and/or in-kind services to provide the required portion of total project costs.
- Provide funds for continuing operation and maintenance actions.
- Obtain required permits and approvals at sponsor cost:
- Provide leadership to help ensure adequate conservation land treatment measures are maintained on at least 50 percent of the watershed area above retention reservoirs.
- Before being credited with the value of any in-kind contribution for any in-kind services and/or acquisition of land rights, Sponsor will sign a Memorandum of Understanding (MOU) with NRCS.

Potential Cooperating Agencies

Agency	Contact Information	Type of Involvement
U.S. Army Corps of Engineers	USACE - Vermont Project Office 11 Lincoln Street, Room 210 Essex Junction, VT 05452 802-872-2893	Regulatory [X]
		Informed []
		Prepare permits or letters of permission document [X]
		Provide input []
U.S. Fish and Wildlife Service	11 Lincoln Street Essex Junction, VT 05452 802-879-1859	Regulatory []
		Informed [X]
		Prepare permits or letters of permission document []
		Provide input [X]
Vermont Department of Environmental Conservation - Watershed Management Division	1 National Life Drive Montpelier, VT 05602 anr.wsmd@vermont.gov 802-828-1115	Regulatory [X]
		Informed []
		Prepare permits or letters of permission document [X]
		Provide input []
Vermont Department of Environmental Conservation - Dam Safety Program	1 National Life Drive Montpelier, VT 05602 802-622-4093 or 802-490-6123	Regulatory [X]
		Informed []
		Prepare permits or letters of permission document [X]
		Provide input [X]
USDA Natural Resources Conservation Service	356 Mountain Drive, Suite 105 Colchester, VT 05446 802-951-6796	Regulatory []
		Informed [X]
		Prepare permits or letters of permission document []
		Provide input [X]
Vermont Agency of Commerce and Community Development - Office of Historic Preservation	1 National Life Drive Deane C. Davis Building, 6 th Floor Montpelier, VT 05620 802-828-3222	Regulatory []
		Informed [X]
		Prepare permits or letters of permission document []
		Provide input [X]
Vermont Agency of Natural Resources - Fish and Wildlife Department	1 National Life Drive Deane C. Davis Building, 2 nd Floor Montpelier, VT 05620 fwinformation@vermont.gov 802-828-1000	Regulatory []
		Informed [X]
		Prepare permits or letters of permission document []
		Provide input [X]

Potential Stakeholders

Stakeholder	Role	Resources	Contribution
Town of Londonderry, VT	Sponsor	Cost-share funds, administration for completion of Plan-EA, design, construction.	Complete Plan-EA with permits, scoping, public meetings, mailings, overall administration of project
USDA-Natural Resources Conservation Service	Lead Agency for Plan-EA, FA/TA, Reviews	Funding, technical reviews	Reviews for project alternatives, inventory needs, Plan-EA supplement
Army Corps of Engineers	404 Permit	Technical reviews, Wetlands-Waters of the US jurisdiction	Permitting, technical review
Vermont Department of Environmental Conservation - Watershed Management Division	Permits	Review for permit	Review for permit
Vermont Department of Environmental Conservation - Dam Safety Program	Dam permits, Water rights review	Technical review & coordination	Technical review, alternate evaluation
Vermont Agency of Commerce and Community Development - Office of Historic Preservation	Cultural review	Review of project APE	Permit for project APE, cultural resource inventory
US Fish and Wildlife Service	Review, Cooperating agency for Plan-EA	Alternatives, ecological inventories	Alternatives, environmental reviews
Vermont Agency of Natural Resources - Fish and Wildlife Department	Permits, Cooperating agency for Plan-EA	Review of Plan-EA	Review of Plan-EA
Principal Sponsors - Primary Stakeholders who will make financial and in-kind commitments to the project.	Regulatory - Entities involved in regulatory aspects of the project's implementation.		Keep Informed - Stakeholders who should be kept informed of the project's progress.

Notifications

If a preliminary investigation findings report is undertaken, the State Conservationist (STC) must notify in writing the Governors concerned, the U.S. Fish and Wildlife Service, the National Oceanic Atmospheric Administration National Marine Fisheries Service, the USACE, and all other Federal agencies concerned with a decision to initiate any survey or field investigation involving water resources development work and furnish them with appropriate information regarding the scope, nature, status, and results of such survey or investigation (Executive Order 10584 Section 3).

	Method and Date Notified
Governor	Letter - 12/15/2022
U.S. Fish and Wildlife Service	Letter - 12/15/2022, Email - 12/21/2022
National Oceanic Atmospheric Administration National Marine Fisheries Service	Letter - 12/15/2022, Email - 12/21/2022
U.S. Army Corps of Engineers	Letter - 12/15/2022, Email - 12/21/2022
Other Federal Agency:	
Other Federal Agency:	
Other Federal Agency:	

Estimated Project Implementation Timeline

Planning Start	5/1/2023
Planning End	5/5/2025
Design Start	11/3/2025
Design End	11/1/2027
Construction Start	5/1/2028
Construction End	11/5/2030

Recommendation

This preliminary investigation and feasibility report has been completed and submitted for approval to:
Robert Thompson.

By:

Name: Robert Huzjak

Title: Project Manager

Date: 12/13/22

Organization: RJH Consultants, Inc.

It has been determined that this potential PL-566 watershed operations project:

Does	Does Not	
☒	☐	meet the statutory acreage, volume/capacity of structure and recreational limit requirements;
☐	☒	meet the requirements of one or more Watershed Operations authorized purposes;
☒	☐	have the potential for a minimum of 20 percent agricultural, or rural, benefits;
☒	☐	have one or more viable alternatives;
☒	☐	have potential project sponsor(s) that meet and agree to all terms of responsibilities;
☐	☒	have apparent insurmountable obstacles.

Preparer Signature

Signature:



Date: 12/13/22

Robert Huzjak

State Watershed Operations
Program Manager

Signature:

Date: Dec. 14, 2022
Robert Thompson

State Technical Lead (SRC, SCE, Other)

Signature:

Date: Dec. 14, 2022
Robert Thompson

X	Not recommended for planning funding
	Accepted and recommended for Planning Funding

State Conservationist

Signature:

Date: Dec. 14, 2022
Travis Thomason

Glossary

Rural - All territories of a State that are not within the outer boundary of any city or town that has a population of 50,000 or more according to the latest decennial census of the United States ([2010 Census Urban and Rural Classification and Urban Area Criteria](#)). [390-506-M, 4th Ed., Apr 2014, National Watershed Program Manual (NWPM) Part 506.50 Glossary, MMM]

Watershed - A watershed area comprises all land and water within the confines of a drainage divide and must follow hydrologic boundaries. In the case of irrigation or salinity projects, the watershed boundary may be based on the irrigation problem area or subsurface hydrologic area, respectively. A watershed area may comprise the land and water of two or more minor drainageways that are separate tributaries to a stream, artificial waterway, lake, or tidal area. Areas from which water is brought in by diversion may be excluded from the watershed if these sources of water have no significant effect on the flood prevention and water management problems of the watershed area. The watershed area must include all direct tributary drainageways and lands from which, after project installation, water and sediment could adversely affect any proposed structural measure, such as an irrigation or drainage canal, floodway, or floodwater retarding structure, included in the plan. (390-506-M, 4th Ed., Apr 2014, NWPM Part 506.50 Glossary, TTT)

Watershed Program - The Watershed Program consists of activities carried out under the authority of Watershed Protection and Flood Prevention Act (Public Law 83-566, as amended), and the Flood Control Act of 1944 (Public Law 78-534 as amended). (390-506-M, 4th Ed., Apr 2014, NWPM Part 506.50 Glossary, UUU)

Appendix

- Sponsor Letter of Request
- WS-4 - PIFR Sponsor Declaration Forms
- Preliminary Environmental Evaluation (CPA 52)
- Preliminary Cost Estimates for Alternatives
- Hydraulic Evaluation for Alternative 4

Town of Londonderry, Vermont

100 Old School Street
South Londonderry, VT 05155
802-824-3356
www.londonderryvt.org

May 26, 2022

Via USPS and email to travis.thomason@usda.gov

Travis Thomason
State Conservationist
USDA - Natural Resources Conservation Service
356 Mountain View Drive
Colchester, VT 05446

Dear Mr. Thomason:

The Town of Londonderry, Vermont hereby requests NRCS Watershed Program planning assistance for a potential Public Law (PL) 566 project in Windham County, specifically the repair/rehabilitation of the Williams Dam on the West River (State of Vermont ID #115.01). The project, if approved, would improve flood control characteristics of the West River, a major tributary of the Connecticut River. The condition of the overall structure of the dam is considered to very poor, and in March 2022 the Vermont Dam Safety Program recharacterized the dam from a low to a significant hazard potential classification.

We are a unit of local government that owns the dam and as such has a legal interest in and responsibility for the watershed project proposed. We understand, as sponsors of a PL 566 planning effort, that our responsibilities will include:

- Assisting in the locally led planning effort,
- Contributing a share of the project costs, as determined by NRCS, by providing funds or eligible services necessary to undertake the activity,
- Before being credited with the value of any in-kind contributions for in-kind services and/or acquisition of land rights, Sponsor will sign a Memorandum of Understanding (MOU) with NRCS,
- Obtaining any necessary real property rights, by eminent domain, if necessary,
- Obtaining any needed water rights, and regulatory permits at the Sponsor's cost,
- Agreeing to provide for any required operation and maintenance of the completed measures.

We look forward to working with NRCS staff to complete a Preliminary Investigation Feasibility Report (PIFR) to provide reasonable assurance that a potential watershed project can be developed that addresses a PL 566 purpose and that there are no apparent insurmountable obstacles to the completion of that project.

In support of this request, I include a completed for SF-424, wetlands and watershed delineation boundary maps, and the narrative portion of a dam study recently prepared for the Town.

Please contact me for any additional information that you might need in assessing our request.

Sincerely,



Shane P. O'Keefe
Town Administrator
townadmin@londonderryvt.org
802-824-3356, ext.5

Cc: Tom Cavanagh, Selectboard Chair, Bob Thompson USDA-NRCS State Conservation Engineer

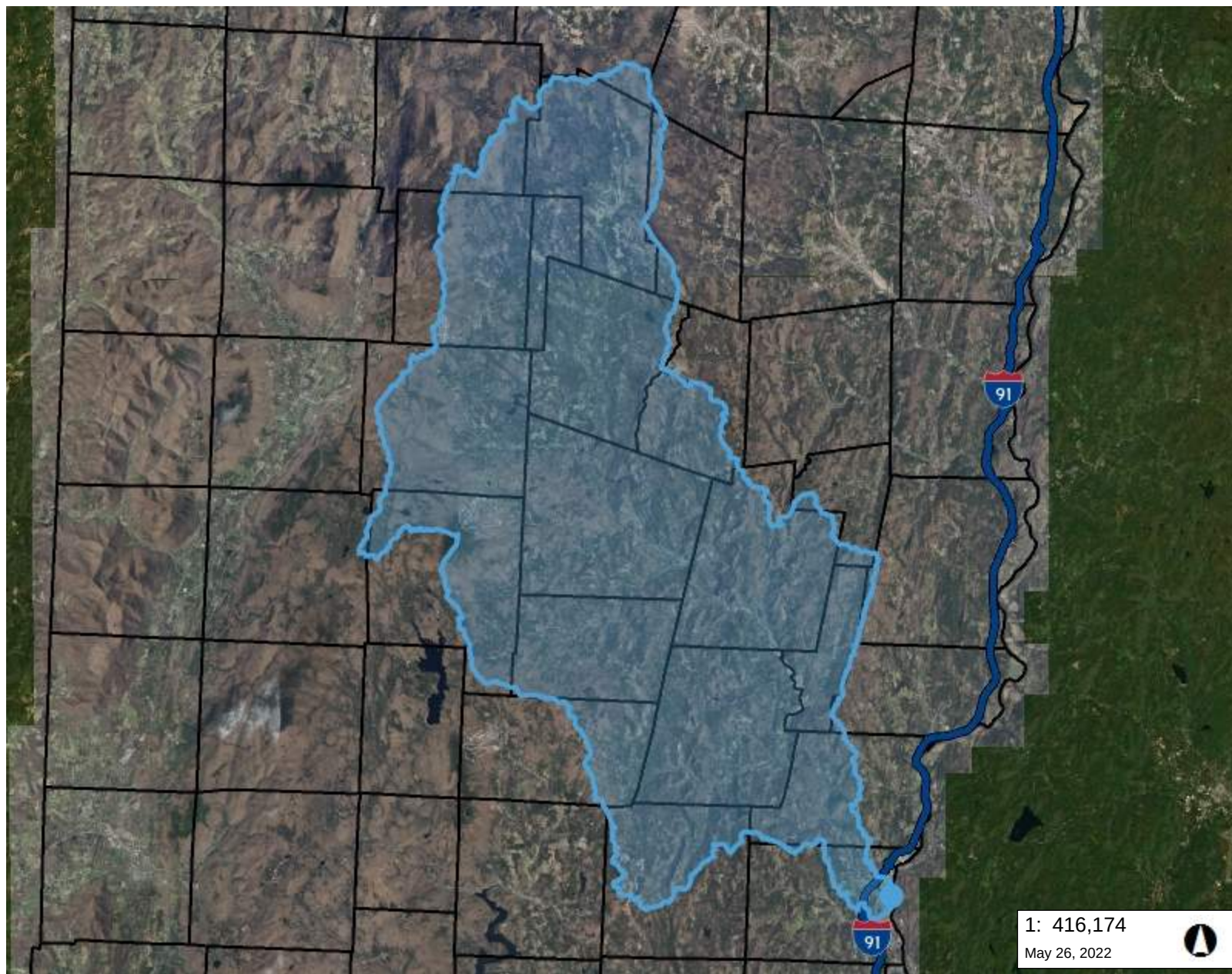


LEGEND

Roads

-  Interstate
-  US Highway; 1
-  State Highway
-  Town Highway (Class 1)
-  Town Highway (Class 2,3)
-  Town Highway (Class 4)
-  State Forest Trail
-  National Forest Trail
-  Legal Trail
-  Private Road/Driveway
-  Proposed Roads

