



# Montgomery Flood Hazard Mitigation Study

**Final**

**Montgomery, Vermont  
Franklin County Natural Resources Conservation District**

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## 1.0 Introduction

SLR was retained by the Franklin County Natural Resources Conservation District (FCNRCD) to complete a flood hazard mitigation study in Montgomery, a rural town located in the Missisquoi River watershed in northern Vermont. The Trout River flows through Montgomery, originating on the western slopes of the green mountains and flowing northwesterly to the Missisquoi River, one of the largest watersheds in the Lake Champlain Basin. This study is focused on the section of the Trout River from just upstream of Montgomery Center to the Enosburgh town line.

Two development centers exist in Montgomery – Montgomery Center (“the Center”) and Montgomery Village (“the Village”). The Center is located in an area where the Trout River transitions from a steeper mountainous setting to a wider lowland valley. The Village is located downstream at the confluence of Black Falls Brook. Numerous homes, businesses, and infrastructure throughout the study area are prone to flooding and fluvial erosion.

SLR collected field data, compiled historic flooding observations, and conducted hydraulic modeling to understand flood patterns. The study also included an alternatives analysis to explore flood mitigation options with the primary goal of reducing flood hazards within the project area.

### 1.1 Watershed Description

The Trout River watershed is 86 square miles in size and drains lands in the towns of Bakersfield, Belvidere, Berkshire, Enosburgh, Jay, Lowell, Montgomery, Richford, and Westfield (VANR). The Trout River is a tributary to the Missisquoi River and was designated as a Wild and Scenic River by the National Park Service in 2014 (Dept. of Interior, 2014). The designation is within the Recreational classification and includes the following Outstandingly Remarkable Values: Culture, Fish, Geology, History, Recreation, Scenery, Wildlife, and Water Quality (Missisquoi & Trout, 2013).

The Trout River originates at the confluence of Jay Brook and Wade Brook east of Montgomery Center and flows 11 miles to the confluence with the Missisquoi River in Berkshire. This study includes the stretch of the Trout River beginning approximately 0.5 miles downstream of the confluence of Jay Brook and Wade Brook and ending 0.1 miles upstream of the Berkshire town line. In total, 7 miles of the Trout River are included in this hydraulic analysis.

The study also includes the largest tributaries to the Trout River, including Hannah Clark Brook, the South Branch of the Trout River, Black Falls Brook, West Hill Brook, and an unnamed tributary that originates along Longley Bridge Road.

The size of the watershed at the upstream end of the study area is 19.3 square miles, compared to 72.6 square miles at the downstream end of the study area. At the upper end of the study area, the Trout River has a narrow valley and steep slope, with abundant bedrock cascades. The slope of the river decreases and the valley widens out as it flows westerly into Montgomery Center. Downstream of the Center the river further flattens and meanders through agricultural and forested lands for much of the study area.

A Phase 2 stream geomorphic assessment was performed on the Trout River during the early 2000s. The study area is within reaches M02, M03, and M04. Bank stabilization in the vicinity of Longley Bridge Road, and river corridor protection are the only projects identified in the assessment report within the project area. The report also details that this section of the Trout River is moderately well connected to its floodplain with some historic channel incision (The Johnson Company, 2007).



Like many Vermont villages, towns, and cities, early settlement patterns and the more recent history of development have landed the Center and the Village in the floodplain. Furthermore, transportation infrastructure with elevated embankments has been placed in many river valleys. Development in the floodplains of large rivers and small streams is the primary reason that flood damages have been so extensive in the region in the past two decades. Flood water surface elevations are locally elevated due to reduced flow capacity at undersized structures that are either backwatered or clogged with sediment and large woody debris. Other mechanisms of increased flooding observed around Vermont over the past several years include reduced floodplain access even in areas where development does not exist.

This project characterizes flooding patterns along the Trout River and major tributaries in Montgomery and evaluates alternatives that have the potential to reduce flood and erosion risks over the long term. The project generally consisted of data review, survey, hydraulic modeling, alternatives analysis, and concept design development. This report summarizes the findings and recommendations of the study.

## 1.2 Goals and Objectives

The primary goal of the study is to create a model of the Trout River and major tributaries and their floodplains and identify potential flood hazard mitigation projects for Montgomery.

Project objectives include the following items.

1. Build on existing information to define the primary flood and erosion risks in Montgomery.
2. Survey the channel and floodplain to create a hydraulic model of the Trout River and major tributaries.
3. Perform an alternatives analysis with the model to explore flood hazard mitigation options.
4. Consider additional project benefits such as water quality improvement and habitat improvement.
5. Provide recommended alternatives for flood risk reduction.
6. Create concept designs for up to five high priority projects.
7. Increase awareness of the risks associated with flooding due to the geophysical setting in the area and possible solutions through this report and public presentations.

## 1.3 Community Engagement

Participation by Montgomery community members in the process of flood hazard mitigation project identification and development was an important component of the project. Four public meetings were held at varying stages of the project to gather important information from community members about flood history and known issues, ideas for flood mitigation projects and strategies, and input on proposed alternatives. Alternatives for which concept designs were prepared were selected by Montgomery residents.