-  Town Boundary
-  Watershed (HU10)



1: 416,174

May 26, 2022



NOTES

Map created using ANR's Natural Resources Atlas

21,142.0 0 10,571.00 21,142.0 Meters

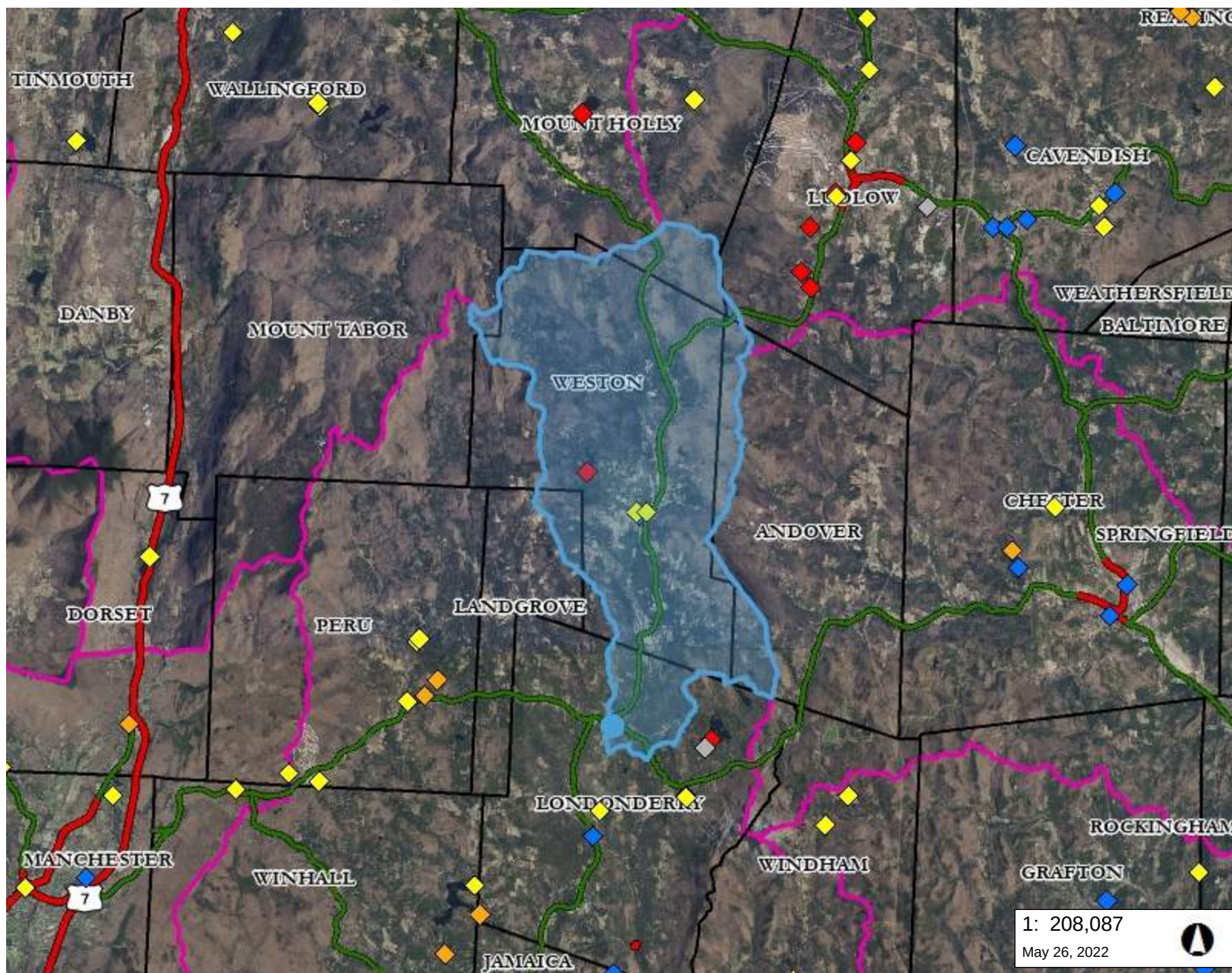
WGS_1984_Web_Mercator_Auxiliary_Sphere

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1" = 34681 Ft. 1cm = 4162 Meters

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LEGEND

Hazard Class

- ◆ High Hazard Potential
- ◆ Significant Hazard Potential
- ◆ Low Hazard Potential
- ◆ Undetermined Hazard Potential

Historical Dam Location

Roads

- Interstate
- US Highway; 1
- State Highway
- Town Highway (Class 1)
- Town Highway (Class 2,3)
- Town Highway (Class 4)
- State Forest Trail
- National Forest Trail
- Legal Trail
- Private Road/Driveway
- Proposed Roads

- Town Boundary
- Watershed (HU10)

1: 208,087

May 26, 2022



NOTES

Map created using ANR's Natural Resources Atlas

10,571.0 0 5,286.00 10,571.0 Meters

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1" = 17341 Ft. 1cm = 2081 Meters

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LEGEND

Wetland - VSWI

- Class 1 Wetland
- Class 2 Wetland
- Buffer

Wetlands Advisory Layer

River Corridors (Aug 27, 2019)

.5 - 2 sqmi.

.25-.5 sqmi.

Soils - Hydric

Parcels (standardized)

Roads

- Interstate
- US Highway; 1
- State Highway
- Town Highway (Class 1)
- Town Highway (Class 2,3)
- Town Highway (Class 4)
- State Forest Trail
- National Forest Trail
- Legal Trail
- Private Road/Driveway
- Proposed Roads

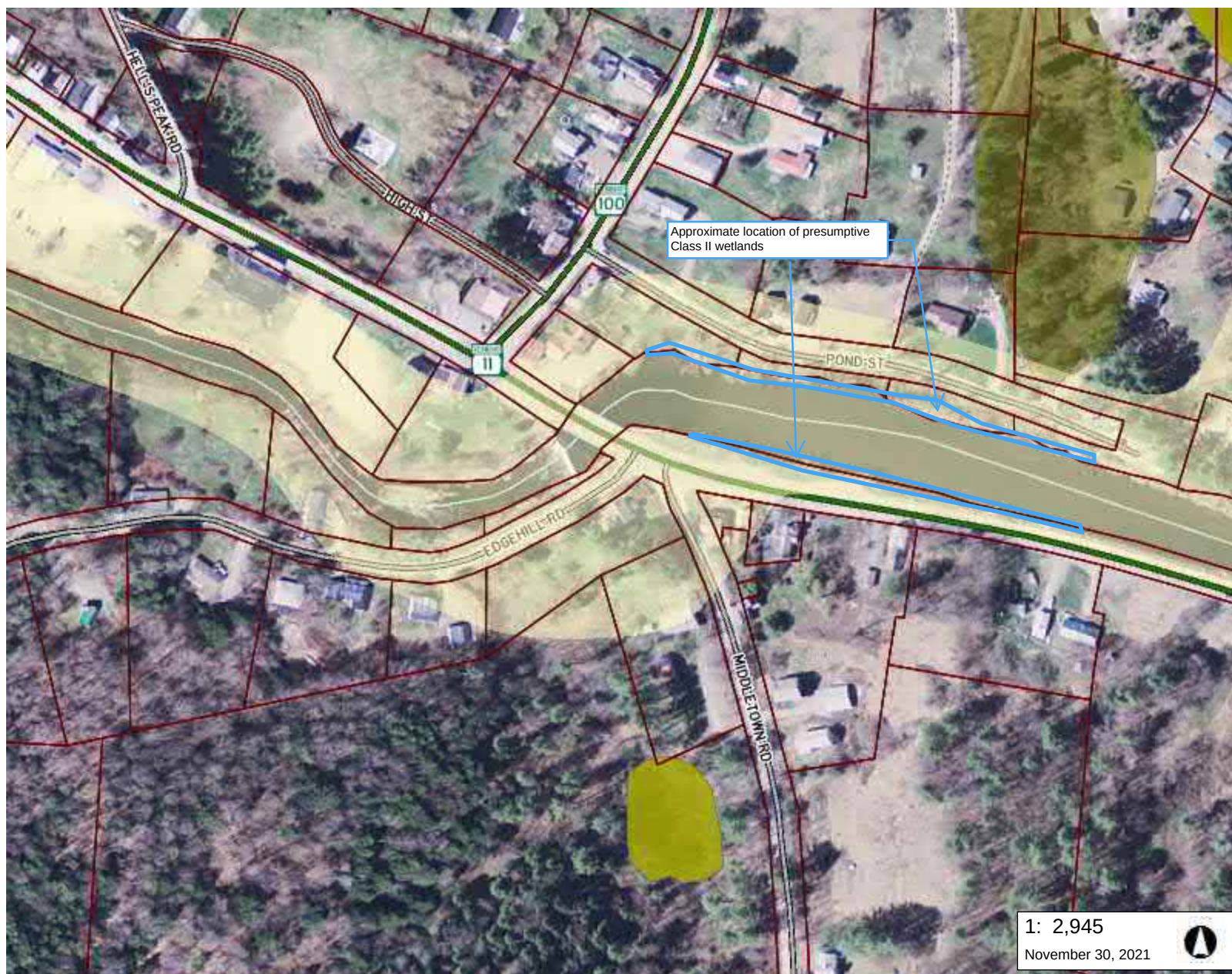
Stream/River

- Stream
- Intermittent Stream

Town Boundary

NOTES

Map created using ANR's Natural Resources Atlas



1: 2,945

November 30, 2021



150.0 0 75.00 150.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

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1" = 245 Ft. 1cm = 29 Meters

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State: **VT** County: **Windham** Watershed: **HUC 12 - 010801070301**

Project Name: **Williams Dam Rehabilitation Project**

Sponsor's Name:	Town of Londonderry		
Sponsor's Mailing Address:	100 Old School Street, South Londonderry, VT 05115		
Contact Name:	Shane O'Keefe	Phone:	(802)824-3356 ext. 5
Title:	Town Adminstrator	Email:	townadmin@londonderryvt.org
Sponsor Website:	https://www.londonderryvt.org/		

Description of the existing condition in the watershed that would be addressed through a Watershed Flood Prevention Operations program project.

Failing dam needs to be renovated. Town wishes to preserve and rebuild dam to maintain aesthetic beauty of the town and to maintain fire protection.

Potential benefits of a Watershed Flood Prevention Operations program project.

The renovated dam will maintain aesthetic nature of surrounding area and maintain wetland resources. Also, the dam will preserve fire protection access for the town and recreation.