## 2.0 Existing Conditions

During 2024, SLR compiled existing data and collected new data to document existing conditions at the project site. Additional details on assessment methodologies are provided in the subsequent sections.

### 2.1 Data Collection

The project was initiated by compiling available data about the study reach. A public project kickoff meeting was held to gather information from project partners and residents of the area about the Trout River and observations of past flooding. Numerous residents attended, as well as representatives from the town and FCNRCD.

Data sources leveraged included:

- FEMA flood damage reporting
- 2017 LiDAR data (0.7m horizontal resolution)
- Historic aerial photos and topo maps
- 2022 aerial imagery (VCGI)
- Photos of flooding provided by residents and the Town
- Anecdotal reports from residents and the Town regarding flooding
- National Weather Service flood reporting
- Stream geomorphic assessment data (2007)

### 2.2 Field Survey

Scientists and engineers from SLR visited the project site several times throughout 2024 to collect field data. Targeted sections of the Trout River and tributaries were walked to document the channel and overbanks and visually assess flood risks. Locations of significant features were recorded using a submeter Global Positioning System (GPS) unit.

Ground survey was collected at nine bridges to define the bridge hydraulic opening and dimensions. Cross sections were surveyed both upstream and downstream of each bridge face. Seven of the bridges cross the Trout River and two cross Black Falls Brook. Three of the structures are historic covered bridges.

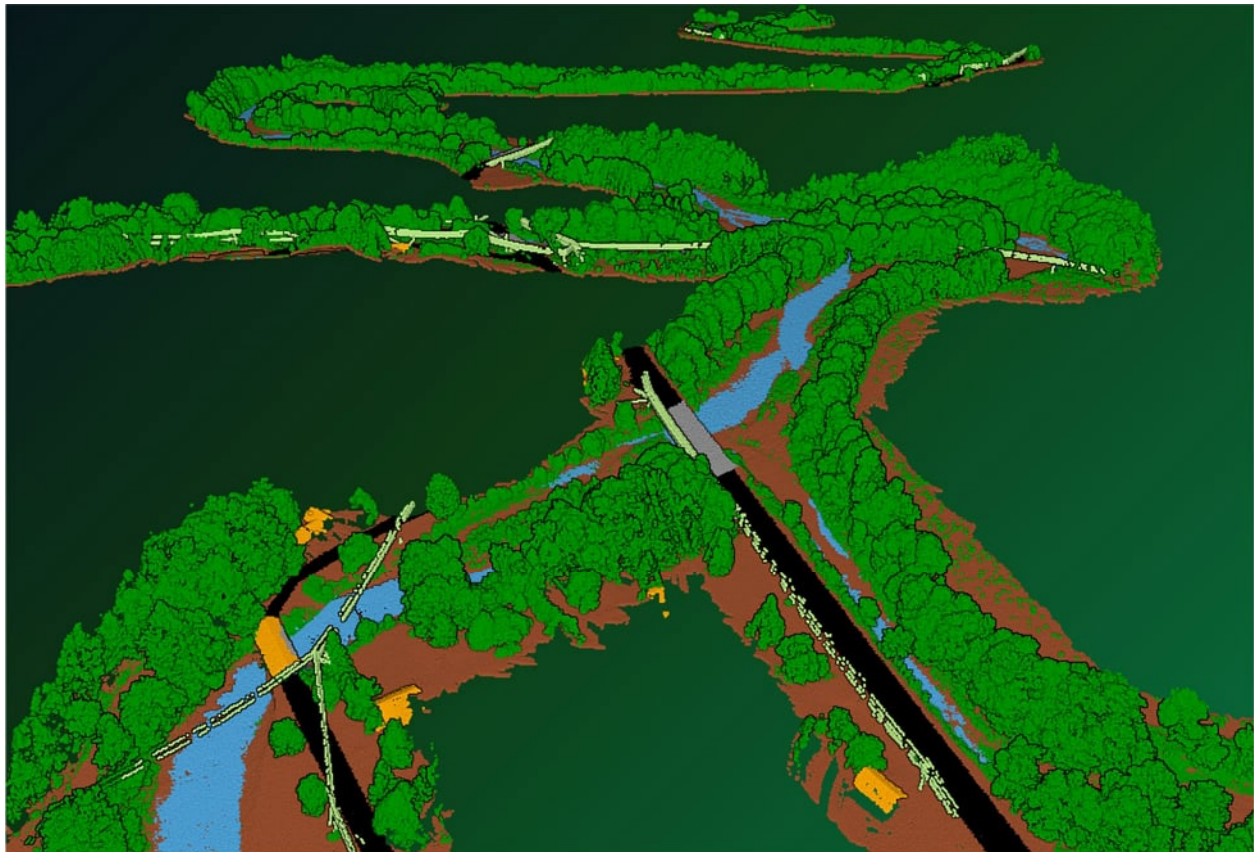
### 2.3 UAS Survey

SLR contracted with Whiteout Solutions to perform survey using unmanned aerial systems (UAS). During late April and early May 2024, Whiteout staff conducted eight flights with a Harris Aerial H6 HL drone equipped with a Reigl VQ 840 GL topobathymetric light detection and ranging (LiDAR) sensor (Figure 1). The sensor is capable of collecting 200 points per square meter with up to two centimeters vertical accuracy. Topobathy LiDAR uses two lasers – one near infrared to map the land and water surface and one green to penetrate the water surface and characterize the streambed. The green LiDAR laser is capable of mapping up to 15 meters or 2.5 times Secchi disk depth underwater. The UAS equipment collected millions of data points within the Montgomery survey area, including below the water surface of the Trout River and tributaries. A point cloud was generated with points classified by return as ground, high vegetation, building, roads, utility, bridges, and water (Figure 2).





**Figure 1.** Topobathymetric LiDAR enabled UAS at the Longley Covered Bridge.



**Figure 2.** UAS classified point cloud looking downvalley from Comstock Covered Bridge.

The UAS point cloud was also used to generate a high accuracy digital terrain model (DTM) for the Trout River and tributaries. The DTM has a cell size of 0.25 feet and encompasses the

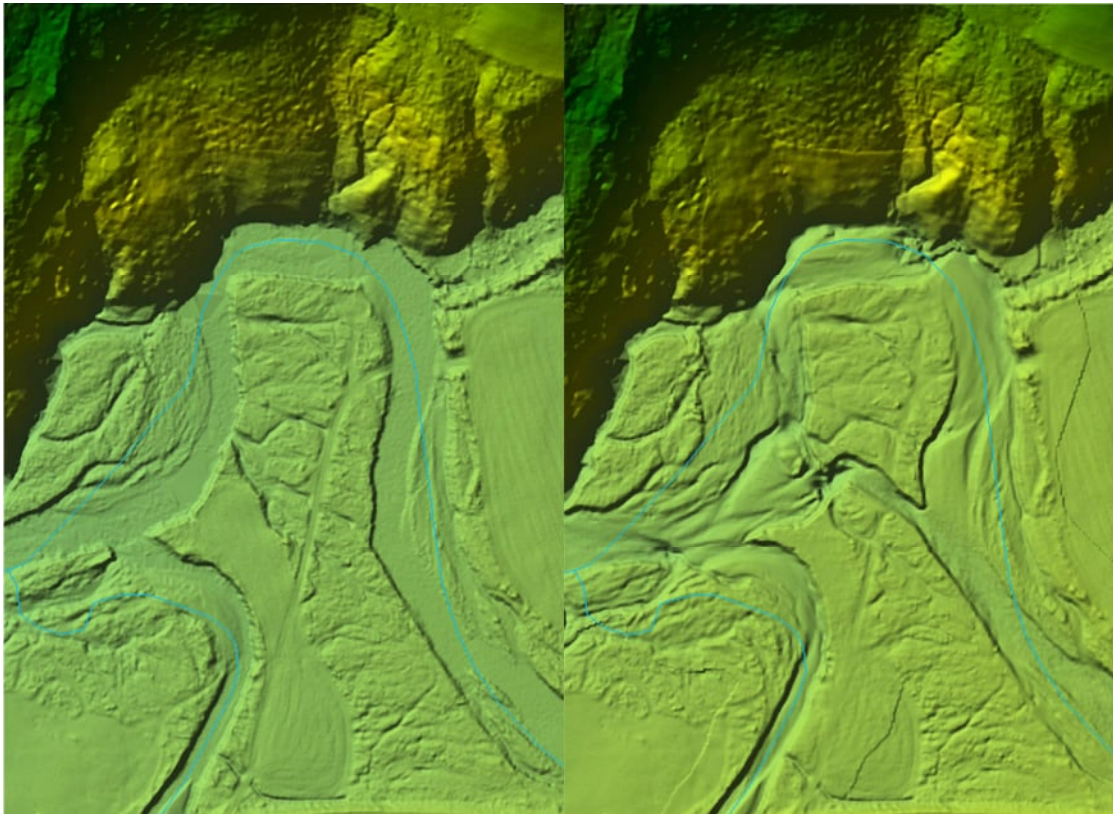


channel and overbanks of the Trout River, Black Falls Brook, West Hill Brook, and the South Branch of the Trout River within the study area.

Whiteout Solutions created the UAS geospatial data in conjunction with ground survey to determine known elevation points, or ground control points (GCPs). Nine ground control points were set and surveyed by both traditional survey equipment and the topobathymetric LiDAR sensing drone. These ground control points were used to correct elevations for the DTM of the study area. GCPs were set in locations with nearly level bare ground with an open view of the sky where their disturbance was unlikely.

Further data correction was conducted through comparison of UAS data to the State LiDAR data from 2017. Slight adjustments were made to the digital terrain model to achieve better agreement between areas where changes in elevation were not anticipated to have occurred between 2017 and 2024.

The post-correction product provides extremely high-resolution terrain data, which was used in the hydraulic model to reflect existing conditions at the site (Figure 3). The topobathy DTM covers the stream channel and banks; 2017 LiDAR was used for all other areas within the model extent.