**Watershed Programs Standard Memorandum
Preliminary Investigation – Feasibility Report
Sponsor Authority and Role Declaration**

**Form Number: WS-4
Version 2021-03-04**

State: VT County: Windham Watershed: HUC 12 - 010801070301

Project Name: Williams Dam Rehabilitation Project

SPONSOR WILL:

- Assist in the locally led planning effort: YES X NO
- Obtain needed land rights including the use of power of eminent domain, if necessary: YES X NO
- Provide local cost-share funds and/or in-kind services to provide the required portion of total project costs: YES X NO
- Provide Funds for continuing Operation and Maintenance actions: YES X NO
- Obtain required permits and approvals at Sponsor cost: YES X NO
- Provide leadership to help ensure adequate conservation land treatment measures are maintained on at least 50% of the watershed area above retention reservoirs: N/A YES X NO
- Before being credited with the value of any in-kind contribution for any in-kind services and/or acquisition of land rights, Sponsor will sign a Memorandum of Understanding (MOU) with NRCS: YES X NO

Authorized Representative of Sponsor

Name (printed): Shane O'Keefe Title: Town Administrator

Signature:  Date: December 13, 2022

U.S. Department of Agriculture Natural Resources Conservation Service		NRCS-CPA-52 4/2013		A. Client Name: Town of Londonderry					
ENVIRONMENTAL EVALUATION WORKSHEET				B. Conservation Plan ID # (as applicable): Program Authority (optional):					
D. Client's Objective(s) (purpose): Alternatives analysis for Williams Dam serves to provide options for reducing the hazard classification of an aging dam which currently poses a major flood risk. The project secondarily serves to improve habitat quality and recreational opportunity in the vicinity of the dam.				C. Identification # (farm, tract, field #, etc. as required):					
E. Need for Action: Lack of maintenance has led to deterioration of the existing dam. Significant overdue work is required to fix the dam and restore it to proper functionality. The dam is classified as a significant hazard dam.		H. Alternatives							
		No Action ☒ if RMS ☐	Structural ☒ if RMS ☐	Non-Structural ☒ if RMS ☐	Pie-in-the-Sky ☒ if RMS ☐				
		The sponsor does not implement flood protection measures using Federal funds. Temporary rehabilitation measures or dam removal may be required. Ratings below assume no action.	Replace the dam. Demolish and remove the existing dam and construct of a new concrete gravity dam approximately 20 feet downstream of the existing structure	Purchase 11 structures located in the area inundated by a breach of the Williams Dam, demolish and remove the structures and utilities, and rezone the land areas to prevent future development.	Replace the existing dam generally following the concept presented by DuBois & King. Construct levees with 10-year event flood protection on both sides of the West River floodplain boundary upstream of the dam. Additionally, raise approximately 2,000 feet of Route 100 to contain the 10-year flood flows.				
Resource Concerns									
In Section "F" below, analyze, record, and address concerns identified through the Resources Inventory process. (See FOTG Section III - Resource Planning Criteria for guidance).									
F. Resource Concerns and Existing/ Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)		I. Effects of Alternatives							
		Alternative 1 (No Action)		Alternative 2 (Structural)		Alternative 3 (Non-Structural)		Alternative 4 (Pie-in-the-Sky)	
		Amount, Status, Description (Document both short and long term impacts)	☒ if does NOT meet PC	Amount, Status, Description (Document both short and long term impacts)	☒ if does NOT meet PC	Amount, Status, Description (Document both short and long term impacts)	☒ if does NOT meet PC	Amount, Status, Description (Document both short and long term impacts)	☒ if does NOT meet PC
SOIL: EROSION									
No resource concern identified		Water will continue to bypass the dam on the left embankment and could possibly lead to future bank erosion issues.		Increased erosion may occur during construction. However, appropriate erosion and sedimentation controls will limit these effects. Shoreline habitat development may reduce future increases in erosion.		Increased erosion may occur during demolition. However, appropriate erosion and sedimentation controls will limit these effects.		Increased erosion may occur during construction. However, appropriate erosion and sedimentation controls will limit these effects. Shoreline habitat development may reduce future increases in erosion. Levees will prohibit sediment from reaching floodplains.	
Refer to PIFR section "Resource Information" subsection "Soils" for information on soil classification within the project area. No signs of significant erosion have been identified.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC	
		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC	
SOIL: SOIL QUALITY DEGRADATION									
Compaction		Existing conditions will persist and no significant changes to soil quality are likely to occur.		Minor compaction of soils around the project area may occur from the presence of construction equipment. Impacts are expected to be minimal. Soil compaction will not affect the ability for new vegetation to take root and new vegetation will promote soil health and stability.		Minor compaction of soils around the project area may occur from the presence of construction equipment. Impacts are expected to be minimal. Soil compaction will not affect the ability for new vegetation to take root and new vegetation will promote soil health and stability. Impervious cover will be removed.		Minor compaction of soils around the project area may occur from the presence of construction equipment. Soil compaction likely required to develop levees and to raise the roadway.	
Refer to PIFR section "Resource Information" subsection "Soils" for information on soil classification within the project area. No signs of significant compaction have been identified.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC	
		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC	
WATER: EXCESS / INSUFFICIENT WATER									
Insufficient		Mill Pond will continue to be full of sediment and will serve little recreational opportunity. Additionally, the once prime fishing pond will continue to have sediment build up and the quality will degrade.		Flows will be disturbed during construction but after the new dam is built the Mill Pond will again be a place of recreation and fish habitat.		Mill Pond will continue to be full of sediment and will serve no recreational purpose. Additionally, the once prime fishing pond will continue to have sediment build up and the quality will degrade.		Flows will be disturbed during construction but after the new dam is built the Mill Pond will again be a place of recreation and fish habitat.	
Large sediment deposits behind the dam have effectively eliminated the Mill Pond.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC	
Excess (Ponding, flooding, seasonal high water table, seeps, and drifted snow)		Overbanks of the West River will continue to flood during the 100-year storm.		Due to dredging the increased storage behind the new dam could lead to less flooding downstream of the dam. New spillway may also help to reduce flooding.		Overbanks of the West River will continue to flood during the 100-year storm. However, properties are no longer at risk of flooding from a dam breach.		Due to dredging the increased storage behind the new dam could lead to less flooding downstream of the dam. Levees will provide increased protection from flooding.	
Refer to PIFR section "Resources of Special Concern" for flooding details.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC	
WATER: WATER QUALITY DEGRADATION									
No resource concern identified		Current conditions will persist.		Construction activities may temporarily increase erosion and sedimentation. However, proper erosion and sedimentation control methods will limit impacts. Post construction, no water quality impacts are expected.		Construction activities may temporarily increase erosion and sedimentation. However, proper erosion and sedimentation control methods will limit impacts. Post construction, no water quality impacts are expected.		Construction activities may temporarily increase erosion and sedimentation. However, proper erosion and sedimentation control methods will limit impacts. Post construction, no water quality impacts are expected.	
No water quality concerns have been identified within the proposed project area.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC	

		☐		☐		☐		☐
		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC
F. Resource Concerns and Existing/ Benchmark Conditions								
(Analyze and record the existing/benchmark conditions for each)	I. (continued)							
	No Action		Alternative 1		Alternative 2		Alternative 3	
	Amount, Status, Description (Document both short and	☐ if does NOT meet PC	Amount, Status, Description (Document both short and	☐ if does NOT meet PC	Amount, Status, Description (Document both short and long term impacts)	☐ if does NOT meet PC	Amount, Status, Description (Document both short and long term impacts)	☐ if does NOT meet PC
AIR: AIR QUALITY IMPACTS								
Emissions of Particulate Matter (PM) and PM Precursors	No impacts to air quality are expected to occur.	☐	Construction activities may result in temporarily increased ozone and PM concentrations. Impacts are expected to be minimal.	☐	Construction activities may result in temporarily increased ozone and PM concentrations. Impacts are expected to be minimal.	☐	Construction activities may result in temporarily increased ozone and PM concentrations. Impacts are expected to be minimal.	☐
The proposed project area is not heavily affected by air pollution.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC
Emissions of Greenhouse Gases (GHGs)	No impacts to air quality are expected to occur.	☐	Construction activities may result in temporarily increased GHG concentrations. Impacts are expected to be minimal.	☐	Construction activities may result in temporarily increased GHG concentrations. Impacts are expected to be minimal.	☐	Construction activities may result in temporarily increased GHG concentrations. Impacts are expected to be minimal.	☐
No significant source of GHG emissions are located within the vicinity of the proposed project area.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC
PLANTS: DEGRADED PLANT CONDITION								
No resource concern identified	Plants will continue to live in current conditions.	☐	Construction activities could affect plants currently living in the project area. Aquatic plants that thrive in ponds would have a chance to rebound. No other long term effects expected.	☐	Construction activities could affect plants currently living in the project area. Impervious cover would be removed and replaced with native vegetation.	☐	Construction activities could affect plants currently living in the project area. Aquatic plants that thrive in ponds would have a chance to rebound. No other long term effects expected.	☐
The proposed project is located in a developed town.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC
		☐		☐		☐		☐
		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC
ANIMALS: INADEQUATE HABITAT FOR FISH AND WILDLIFE								
Habitat degradation	Sediment will continue to deposit further limiting once thriving trout from populating the pond.	☐	The pond and inhabiting organisms will be disturbed during dredging. Mill Pond will be restored to its full capacity, opening the door for different ecosystem composition.	☐	Sediment will continue to deposit further limiting once thriving trout from populating the pond. Floodplain habitat will be improved.	☐	The pond and inhabiting organisms will be disturbed during dredging. Mill Pond will be restored to its full capacity, opening the door for different ecosystem composition.	☐
Mill Pond has lost much of its volume to sediment deposition.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC
ANIMALS: LIVESTOCK PRODUCTION LIMITATION								
No resource concern identified	No impacts are expected to occur.	☐	No impacts are expected to occur.	☐	No impacts are expected to occur.	☐	No impacts are expected to occur.	☐
No resources associated with livestock have been identified near or within the proposed project area.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC
		☐		☐		☐		☐
		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC
ENERGY: INEFFICIENT ENERGY USE								
No resource concern identified	No impacts are expected to occur.	☐	No impacts are expected to occur.	☐	No impacts are expected to occur.	☐	No impacts are expected to occur.	☐
No energy consumption benchmark is related to this area.		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC
		☐		☐		☐		☐
		NOT meet PC		NOT meet PC		NOT meet PC		NOT meet PC
HUMAN: ECONOMIC AND SOCIAL CONSIDERATIONS								
Land Use	Continued sediment deposition will continue to lower the recreational value of Mill Pond.		After construction the dredging of the pond may restore the past recreational benefits of the pond like fishing, paddling, and swimming.		Continued sediment deposition will continue to lower the recreational value of Mill Pond. 11 structures that once were used by residents will be demolished and their value to the town will be lost.		After construction the dredging of the pond may restore the past recreational benefits of the pond like fishing, paddling, and swimming.	
Mill Pond used to provide recreation before excessive sediment deposition								

Public Health and Safety Dry Hydrant located in Mill Pond	Continued sediment deposition will continue to decrease the utility of the dry hydrant.	Dredging and hydrant relocation will improve the intake conditions for the dry hydrant.	Continued sediment deposition will continue to decrease the utility of the dry hydrant.	Dredging and hydrant relocation will improve the intake conditions for the dry hydrant.				
Risk The Williams Dam is a significant hazard class	The dam integrity will continue to deteriorate and the risk of a failure will increase.	After construction of a new dam the risk of a dam failure will become very low for many years and even longer with proper maintenance.	There will no longer be structures located in the area that would be inundated by a breach of the Williams Dam. This would likely lower the hazard class.	After construction of a new dam the risk of a dam failure will become very low for many years and even longer with proper maintenance .				
Special Environmental Concerns: Environmental Laws, Executive Orders, policies, etc.								
In Section "G" complete and attach Environmental Procedures Guide Sheets for documentation as applicable. Items with a "•" may require a federal permit or consultation/coordination between the lead agency and another government agency. In these cases, effects may need to be determined in consultation with another agency. Planning and practice implementation may proceed for practices not involved in consultation.								
G. Special Environmental Concerns (Document existing/ benchmark conditions)	J. Impacts to Special Environmental Concerns							
	No Action		Alternative 1		Alternative 2		Alternative 3	
	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action
•Clean Air Act Guide Sheet FS1 FS-2 The proposed project area is not currently heavily affected by air pollution.	No Effect No pollution emitting equipment or excavation will be required; therefore, emissions will not increase.	□	May Effect Construction activities may temporarily increase emissions of GHGs, and PM and ozone precursors. However, this increase is expected to be minimal and temporary. The need for a Title V permit is unlikely.	□	May Effect Construction activities may temporarily increase emissions of GHGs, and PM and ozone precursors. However, this increase is expected to be minimal and temporary. The need for a Title V permit is unlikely.	□	May Effect Construction activities may temporarily increase emissions of GHGs, and PM and ozone precursors. However, this increase is expected to be minimal and temporary. The need for a Title V permit is unlikely.	□
•Clean Water Act / Waters of the U.S. Guide Sheet Fact Sheet No waters within the proposed project area are currently impaired.	No Effect No discharges into regulated waters will occur. Conditions at the site will generally remain unchanged.	□	May Effect Increased erosion and sedimentation may occur from excavation during construction. Erosion and sedimentation control methods are required throughout the duration of construction. Reseeding of areas impacted by construction is required to prevent future erosion. A Section 404 Permit will likely be required.	□	May Effect Increased erosion and sedimentation may occur from excavation during construction. Erosion and sedimentation control methods are required throughout the duration of construction. Reseeding of areas impacted by construction is required to prevent future erosion. A Section 404 Permit will likely be required.	□	May Effect Increased erosion and sedimentation may occur from excavation during construction. Erosion and sedimentation control methods are required throughout the duration of construction. Reseeding of areas impacted by construction is required to prevent future erosion. A Section 404 Permit will likely be required.	□
•Coastal Zone Management Guide Sheet Fact Sheet N/A	N/A	□	N/A	□	N/A	□	N/A	□
Coral Reefs Guide Sheet Fact Sheet N/A	N/A	□	N/A	□	N/A	□	N/A	□
•Cultural Resources / Historic Properties Guide Sheet Fact Sheet Neither cultural resources nor historic properties have been identified near or within the proposed project area.	No Effect Conditions will remain generally unchanged, and no effects will occur.	□	No Effect Neither cultural resources nor historic properties have been identified near or within the proposed project area. The Vermont Division for Historic Preservation Office will be consulted during planning to ensure no impacts to cultural resources occur.	□	No Effect Neither cultural resources nor historic properties have been identified near or within the proposed project area. The Vermont Division for Historic Preservation Office will be consulted during planning to ensure no impacts to cultural resources occur.	□	No Effect Neither cultural resources nor historic properties have been identified near or within the proposed project area. The Vermont Division for Historic Preservation Office will be consulted during planning to ensure no impacts to cultural resources occur.	□
•Endangered and Threatened Species Guide Sheet Fact Sheet Refer to PIFR section "Resources of Special Concern" subsection "Threatened and Endangered Species" for detailed information.	No Effect Mill Pond will continue to accumulate sediment and the habitat behind the dam is expected to degrade. However, most identified RTE species will be largely unaffected.	□	May Effect Construction activities may temporarily disrupt protected species. However, these effects are expected to be minimal and only last through the duration of construction. No long-term impact is expected.	□	May Effect Construction activities may temporarily disrupt protected species. However, removal of structures and impervious cover in favor of plants and trees may improve habitat for RTE species. Mill Pond will continue to accumulate sediment and the habitat behind the dam is expected to degrade.	□	May Effect Construction activities may temporarily disrupt protected species. However, these effects are expected to be minimal and only last through the duration of construction. No long-term impact is expected.	□
Environmental Justice Guide Sheet Fact Sheet Refer to PIFR section "Resources of Special Concern" subsection "Environmental Justice" for detailed information. No significant environmental justice concerns currently exist.	No Effect Current opportunities for recreation will be maintained	□	No Effect Reconstruction of the dam will improve current opportunities for recreation in Mill Pond.	□	May Effect Families within the 100-year floodplain may vacate their homes and relocate. This causes temporary hardship while limiting threats to safety.	□	No Effect Reconstruction of the dam will improve current opportunities for recreation in Mill Pond.	□
•Essential Fish Habitat Guide Sheet Fact Sheet No federally regulated essential fish habitat is located within the project area. There is essential fish habitat downstream but there is a second dam in between there and the project area. Refer to PIFR section "Resources of Special Concern" subsection "Essential Fish Habitat" for detailed information.	No Effect Essential fish habitat is unlikely to be affected.	□	No Effect Essential fish habitat is unlikely to be affected.	□	No Effect Essential fish habitat is unlikely to be affected.	□	No Effect Essential fish habitat is unlikely to be affected.	□

Floodplain Management Guide Sheet Fact Sheet Refer to PIFR section "Resources of Special Concern" for flooding details.	No Effect Current floodplains will continue to exist, and overbanks will overtop as they have in recent history during 100-year storm events.	□	May Effect Due to dredging the increased storage behind the new dam could lead to less flooding downstream of the dam. However, significant changes in flood attenuation are not expected.	□	May Effect Current floodplains will continue to exist, and overbanks will overtop as they have in recent history during 100-year storm events. However, no structures will be within the area of inundation during a breach of Williams Dam.	□	May Effect Current floodplains will continue to exist, and overbanks will overtop as they have in recent history during 100-year storm events. Additionally, levees would provide protection during a 10-year flood event.	□
Invasive Species Guide Sheet Fact Sheet No invasive species are known to be around the project area.	No Effect No new potential introduction of invasive species will occur, and current conditions will persist.	□	May Effect Construction activities may allow for the introduction of invasive species within the proposed project area. Reseeding of disturbed areas will be required to prevent the proliferation of invasive plants.	□	May Effect Construction activities may allow for the introduction of invasive species within the proposed project area. Reseeding of disturbed areas will be required to prevent the proliferation of invasive plants. Rezoned areas will be planted with native species.	□	May Effect Construction activities may allow for the introduction of invasive species within the proposed project area. Reseeding of disturbed areas will be required to prevent the proliferation of invasive plants.	□
• Migratory Birds/Bald and Golden Eagle Protection Act Guide Sheet Fact Sheet Refer to PIFR section "Resources of Special Concern" subsection "Migratory Birds/Bald and Golden Eagle Protection Action" for detailed information on protected species potentially located near or within the proposed project area.	No Effect No disturbance to protected species will occur.	□	May Effect Construction activities may temporarily disturb protected species. However, these effects are only expected to persist through the duration of construction. Increasing pond water volumes may provide for enhanced foraging opportunities for bird species.	□	May Effect Construction activities may temporarily disturb protected species. However, these effects are only expected to persist through the duration of construction. Rezoned properties may include high quality habitat for migratory species.	□	May Effect Construction activities may temporarily disturb protected species. However, these effects are only expected to persist through the duration of construction. Increasing pond water volumes may provide for enhanced foraging opportunities for bird species.	□
Natural Areas Guide Sheet Fact Sheet Terrible Mountain and Jamaica State Park are two natural areas within 15 miles of the project area. They are out of the realm of influence and are not impacted by the Williams Dam	No Effect Current dam and pond conditions will persist and will not affect the Natural Areas.	□	No Effect Neither construction activities nor the new dam will affect the Natural Areas.	□	No Effect Demolition of the structures around the dam will not affect Natural Areas.	□	No Effect Neither construction activities nor the new dam and levee system will affect the Natural Areas.	□
Prime and Unique Farmlands Guide Sheet Fact Sheet Soils that are considered prime farmland and soils of statewide importance are in the project area. However, they are located on already developed land.	No Effect Prime and unique farmlands are not expected to be affected.	□	No Effect Prime and unique farmlands are not expected to be affected.	□	No Effect Prime and unique farmlands are not expected to be affected.	□	No Effect Prime and unique farmlands are not expected to be affected.	□
Riparian Area Guide Sheet Fact Sheet Refer to PIFR section "Resources of Special Concern" subsection "Riparian Area" for detailed information.	No Effect No change to the current conditions expected.	□	May Effect Construction activities could damage the riparian area around the existing dam temporarily. Riparian function expected to return to current conditions after construction.	□	May Effect Removal of structures and impervious cover from the riparian area will improve buffer conditions.	□	May Effect Construction activities could damage the riparian area around the existing dam temporarily. Riparian function expected to return to current conditions after construction.	□
Scenic Beauty Guide Sheet Fact Sheet Refer to PIFR section "Resources of Special Concern" subsection "Scenic Beauty" for detailed information.	No Effect The aesthetic of the dam will remain.	□	May Effect Construction will temporarily disrupt the beauty of the river. The replacement dam may not offer equal aesthetics, though the design will likely be similar.	□	May Effect Construction will temporarily disrupt the beauty of the river. The aesthetic of the dam will remain.	□	May Effect Construction will temporarily disrupt the beauty of the river. The replacement dam may not offer equal aesthetics, though the design will likely be similar. Although, 10-foot levees may impede views of the river and the dam.	□

Wetlands Guide Sheet Fact Sheet 32.5 acres of wetlands are located starting 1,400 feet upstream of the dam.	No Effect With no construction or altering of the dam the existing wetlands will persist.	☐	No Effect Construction will be performed in a sequence that will limit disturbance to upstream wetlands.	☐	No Effect With no construction upstream and no altering of the dam the existing wetlands will persist.	☐	No Effect Construction will be performed in a sequence that will limit disturbance to upstream wetlands.	☐																											
Wild and Scenic Rivers Guide Sheet Fact Sheet No Wild and Scenic Rivers are located within or downstream of the proposed project area.	No Effect No Wild and Scenic Rivers are located within or downstream of the proposed project area.	☐	No Effect No Wild and Scenic Rivers are located within or downstream of the proposed project area.	☐	No Effect No Wild and Scenic Rivers are located within or downstream of the proposed project area.	☐	No Effect No Wild and Scenic Rivers are located within or downstream of the proposed project area.	☐																											
K. Other Agencies and Broad Public Concerns Easements, Permissions, Public Review, or Permits Required and Agencies Consulted.	No Action		Alternative 1		Alternative 2		Alternative 3																												
Cumulative Effects Narrative (Describe the cumulative impacts considered, including past, present and known future actions regardless of who performed the actions)	Delaying dam rehabilitation increases the risks of dam failure, and water volumes within the pond may decrease due to sedimentation. Decreased water volumes limit recreation opportunities and wildlife habitat within the pond. The functionality of the dry hydrant would also be expected to decline with further sedimentation behind the dam.		Replacing the dam will provide future flood protection, allow for recreation activities to be restored at the pond, and ensure adequate dry hydrant function.		Delaying dam rehabilitation increases the risks of dam failure, and water volumes within the pond may decrease due to sedimentation. Decreased water volumes limit recreation opportunities and wildlife habitat within the pond. The functionality of the dry hydrant would also be expected to decline with further sedimentation behind the dam. However, this alternative removes 11 structures from risk of being inundated by a dam breach.		Replacing the dam will provide future flood protection, allow for recreation activities to be restored at the pond, and ensure adequate dry hydrant function. The combination of levees and raising Route 100 will provide protection to Londonderry and its residents during a 10-year flood event.																												
L. Mitigation (Record actions to avoid, minimize, and compensate)																																			
M. Preferred Alternative	☒ preferred alternative	☐	☐	☐	☐	☐	☐	☐																											
	Supporting reason																																		
N. Context (Record context of alternatives analysis) The significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality.																																			
O. Determination of Significance or Extraordinary Circumstances Intensity: Refers to the severity of impact. Impacts may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts. If you answer ANY of the below questions "yes" then contact the State Environmental Liaison as there may be extraordinary circumstances and significance issues to consider and a site specific NEPA analysis may be required.																																			
<table border="1"> <tr> <th>Yes</th> <th>No</th> <th></th> </tr> <tr> <td>☐</td> <td>☒</td> <td>Is the preferred alternative expected to cause significant effects on public health or safety?</td> </tr> <tr> <td>☐</td> <td>☒</td> <td>Is the preferred alternative expected to significantly affect unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?</td> </tr> <tr> <td>☐</td> <td>☒</td> <td>Are the effects of the preferred alternative on the quality of the human environment likely to be highly controversial?</td> </tr> <tr> <td>☐</td> <td>☒</td> <td>Does the preferred alternative have highly uncertain effects or involve unique or unknown risks on the human environment?</td> </tr> <tr> <td>☐</td> <td>☒</td> <td>Does the preferred alternative establish a precedent for future actions with significant impacts or represent a decision in principle about a future consideration?</td> </tr> <tr> <td>☐</td> <td>☒</td> <td>Is the preferred alternative known or reasonably expected to have potentially significant environment impacts to the quality of the human environment either individually or cumulatively over time?</td> </tr> <tr> <td>☐</td> <td>☒</td> <td>Will the preferred alternative likely have a significant adverse effect on ANY of the special environmental concerns? Use the Evaluation Procedure Guide Sheets to assist in this determination. This includes, but is not limited to, concerns such as cultural or historical resources, endangered and threatened species, environmental justice, wetlands, floodplains, coastal zones, coral reefs, essential fish habitat, wild and scenic rivers, clean air, riparian areas, natural areas, and invasive species.</td> </tr> <tr> <td>☐</td> <td>☒</td> <td>Will the preferred alternative threaten a violation of Federal, State, or local law or requirements for the protection of the environment?</td> </tr> </table>	Yes	No		☐	☒	Is the preferred alternative expected to cause significant effects on public health or safety?	☐	☒	Is the preferred alternative expected to significantly affect unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?	☐	☒	Are the effects of the preferred alternative on the quality of the human environment likely to be highly controversial?	☐	☒	Does the preferred alternative have highly uncertain effects or involve unique or unknown risks on the human environment?	☐	☒	Does the preferred alternative establish a precedent for future actions with significant impacts or represent a decision in principle about a future consideration?	☐	☒	Is the preferred alternative known or reasonably expected to have potentially significant environment impacts to the quality of the human environment either individually or cumulatively over time?	☐	☒	Will the preferred alternative likely have a significant adverse effect on ANY of the special environmental concerns? Use the Evaluation Procedure Guide Sheets to assist in this determination. This includes, but is not limited to, concerns such as cultural or historical resources, endangered and threatened species, environmental justice, wetlands, floodplains, coastal zones, coral reefs, essential fish habitat, wild and scenic rivers, clean air, riparian areas, natural areas, and invasive species.	☐	☒	Will the preferred alternative threaten a violation of Federal, State, or local law or requirements for the protection of the environment?								
Yes	No																																		
☐	☒	Is the preferred alternative expected to cause significant effects on public health or safety?																																	
☐	☒	Is the preferred alternative expected to significantly affect unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?																																	
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☐	☒	Will the preferred alternative threaten a violation of Federal, State, or local law or requirements for the protection of the environment?																																	
P. To the best of my knowledge, the data shown on this form is accurate and complete:																																			
In the case where a non-NRCS person (e.g. a TSP) assists with planning they are to sign the first signature block and then NRCS is to sign the second block to verify the information's accuracy.																																			
Signature (TSP if applicable)			Title			Date																													
Signature (NRCS)			Title			Date																													
If preferred alternative is not a federal action where NRCS has control or responsibility and this NRCS-CPA-52 is shared with someone other than the client then indicate to whom this is being provided.																																			