**Figure 3.** 2017 LiDAR only (left) 2017 LiDAR with 2023 UAS survey added (right) shows the streambed beneath the water surface and channel migration not reflected in LiDAR data

UAS surfaces do not replace traditional ground survey and are not suitable for construction design.



## 2.4 Structures

A brief description of the bridges and culverts located in the study area follows. Structures are ordered from upstream to downstream on the Trout River, and then upstream to downstream on tributaries.

### North Main Street Bridge

North Main Street (Route 118) crosses the Trout River in Montgomery Center between Mountain Road and Hazens Notch Road. The bridge was destroyed during the flood of 1997 and a new bridge was built the same year. The structure has a concrete deck with concrete abutments with a 60-foot span and a 13.5-foot rise (Figure 4).



**Figure 4.** North Main Street Bridge in Montgomery Center.

### Snowmobile Bridge

Approximately 550 feet downstream of the North Main Street Bridge, a snowmobile bridge crosses the Trout River, connecting from River Street to agricultural lands on the south side of the river. The bridge is part of the Vermont Association of Snow Travelers (VAST) trail network. The bridge is comprised of two steel I beams with a timber deck and stone abutments and has a 100-foot span and 12.8-foot rise (Figure 5).





**Figure 5.** Snowmobile bridge in Montgomery Center.

#### Vincents Bridge

Less than half a mile upstream of Montgomery Village, Vincents Bridge Road crosses the Trout River, connecting Route 118 to homes on the south side of the river. The bridge has an 89-foot span and a concrete deck over steel beams and concrete abutments. The bridge was built in 1974.

#### Comstock Covered Bridge

Just west of Montgomery Village, Comstock Bridge Road crosses the Trout River approximately 500 feet upstream of Route 118. The bridge is a historic covered bridge originally built in 1883 and reconstructed in 2003. The covered bridge is constructed of wood and has a 58-foot span (Figure 6).



**Figure 6.** Comstock Covered Bridge.



### Route 118 Bridge (1)

The first of two bridges in close proximity over the Trout River on Route 118 (North Main Street) is located immediately east of the western Comstock Bridge Road intersection. The bridge has a 170-foot span with two piers. The bridge was built in 1953 and reconstructed in 2022.

### Route 118 Bridge (2)

A second bridge over the Trout River is located approximately 1/10 mile west of the West Hill Road intersection. The bridge is constructed of steel beams with a concrete deck and concrete abutments and has a 185-foot span with two concrete piers. The bridge was constructed in 1953 and reconstructed in 2006.

### Longley Covered Bridge

Just west of the intersection of Longley Bridge Road with Route 118, a historic covered bridge crosses the Trout River. The bridge was built in 1863 and was reconstructed in 2017. The covered bridge is constructed of wood and has a 66-foot span (Figure 7).



**Figure 7.** Longley Covered Bridge.

### Driveway Bridge to 768 Mountain Road – Hannah Clark Brook

A bridge over Hannah Clark Brook connects the home at 768 to Mountain Road. The bridge is single lane, comprised of steel beams, has concrete abutments, and has a timber deck. The bridge has a span of 35 feet and a rise of 11 feet (Figure 8).





**Figure 8.** Driveway bridge to 768 Mountain Road.

Black Falls Road – Black Falls Brook

Black Falls Road crosses Black Falls Brook just north of the intersection with North Hill Road. The bridge has a 65-foot span and was built in 1970.

Fuller Covered Bridge – Black Falls Brook

In Montgomery Village, Fuller Bridge Road crosses Black Falls Brook between the intersections of Brook Road and Black Falls Road. The structure is a historic covered bridge built in 1890 and reconstructed in 2000. The wooden covered bridge has a span of 42 feet (Figure 9).



**Figure 9.** Fuller Covered Bridge.



### Route 118 Bridge – West Hill Brook

Route 118 (North Main Street) crosses West Hill Brook between the intersections of West Hill Road and Hill West Road. The bridge has a 120-foot span with two piers. The rise varies from 2.6 feet to 6.4 feet with significant accumulation of sediment throughout the structure (Figures 10 and 11).



**Figure 10.** Sediment accumulation at West Hill Brook bridge.



**Figure 11.** West Hill Brook bridge from upstream.

### Longley Bridge Road Culvert – Longley Bridge Road Tributary

Longley Bridge Road crosses an unnamed tributary to the Trout River approximately 0.7 miles from the intersection with Route 118. A concrete box culvert exists under the road with a span and rise of 7 feet. The culvert has 1-foot concrete baffles on the bottom with staggered



placement throughout the structure. At the time of field data collection, an outlet drop of 1 foot exists from the culvert floor to the water surface of the downstream pool (Figures 12 and 13).



**Figure 12.** Longley Bridge Road tributary culvert outlet.



**Figure 13.** Longley Bridge Road tributary culvert outlet.

### 3.0 Hydrology

Peak flows were estimated for the Trout River, Hannah Clark Brook, the South Branch of the Trout River, Black Falls Brook, West Hill Brook, and one unnamed tributary to the Trout River for input into the hydraulic model. A gage analysis was performed using available stream gaging data from two nearby gages and compared to estimates calculated using United States Geological Survey (USGS) regional regression equations (Olson, 2014) (USGS, 2019), the



Steep Streams Regression (Jacobs, 2010), and the FEMA flood insurance study (FEMA, 2001). Estimates were calculated for the following locations.