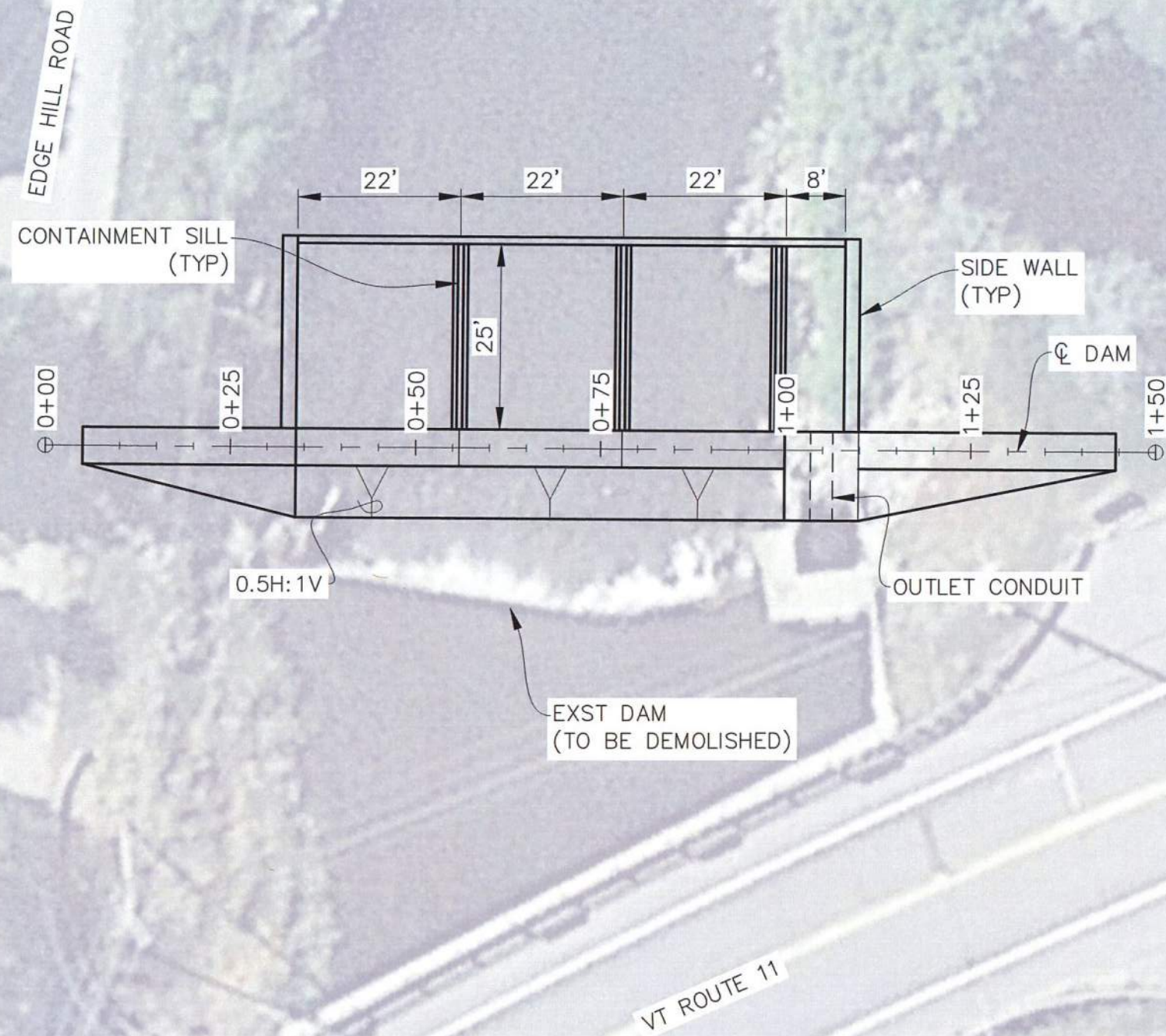
The following sections are to be completed by the Responsible Federal Official (RFO)		
NRCS is the RFO if the action is subject to NRCS control and responsibility (e.g., actions financed, funded, assisted, conducted, regulated, or approved by NRCS). These actions do not include situations in which NRCS is only providing technical assistance because NRCS cannot control what the client ultimately does with that assistance and situations where NRCS is making a technical determination (such as Farm Bill HEL or wetland determinations) not associated with the planning process.		
Q. NEPA Compliance Finding (check one)		
The preferred alternative:		Action required
☐	1) is not a federal action where the agency has control or responsibility.	Document in "R.1" below. No additional analysis is required
☐	2) is a federal action ALL of which is categorically excluded from further environmental analysis AND there are no extraordinary circumstances as identified in Section "O" .	Document in "R.2" below. No additional analysis is required
☐	3) is a federal action that has been sufficiently analyzed in an existing Agency state, regional, or national NEPA document and there are no predicted <u>significant adverse environmental effects or extraordinary circumstances</u> .	Document in "R.1" below. No additional analysis is required.
☐	4) is a federal action that has been sufficiently analyzed in another Federal agency's NEPA document (EA or EIS) that addresses the proposed NRCS action and its' effects and has been formally adopted by NRCS . NRCS is required to prepare and publish its own Finding of No Significant Impact for an EA or Record of Decision for an EIS when adopting another agency's EA or EIS document. (Note: This box is not applicable to FSA)	Contact the State Environmental Liaison for list of NEPA documents formally adopted and available for tiering. Document in "R.1" below. No additional analysis is required
☐	5) is a federal action that has NOT been sufficiently analyzed or may involve predicted significant adverse environmental effects or extraordinary circumstances and may require an EA or EIS.	Contact the State Environmental Liaison. Further NEPA analysis required.
R. Rationale Supporting the Finding		
R.1 Findings Documentation		
R.2 Applicable Categorical Exclusion(s) (more than one may apply) <i>7 CFR Part 650 Compliance With NEPA, subpart 650.6 Categorical Exclusions states prior to determining that a proposed action is categorically excluded under paragraph (d) of this section, the proposed action must meet six sideboard criteria. See NECH 610.116.</i>		
<i>I have considered the effects of the alternatives on the Resource Concerns, Economic and Social Considerations, Special Environmental Concerns, and Extraordinary Circumstances as defined by Agency regulation and policy and based on that made the finding indicated above.</i>		
S. Signature of Responsible Federal Official:		
Signature	Title	Date
Additional notes		



Opinion of Probable Construction Costs
Williams Dam Alternative 2
RJH Project No. 22117

Item	Description	Total Quantity	Unit	Unit Price	Extension
General Items					
1	Mobilization @ 10% of BCS	1	Lump Sum	\$ 177,222	\$ 177,222
2	Temporary Facilities	1	Lump Sum	\$ 150,000	\$ 150,000
3	Site Restoration	1	Lump Sum	\$ 50,000	\$ 50,000
4	Dewatering	1	Lump Sum	\$ 75,000	\$ 75,000
Williams Dam Removal and Replacement					
5	Dam Removal	1	Lump Sum	\$ 90,000	\$ 90,000
6	New Concrete Dam	1	Lump Sum	\$ 1,060,000	\$ 1,060,000
Channel and Reservoir Improvements					
7	Sediment Excavation	6,000	Cubic Yard	\$ 18	\$ 108,000
8	Sediment Haul	6,000	Cubic Yard	\$ 22	\$ 132,000
9	Other Improvements	1	Lump Sum	\$ 50,000	\$ 50,000
Base Construction Subtotal (BCS)					\$ 1,892,222
Bonds/Insurance (2% of BCS)		2%			\$ 37,844
Unsheduled Items (20% of BCS)		20%			\$ 378,444
Direct Construction Subtotal (DCS)					\$ 2,308,511
Construction Contingencies (30% of DCS)		30%			\$ 692,553
Permitting (15% of DCS)		15%			\$ 346,277
Design Engineering (12% of DCS)		12%			\$ 277,021
Construction Engineering and Testing (12% of DCS)		12%			\$ 277,021
OPINION OF PROBABLE CONSTRUCTION COSTS					\$ 3,901,384

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PRELIMINARY
NOT FOR CONSTRUCTION



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SCALE IN FEET



WILLIAMS DAM

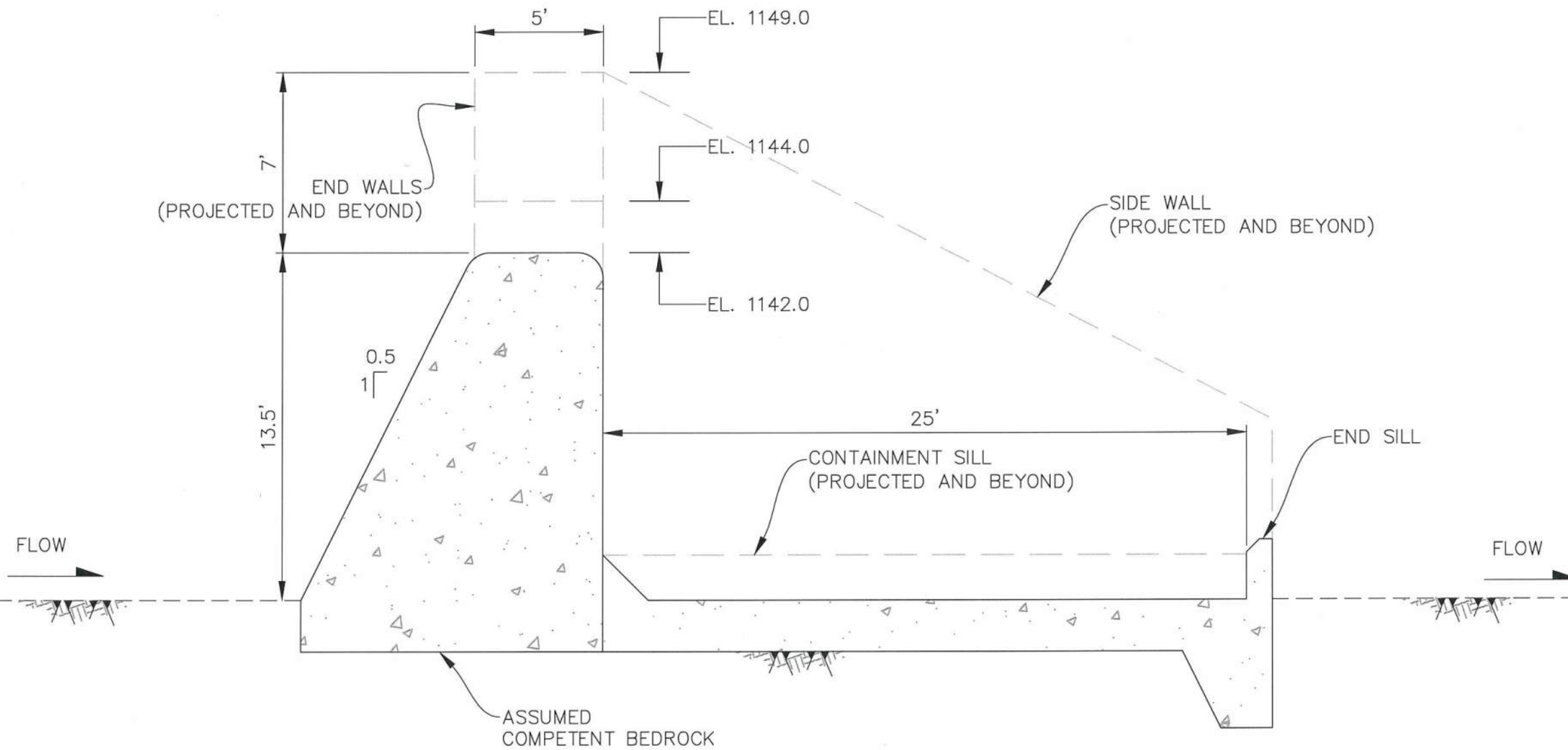
PROJECT NO. 22117

DAM REPLACEMENT
PLAN VIEW

November 2022

Figure 1

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PRELIMINARY
NOT FOR CONSTRUCTION