- The Trout River at the upstream end of the model – behind 1055 Hazens Notch Road
- Hannah Clark Brook at the confluence with the Trout River (approximately 0.3 miles upstream of Montgomery Center)
- The South Branch of the Trout River at the confluence with the Trout River (across from River Street in Montgomery Center)
- Black Falls Brook at the Confluence with the Trout River in Montgomery Village
- West Hill Brook at the confluence with the Trout River just downstream of Montgomery Village
- Longley Bridge Road Tributary at the confluence with the Trout River downstream of the Longley Covered Bridge

Flood frequency analysis was performed for two stream gages located near the project area. The Missisquoi River near North Troy (USGS 04293000) is located approximately 13 miles from the study area and has a drainage area of 131 square miles. The Black River at Coventry, VT (USGS 04296000) is approximately 17 miles from the study area and has a drainage area of 122 square miles. The Missisquoi River gage has been collecting data since 1932, while the Black River gage has been in operation since 1952. Statistical analysis was performed on all available peak flow data for each gage using HEC-SSP (Hydraulic Engineering Center Statistical Software Package). HEC-SSP was used to perform a USGS Bulletin 17C analysis of peak flow data to determine the return period and probability for each reported peak flow (England et al., 2019). The peak flows were then scaled using drainage area to the project site to provide estimated flows for a range of recurrence intervals from 2-year to 500-year.

A USGS gage was in operation on the Trout River from July 31, 2009 through October 13, 2011. This gage, Trout River at Hopkins BR, NR Enosburg Falls, VT (USGS 04293600), does not have a long enough flow record to support statistical analysis of flood flows. However, the gage was in operation for one important flood within the Trout River watershed – Tropical Storm Irene on August 28, 2011. The gage is located 0.9 miles downstream of the lower end of the hydraulic model at Hopkins Bridge Road.

Flows for the four calculation methods were compared (Table 1). The scaled gage flows from the Bulletin 17C analysis were substantially lower than the flows reported in the FEMA flood insurance study, those calculated with StreamStats, and those calculated with the Jacobs equation.

The scaled gage flows were also very different between the Missisquoi and Black River gages, with the scaled Black River flows being approximately half the scaled Missisquoi River flows. This suggests that the flow gage data from these two watersheds do not scale well for comparison. The Trout River watershed at the study area is much smaller and comprised of more mountainous terrain, creating flashier flow conditions and different flooding patterns.

The flows reported in the FEMA flood insurance study were used in the model where available and supplemented with StreamStats flows for tributaries not included in the study (Table 1). Among the flow calculation methods analyzed, agreement was best between the StreamStats and FEMA flows where the two could be compared.

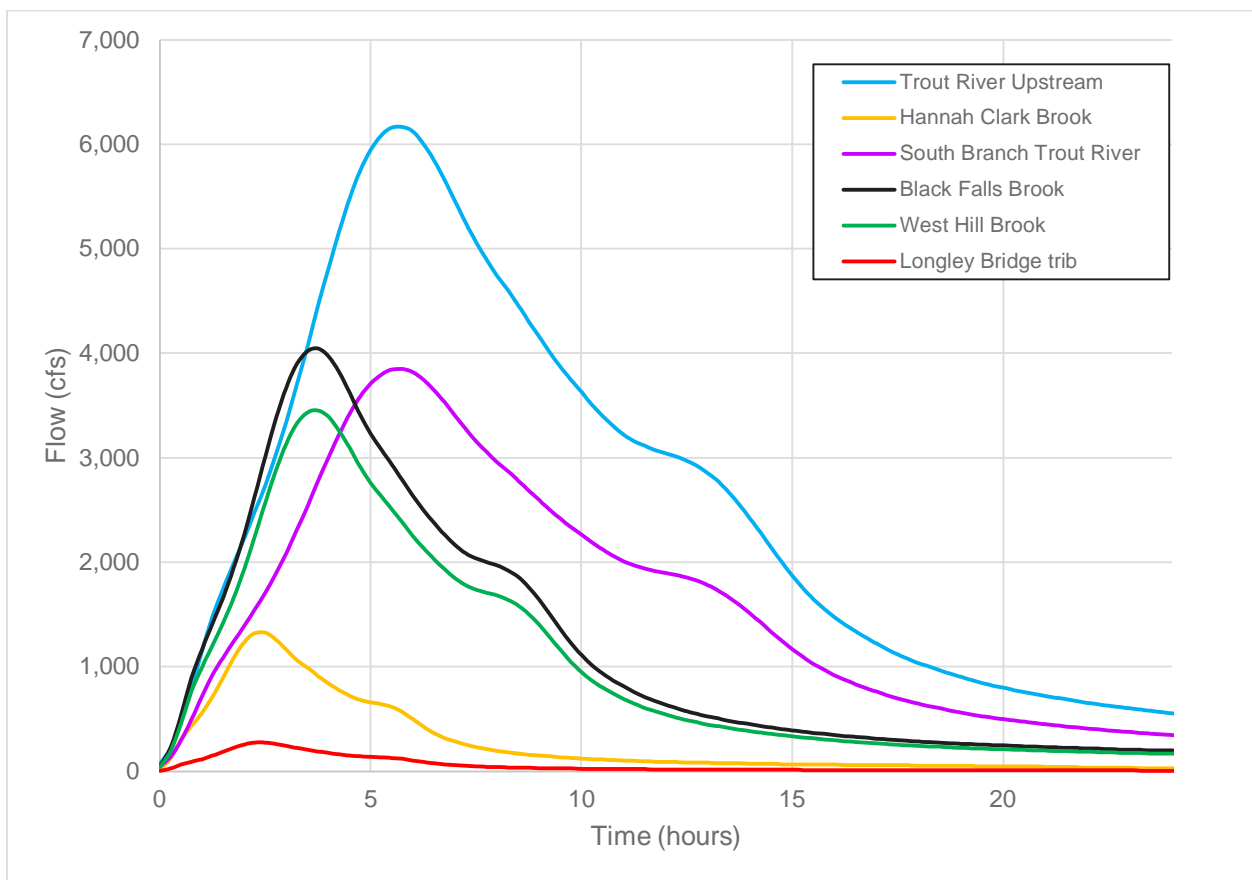
Peak flows were converted to hydrographs using the shape of the flood hydrograph for Tropical Storm Irene at the Trout River USGS gage (Figure 14).