WILLIAMS DAM

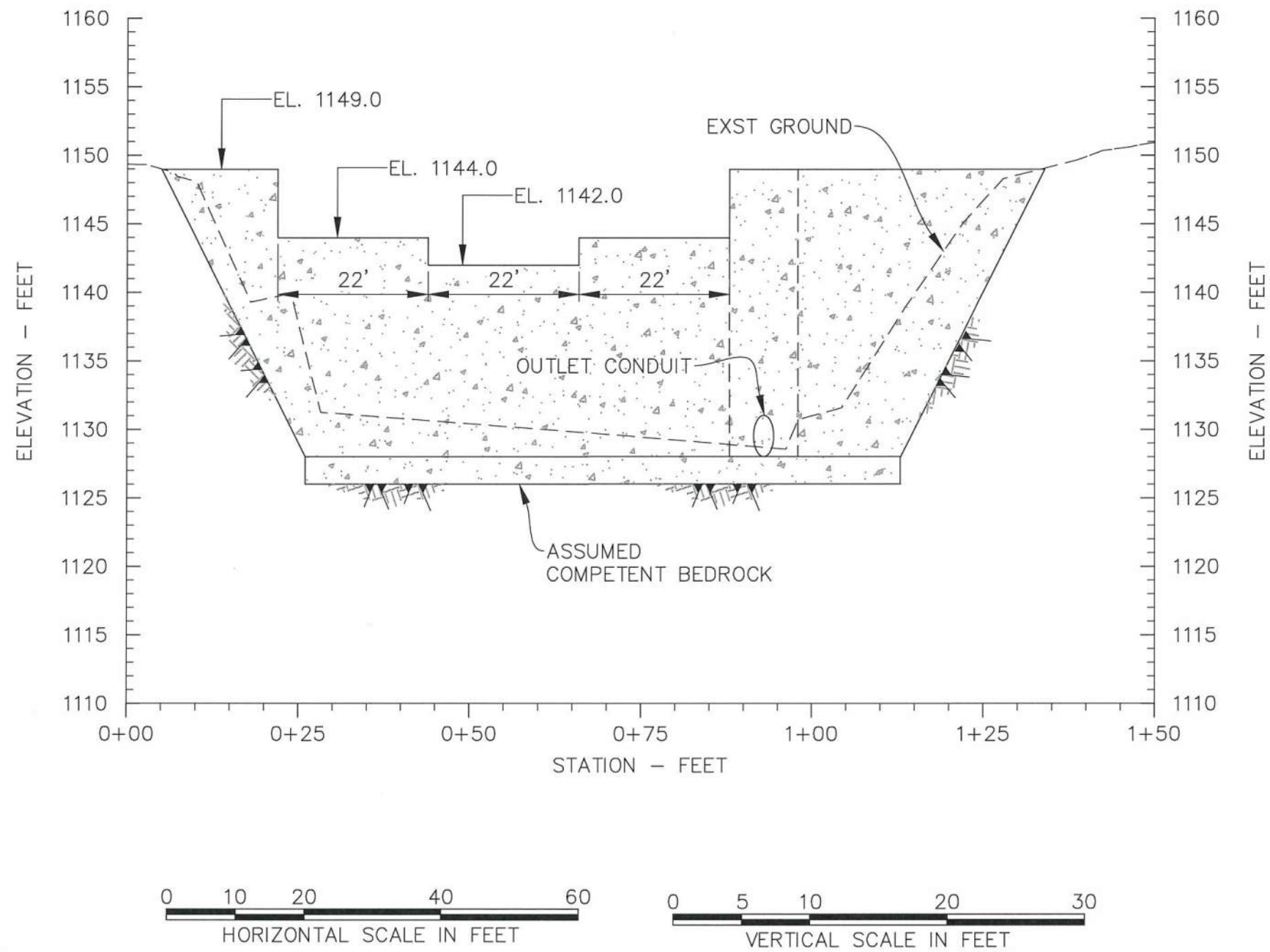
DAM REPLACEMENT
SECTION VIEW

PROJECT NO. 22117

November 2022

Figure 2

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PRELIMINARY
NOT FOR CONSTRUCTION



WILLIAMS DAM

DAM REPLACEMENT
PROFILE VIEW

PROJECT NO. 22117

November 2022

Figure 3



Opinion of Probable Construction Costs
Williams Dam Alternative 3
RJH Project No. 22117

Unit	Description	Estimated Value	Square Footage	Demolition Cost	Disposal Cost	Total Unit Cost
1	Restaurant/Bar ⁽³⁾	\$1,225,000	7,000	\$30,000	\$65,625	\$1,320,625
2	Restaurant ⁽³⁾	\$800,000	4,000	\$25,000	\$37,500	\$862,500
3	Residence ⁽¹⁾	\$50,000	800	\$10,000	\$7,500	\$67,500
4	Restaurant ⁽³⁾	\$800,000	4,000	\$25,000	\$37,500	\$862,500
5	Market ⁽³⁾	\$437,500	2,500	\$20,000	\$50,000	\$507,500
6	Liquor Store ⁽³⁾	\$665,000	3,800	\$25,000	\$35,625	\$725,625
7	Salon ⁽³⁾	\$350,000	2,000	\$15,000	\$18,750	\$383,750
8	Auto Store ⁽³⁾	\$525,000	3,000	\$20,000	\$28,125	\$573,125
9	Residence ⁽¹⁾	\$200,000	1,500	\$15,000	\$250,000	\$465,000
10	Residence ⁽¹⁾	\$200,000	1,500	\$15,000	\$250,000	\$465,000
11	Residence	\$250,000	1,800	\$15,000	\$16,875	\$281,875
Subtotal						\$ 6,515,000
Total (Subtotal x 110%)						\$ 7,166,500

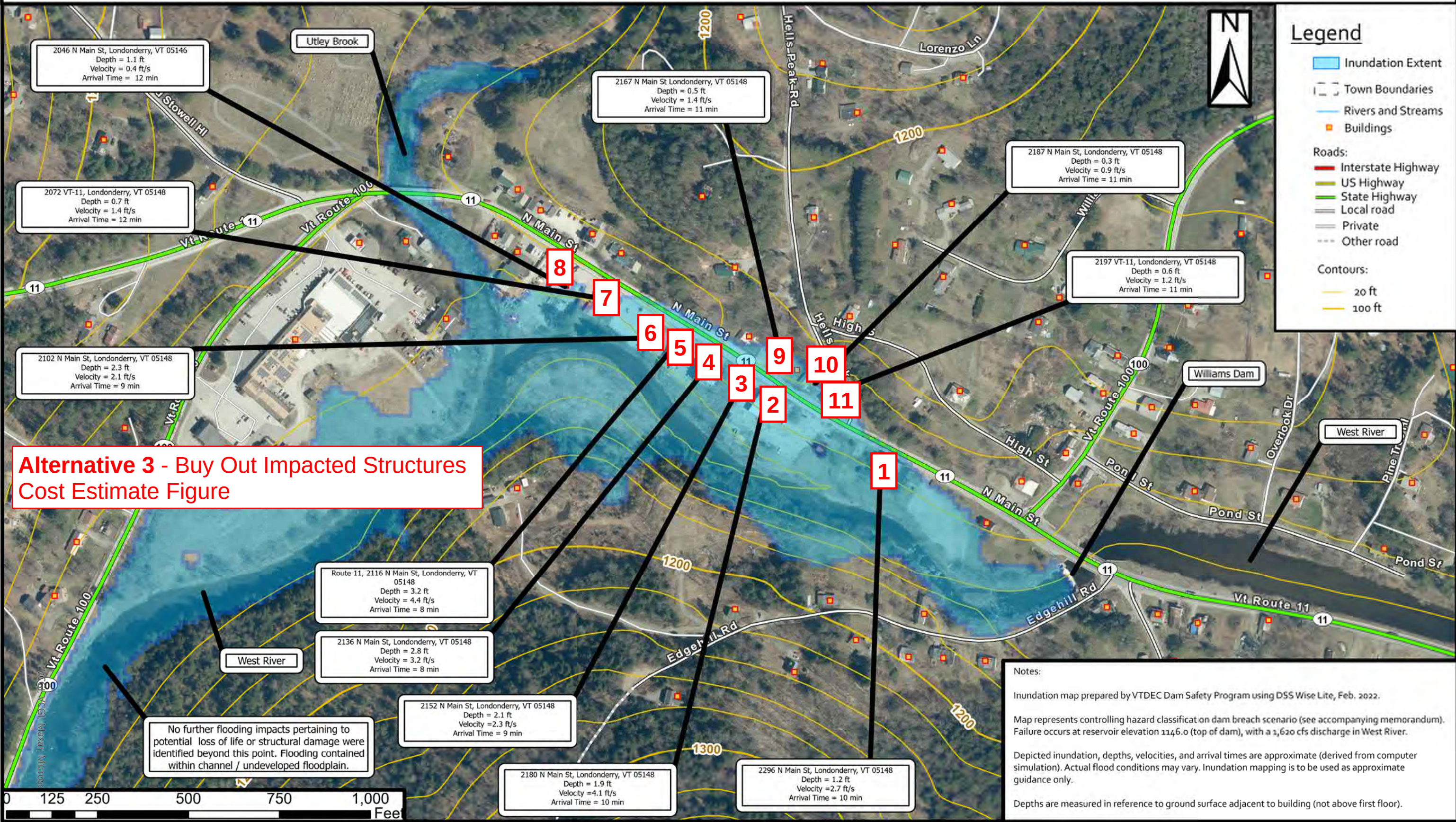
Notes:

1. Square footage and value approximated.
2. Value approximated.
3. Value approximated based on average building costs per square foot.



Williams Dam (No. 115.01) - Londonderry, VT - Flood Inundation Map

Vermont Agency of Natural Resources - Department of Environmental Conservation - Dam Safety Program





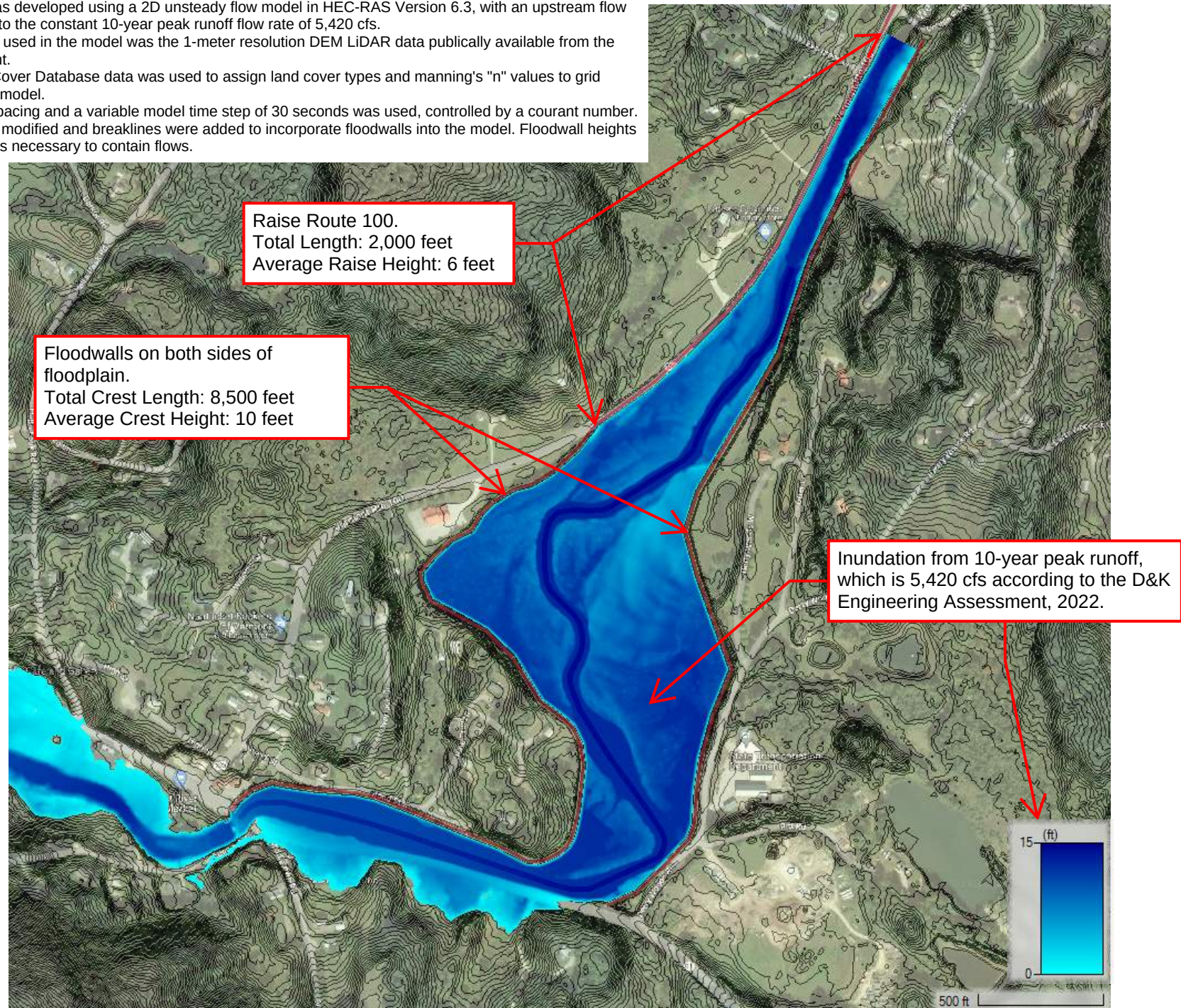
Opinion of Probable Construction Costs
Williams Dam Alternative 4
RJH Project No. 22117

Item	Description	Total Quantity	Unit	Unit Price	Extension
General Items					
1	Mobilization @ 10% of BCS	1	Lump Sum	\$ 1,497,778	\$ 1,497,778
2	Temporary Facilities and Traffic Control	1	Lump Sum	\$ 500,000	\$ 500,000
3	Site Restoration	1	Lump Sum	\$ 100,000	\$ 100,000
4	Dewatering	1	Lump Sum	\$ 200,000	\$ 200,000
Williams Dam Removal and Replacement					
5	Dam Removal	1	Lump Sum	\$ 90,000	\$ 90,000
6	New Concrete Dam	1	Lump Sum	\$ 1,060,000	\$ 1,060,000
Channel and Reservoir Improvements					
7	Sediment Excavation	6,000	Cubic Yard	\$ 18	\$ 108,000
8	Sediment Haul	6,000	Cubic Yard	\$ 22	\$ 132,000
9	Other Improvements	1	Lump Sum	\$ 50,000	\$ 50,000
Flood Protection					
10	Flood Risk Reduction Floodwall	8,500	Lineal Foot	\$ 1,220	\$ 10,370,000
12	Vermont Rte 100 Road Raise	2,000	Lineal Foot	\$ 370	\$ 740,000
Base Construction Subtotal (BCS)					\$ 14,847,778
Bonds/Insurance (2% of BCS)		2%			\$ 296,956
Unsheduled Items (20% of BCS)		20%			\$ 2,969,556
Direct Construction Subtotal (DCS)					\$ 18,114,289
Construction Contingencies (30% of DCS)		30%			\$ 5,434,287
Permitting (15% of DCS)		15%			\$ 2,717,143
Design Engineering (12% of DCS)		12%			\$ 2,173,715
Construction Engineering and Testing (12% of DCS)		12%			\$ 2,173,715
OPINION OF PROBABLE CONSTRUCTION COSTS					\$ 30,613,148

Williams Dam PIFR - Alternative 4

Floodwall Concept Figure

This concept was developed using a 2D unsteady flow model in HEC-RAS Version 6.3, with an upstream flow hydrograph set to the constant 10-year peak runoff flow rate of 5,420 cfs. The topography used in the model was the 1-meter resolution DEM LiDAR data publicly available from the State of Vermont. National Land Cover Database data was used to assign land cover types and Manning's "n" values to grid elements in the model. A 10-foot grid spacing and a variable model time step of 30 seconds was used, controlled by a Courant number. The terrain was modified and breaklines were added to incorporate floodwalls into the model. Floodwall heights were adjusted as necessary to contain flows.



Appendix C VTDSP Dam Inspection

Williams Dam Flooding Analysis

Londonderry, Vermont

SLR Project No.: 20433.00002

January 5, 2024



Appendix D VTDSP Dam Breach Analysis

Williams Dam Flooding Analysis

Londonderry, Vermont

SLR Project No.: 20433.00002

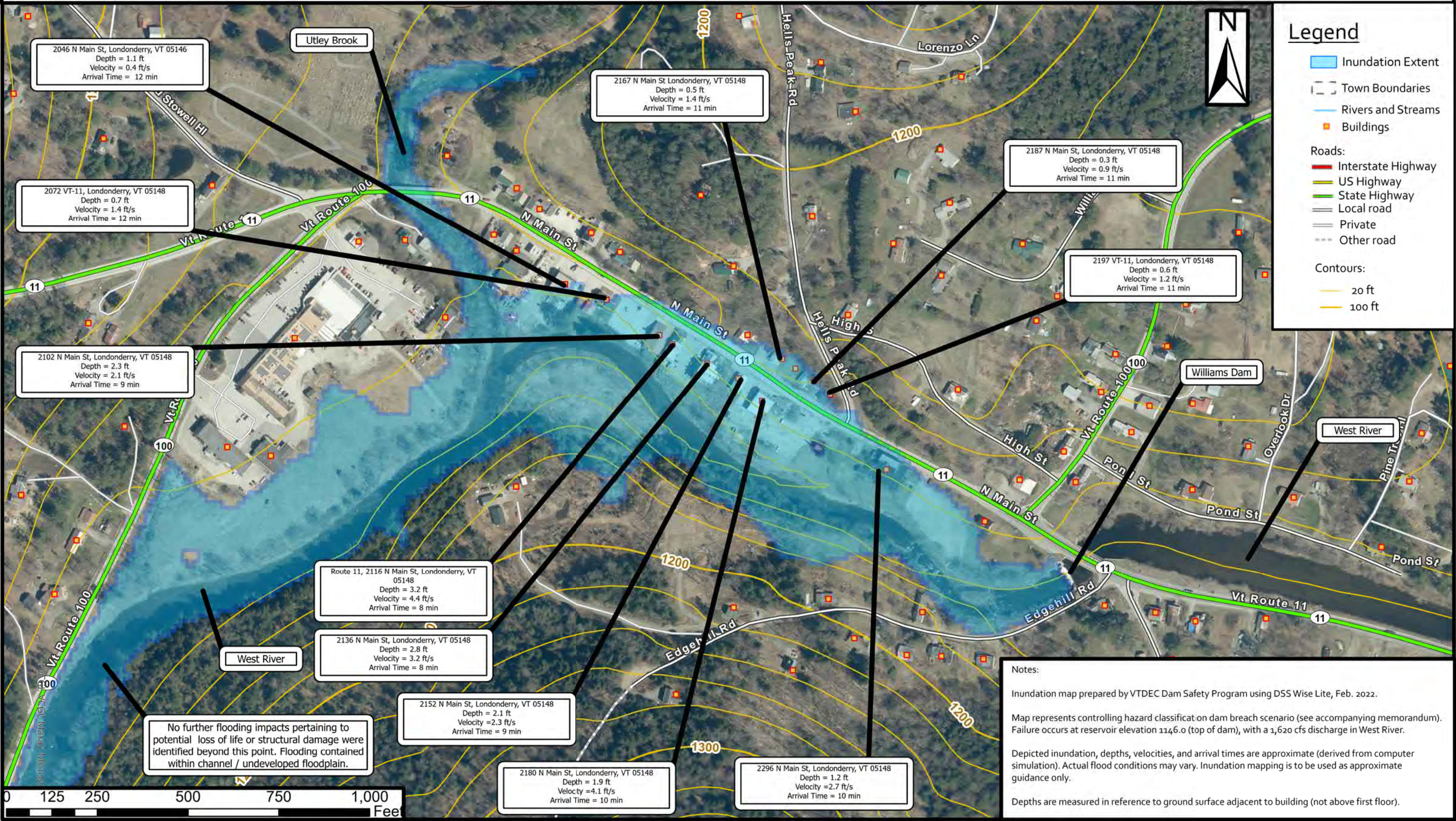
January 5, 2024





Williams Dam (No. 115.01) - Londonderry, VT - Flood Inundation Map

Vermont Agency of Natural Resources - Department of Environmental Conservation - Dam Safety Program



Appendix E VTrans Boring Data for VT Route 11 Bridge

Williams Dam Flooding Analysis

Londonderry, Vermont

SLR Project No.: 20433.00002

January 5, 2024



SOIL CLASSIFICATION

AASHTO

A1	Gravel and Sand
A2	Fine Sand
A3	Silty or Clayey Gravel and Sand
A4	Silty Soil - Low Compressibility
A5	Silty Soil - Highly Compressible
A6	Clayey Soil - Low Compressibility
A7	Clayey Soil - Highly Compressible

UNIFIED SOIL SYSTEM

GW/GP	Clean Gravels (Few Fines)
GM/GC	Gravels (Appreciable Fines)
SW/SP	Clean Sands (Few Fines)
SM/SC	Sand (Appreciable Fines)
ML/CL	Low Plastic Silts & Clays
OL	Low Plastic Organic Silt
MH/CH	High Plastic Silts & Clays
OH	High Plastic Organic Silt
PT	Highly Organic Soils

MOISTURE

DESCRIPTIVE TERM	OBSERVED IN FIELD	% ± BY ANALYSIS
Dry	No Visible Water	<10
Moist	Damp	10-20
Moist to Wet	Moist to Wet	21-50
Wet	Visible Water	51-70
Saturated		>70

ROCK QUALITY DESIGNATION

R.O.D.	ROCK DESCRIPTION
<.25	Very Poor
.25 to .50	Poor
.51 to .75	Fair
.76 to .90	Good
>.90	Excellent

SHEAR STRENGTH

UNDRAINED SHEAR STRENGTH IN P.S.F.	CONSISTENCY
<250	Very Soft
250-500	Soft
500-1000	Med. Stiff
1000-2000	Stiff
2000-4000	Very Stiff
>4000	Hard

CORRELATION GUIDE OF "N" TO DENSITY/CONSISTENCY

DENSITY (GRANULAR SOILS)		CONSISTENCY (COHESIVE SOILS)	
N	DESCRIPTIVE TERM	N	DESCRIPTIVE TERM
<5	Very Loose	<2	Very Soft
5-10	Loose	2-4	Soft
11-24	Med. Dense	5-8	Med. Stiff
25-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		31-60	Hard
		>60	Very Hard

COMMONLY USED SYMBOLS

▼	Water Elevation
⊙	Standard Penetration Boring
⊕	Auger Boring
⊖	Rod Sounding
S	Sample
N	Standard Penetration Test (SPT)
	Blow Count Per Foot For:
	2" O.D. Sampler
	1 3/8" I.D. Sampler
	Hammer Weight Of 140 Lbs.
	Hammer Fall Of 30"
R	Refusal - SPT blows per foot =
	to or > 100
VS	Field Vane Shear Test
US	Undisturbed Soil Sample
B	Blast
DC	Diamond Core
MD	Mud Drill
WA	Wash Ahead
HSA	Hollow Stem Auger
AX	Core Size 1 1/8"
BX	Core Size 1 3/8"
NX	Core Size 2 1/8"
M	Double Tube Core Barrel Used
LL	Liquid Limit
PL	Plastic Limit
PI	Plasticity Index
NP	Non Plastic
w	Moisture Content (Dry Wgt. Basis)
D	Dry
M	Moist
MTW	Moist To Wet
W	Wet
Sat	Saturated
Bo	Boulder
Gr	Gravel
Sa	Sand
Sl	Silt
Cl	Clay
HP	Hardpan
Le	Ledge
NLTD	No Ledge To Depth
CNPF	Can Not Penetrate Further
TLOB	To Ledge Or Boulder
NR	No Recovery
Rec.	Recovery
%Rec.	Percent Recovery
RQD	Rock Quality Designation
CBR	California Bearing Ratio
<	Less Than
>	Greater Than

COLOR

blk	Black	prk	Pink
bl	Blue	pu	Purple
brn	Brown	rd	Red
dk	Dark	tn	Tan
gr	Gray	wh	White
gn	Green	yel	Yellow
lt	Light	mltc	Multicolored
or	Orange		

DEFINITIONS (AASHTO)

BEDROCK (LEDGE) - Rock in its native location of indefinite thickness.