**Table 1. Model flows (cubic feet per second)**

Flow Input Location	Drainage Area (sq mi.)	Recurrence Interval				
		2-year	10-year	50-year	100-year	500-year
Trout River at Upstream End of Model	19.3	1,180*	2,878	4,980	6,250	9,490
Hannah Clark Brook	4.7	319*	672*	1,120*	1,350*	2,010*
South Branch Trout River	18.3	911*	2,550	3,800	3,900	5,500
Black Falls Brook	10.6	696*	1,900	3,400	4,100	5,900
West Hill Brook	12.4	671*	1,800	3,000	3,500	5,000
Longley Bridge Tributary	1.26	65.6*	140*	234*	282*	417*

\*Flows from StreamStats. All other flows are from the FEMA Flood Insurance Study.



**Figure 14. 100-Year Flow Hydrographs for Model Inputs**



## 4.0 Hydraulic Modeling

### 4.1 Modeling Approach

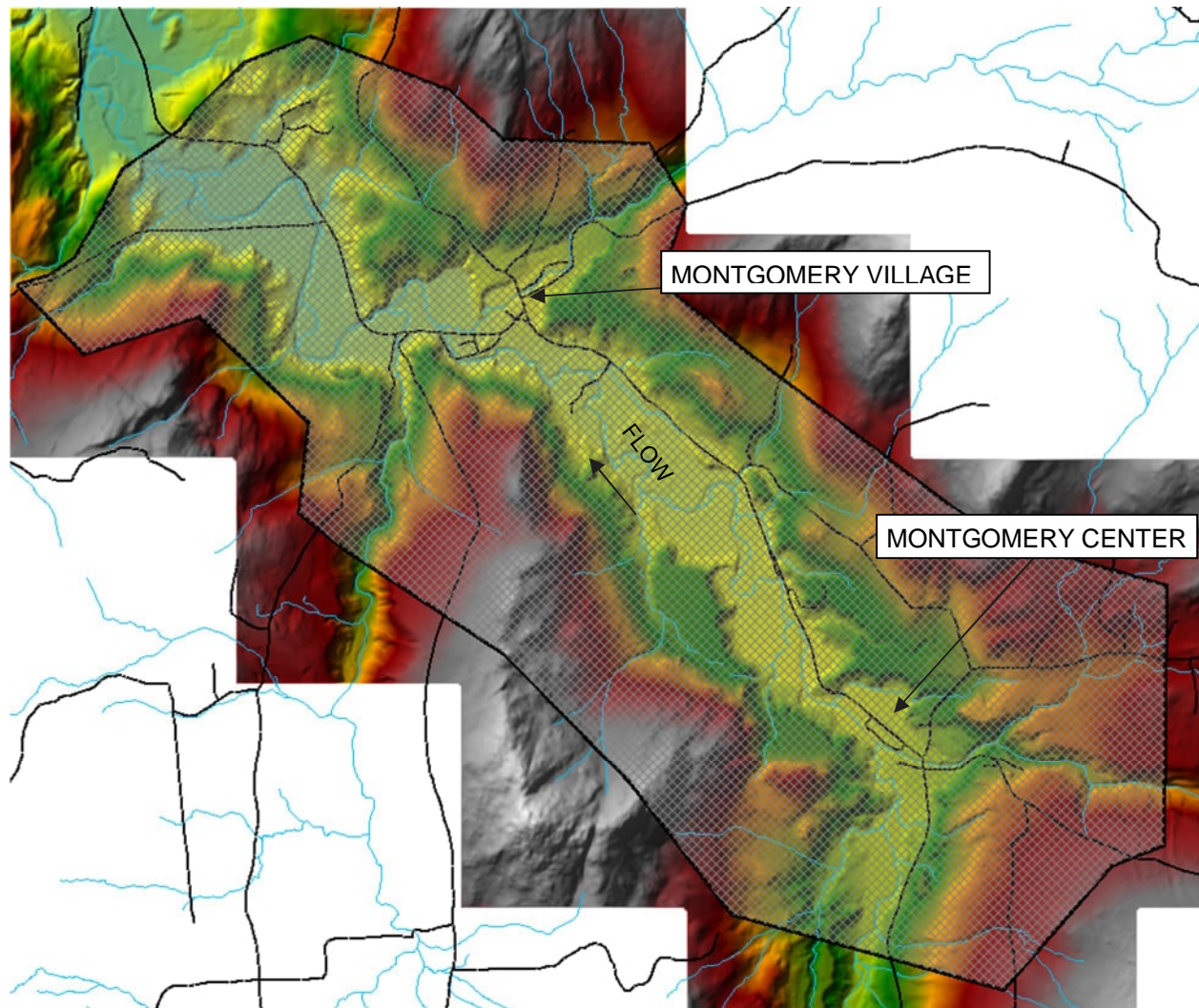
Hydraulic modeling was performed to predict water depth, flow velocity, potential for scour, and flood extent for the flows reported above. The modeling was performed for existing and proposed conditions to evaluate flood mitigation alternatives.