BOULDER - A rock fragment with an average dimension > 12 inches.

COBBLE - Rock fragments with an average dimension between 3 and 12 inches.

GRAVEL - Rounded particles of rock < 3" and > 0.075" (#10 sieve).

SAND - Particles of rock < 0.075" (#10 sieve) and > 0.0025" (#200 sieve).

SILT - Soil < 0.0025" (#200 sieve), non or slightly plastic and exhibits no strength when air-dried.

CLAY - Fine grained soil, exhibits plasticity when moist and considerable strength when air-dried.

VARVED - Alternate layers of silt and clay.

HARDPAN - Extremely dense soil, cemented layer, not softened when wet.

MUCK - Soft organic soil (containing > 10% organic material).

MOISTURE CONTENT - Weight of water divided by dry weight of soil.

FLOWING SAND - Granular soil so saturated (loose) that it flows into drill casing during extraction of wash rod.

STRIKE - Angle from magnetic north to line of intersection of bed with a horizontal plane.

DIP - Inclination of bed with a horizontal plane.

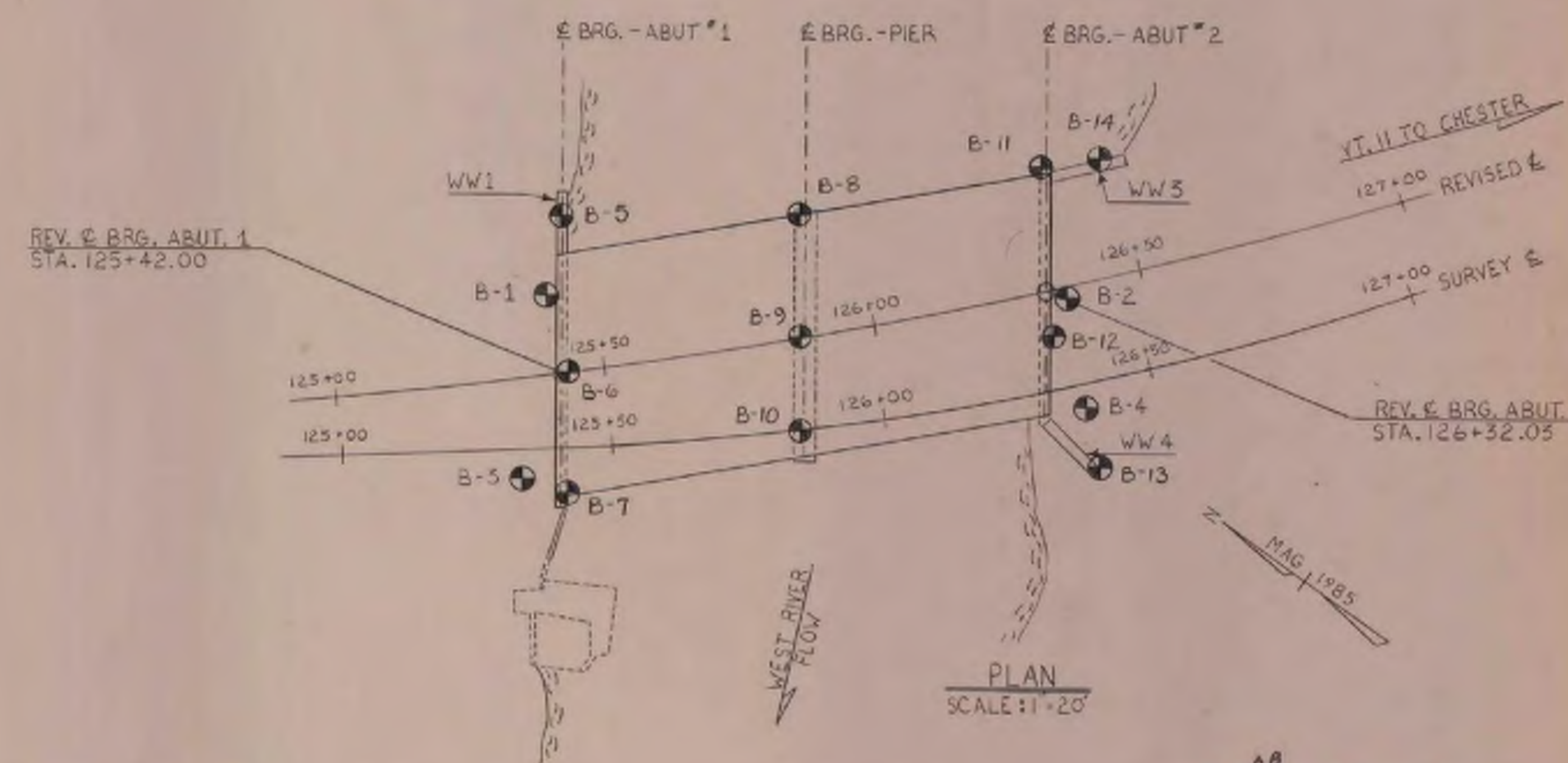
GENERAL NOTES

- The subsurface explorations shown herein were made between 2-22-86 and 2-27-91 by the Agency.
- Soil and rock classifications, properties and descriptions are based on engineering interpretation from available subsurface information by the Agency and may not necessarily reflect actual variations in subsurface conditions that may be encountered between individual boring or sample locations.
- Observed water levels and/or conditions indicated are as recorded at the time of exploration and may vary according to the prevailing rainfall, methods of exploration and other factors.

- Engineering judgement was exercised in preparing the subsurface information presented herein. Analysis and interpretation of subsurface data was performed and interpreted for Agency design and estimating purposes. Presentation of the information in the Contract is intended to provide the Contractor access to the same data available to the Agency. The subsurface information is presented in good faith and is not intended as a substitute for personal investigation, independent interpretation, independent analysis or judgement by the Contractor.

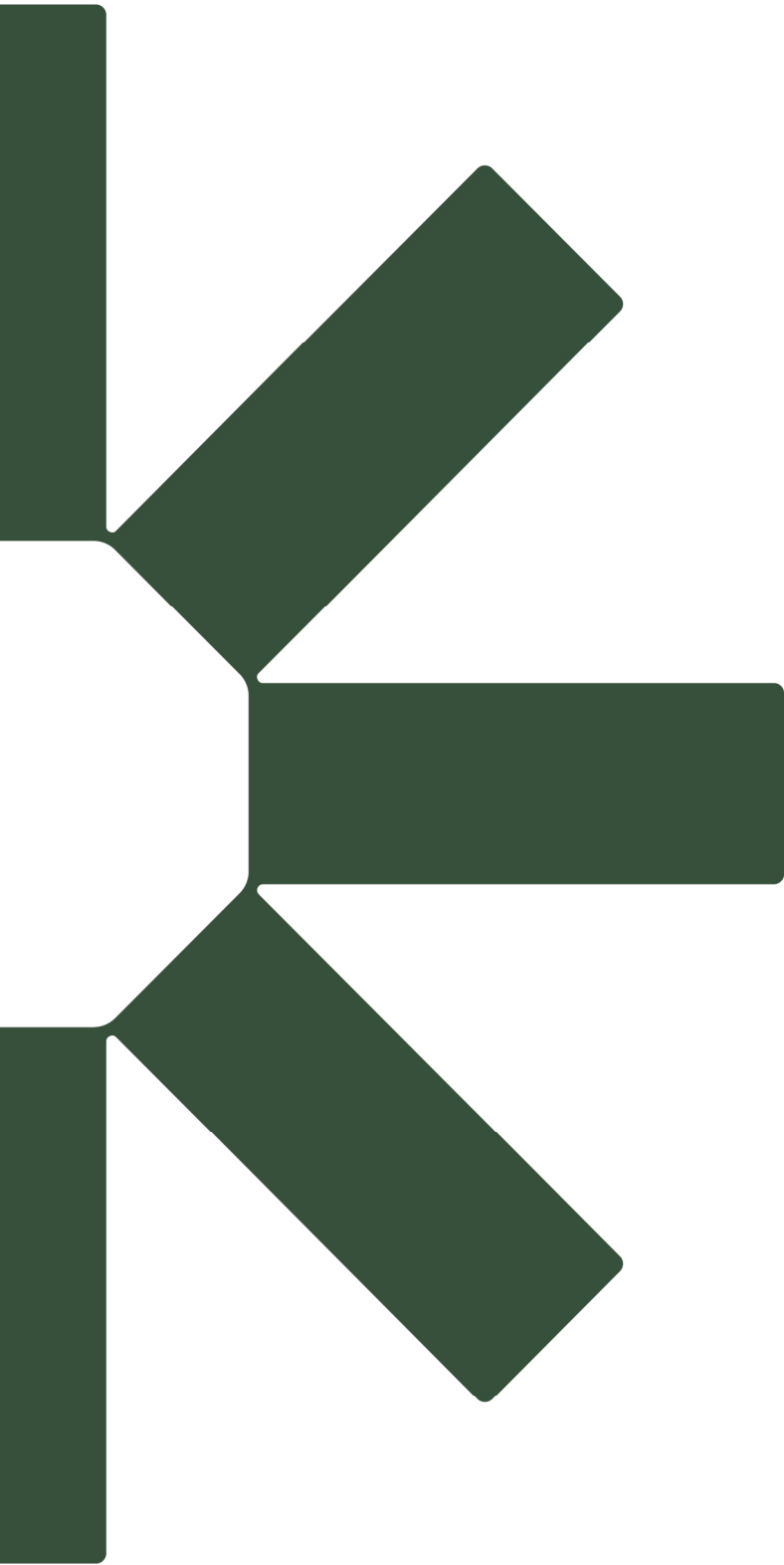
- Pictorial structure details shown on the boring plan layout or soils profile are for illustrative purposes only and may not accurately portray final contract details.

BORING NO.	STATION	OFFSET	GRD. ELEV.	LEDGE ELEV.
B-1	125+39	28' LT.	1150.2'	1131.2'
B-2	126+37	16' LT.	1150.6'	1129.4'
B-3	125+33	5' RT.	1149.5'	1131.5'
B-4	126+37	4' RT.	1150.8'	1129.8'
B-5	125+41	42' LT.	1148.5'	1134.5'
B-6	125+41	14' LT.	1150.5'	1133.0'
B-7	125+40	8' RT.	1149.4'	1132.4'
B-8	125+89	39' LT.	1143.7'	1130.2'
B-9	125+87	17' LT.	1150.9'	1130.9'
B-10	125+85	9'	1151.0'	1133.0'
B-11	126+36	40' LT.	1143.7'	1128.2'
B-12	126+32	10' LT.	1150.8'	1129.8'
B-13	126+36	15' RT.	1150.6'	1143.6'
B-14	126+50	39' LT.	1143.7'	1129.7'



STATE OF VERMONT AGENCY OF TRANSPORTATION

Town of LONDONDERRY	Bridge No. 28
Highway No. VT 11	Log Sta. 125+27
	REV. Sta. 125+87.02
BORING INFORMATION SHEET	
VT. II OVER THE WEST RIVER	
Designed By C.W. MEUNIER	Drawn By J. CLARK
Checked By DAVID J. HOYNE	Bridge Design Supervisor
Date 1-94	J.B. MCCARTHY Date 1-94
PROJECT LONDONDERRY	PROJECT NO. BR 016-1(13)S
I.G.C. Info. ZFAH70JDBORINGSD.DGN / R. S. HAUPT 2-85 / REV. 1-87	
Bridge Sheet No. BR 104	Sheet 37 of 119



Making Sustainability Happen