Hydraulic modeling was completed using the United States Army Corps of Engineers (USACE) *Hydrologic Engineering Center – River Analysis System* (HEC-RAS) version 6.5 computer modeling software (USACE, 2022). A two-dimensional (2D) hydraulic model was developed to evaluate the Trout River and tributaries within the study area. 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.

The 2D mesh for the Trout River model has an area of over 4,600 acres (7.2 square miles) and encompasses 7 miles of the Trout River channel. The model includes eleven bridges and one culvert. Flow is input to the model mesh from the Trout River and five tributaries. Model results, including water surface elevations, flow velocities, and shear stress are predicted across the 2D mesh and are used to evaluate existing conditions for flooding within the study area and to test flood mitigation alternatives.

The Trout River was modeled from behind 1055 Hazens Notch Road downstream to 1.1 miles downstream of the Longley Bridge. The 2D model extent encompasses the width of the Trout River valley and tributaries (Figure 15).





**Figure 15.** 2D hydraulic model mesh.

#### **4.1.1 Model Setup**

The model terrain was developed from a combination of 0.7-meter resolution LiDAR data (VCGI, 2017) and UAS-based green LiDAR elevation data covering the Trout River mainstem and several tributaries. The green LiDAR penetrates the water surface to capture the bathymetry of the river, with a derived output digital terrain model that includes the streambed. The traditional LiDAR does not penetrate water, so model terrain in these areas, which are located upstream of all areas of concern, is representative of the water surface or shallow river features such as riffles.

Nominal node spacing in the computational domain was set to 50 feet with a square mesh pattern. Refinement regions, with a reduced cell size of 10 feet, were used to define areas of concern where homes and infrastructure are at risk, as well as the stream channels. Breaklines were also used to define linear features with a cell spacing of 10 feet (roads, bridges, and culverts).



Manning's roughness coefficients were categorized by land cover and assigned based on 2016 land cover mapping conducted by the University of Vermont Spatial Analysis Laboratory (Table 2).

**Table 2. Manning's Roughness Coefficients by Landcover**

Landcover Type	Roughness Coefficient
Agricultural	0.035
Bare Earth	0.025
Building	10
Grass / herbaceous	0.030
Other Paved	0.016
Roads	0.020
Scrub-shrub	0.100
Tree Canopy	0.080
Water	0.035

Stream crossings were incorporated into the model mesh using 2D connections. The downstream boundary condition for the model was determined using normal depth calculations based on an interpolated energy grade line (EGL) slope for the downstream channel. The model was run in an unsteady state condition with the flood hydrographs input into each tributary at the upstream boundaries for a range of flood sizes (2-, 10-, 50-, 100-, 500-year).

## 4.2 Existing Conditions

The existing conditions model was created by combining LiDAR data (2017) with UAS green LiDAR data (2024) to create a representative terrain of the project area. The 2D model mesh has over 250,000 cells.

Existing conditions modeling provides important information about current flood patterns within the study area. Results from the existing conditions modeling are shown by flood event (Appendix A).

Existing conditions results for all modeled events were examined to determine extent of flooding around buildings, roads, and bridges. Results were evaluated for the 50-year, 100-year, and 500-year flood events. Discussion of results is focused on Montgomery Center, Montgomery Village, and other known problem areas.

For the 50-year flood, existing conditions modeling shows that floodwaters remain in the channel of the Trout River until the western half of River Street in Montgomery Center. The model shows 0.5 to 2 feet of water around houses along River Street and 0.5 to 3 feet around houses on North Main Street just west of River Street. In the Village, the model results show 0.5 feet of flood water around homes and businesses on the south side of Black Falls Brook for the 50-year flood, with 0.5 feet to 1 foot at the base of Brook Road to the north of Black Falls Brook. The lower portion of the Village sees overtopping of Comstock Bridge Road and Route 118 with



0.5 feet to 1 foot of water at the eastern intersection of the two roads, as shown on the 50-year flood map for the Village in Appendix A.

The modeled 50-year flood also shows overtopping of Comstock Bridge Road just east of the covered bridge with 0.5 feet to 1 foot of water over the road and 0.5 feet to 3 feet of water around homes. In the vicinity of the Route 118 bridge over West Hill Brook, less than 0.5 feet of water is shown overtopping Route 118 over a 500-foot length of roadway with 0.5 to 2 feet of water around homes on West Hill Road. At Longley Bridge Road, 0.5 to 1.5 feet of floodwaters are shown overtopping the road west of the covered bridge.

For the 100-year flood, existing conditions modeling shows that floodwaters remain mostly in the channel of the Trout River until River Street in Montgomery Center, with 0.5 to 2.5 feet of water around houses along River Street and 1 to 4 feet around houses on North Main Street just west of River Street. In the Village, less than 0.5 feet of water is shown around many homes and businesses on the south side of Black Falls Brook with 0.5 feet to 2 feet at the base of Brook Road to the north of Black Falls Brook.

In the lower Village, overtopping of Comstock Bridge Road and Route 118 with 0.5 feet to 2 feet of water at the eastern intersection of the two roads is shown in the 100-year flood model results. Overtopping is also seen at Comstock Bridge Road just east of the covered bridge with 0.5 feet to 1.5 feet of water over the road and 0.5 feet to 4 feet of water around homes. In the vicinity of the Route 118 bridge over West Hill Brook, 0.5 feet to 1 foot of water is shown overtopping Route 118 over a 450-foot length of roadway with 0.5 to 2 feet of water around homes on West Hill Road. At Longley Bridge Road, 0.5 to 2 feet of floodwaters are shown overtopping the road west of the covered bridge.

For the 500-year flood, existing conditions modeling shows that floodwaters remain in the channel of the Trout River until just upstream of the Montgomery Center for the Arts in Montgomery Center. Floodwaters exit the channel on both banks in this location and flow down North Main Street around homes and businesses, inundating most of the Center. Depth mapping from the model shows 1 to 3 feet around homes and businesses east of Mountain Road, 0.5 to 2 feet around businesses and homes in the eastern portion of the Center, with locally deeper water up to 4 feet around the houses closest to the river on River Street. The western portion of the Center has greater 100-year flood water depths of 1 to 6 feet around homes and businesses. The entire length of North Main Street within the Center is overtopped by 0.5 to 4 feet of water. Homes and businesses on the southern side of the Trout River in the Center are also shown to be surrounded by 0.5 to 4 feet of water.

For the 500-year flood in the Village, the model results show 0.5 to 2 feet of floodwaters flow down Black Falls Road, Brook Road, Fuller Bridge Road, and On the Common. Homes and businesses throughout the Village are surrounded by 0.5 to 3 feet of water. At the eastern intersection of Comstock Bridge Road and Route 118, 0.5 to 3.5 feet of water overtop both roads. Route 118 is overtopped from the eastern intersection of Comstock Bridge Road for over half a mile to the western Route 118 bridge with a very short section at the base of Hill West Road being shown as dry. Comstock Bridge Road in vicinity of the covered bridge is shown to be overtopped by 1 to 2 feet of water, with 1 to 3 feet of water around homes, and locally higher up to 7 feet closest to the Route 118 bridge. Route 118 is overtopped in the vicinity of West Hill Brook with the entire stretch of Route 118 between bridges under 1 to 4 feet of water. Water is 1 to 3 feet deep around homes along West Hill Brook. Longley Bridge Road is overtopped by 1 to 3 feet of water west of the covered bridge.



### 4.3 Model Validation and Convergence

The hydraulic model was validated using damage information and photographs from past flooding events. Three calibration events were used – Tropical Storm Irene on August 28, 2011; the Halloween 2019 storm on October 31, 2019; and the flash flood on July 15, 1997. Vermont Emergency Management provided damage data for the 2011 and 2019 floods in the form of Federal Emergency Management Agency (FEMA) project worksheets for Tropical Storm Irene and a spreadsheet summarizing damage data for the Halloween storm. Flood and damage records are more anecdotal for the 1997 flood.

The Trout River USGS gage was in operation during Tropical Storm Irene. A comparison of the flow recorded at the gage with the FEMA flood insurance study flow recurrence intervals indicates that Tropical Storm Irene produced flows likely between a 10-year and 50-year flood. Project worksheets detail Irene-related damages at a handful of discrete locations within the Trout River watershed as well as more general town-wide damages.

Two specific damage locations were used to evaluate and validate hydraulic model results. The project worksheet for Longley Bridge Road describes damage to 600 linear feet of roadway immediately west of the covered bridge due to overtopping by floodwaters. The length of road overtopping on this section of road was reviewed in the hydraulic model and showed good agreement between the model results in this location and observed damages. The project worksheet for damage to Black Falls Road, which runs parallel to Black Falls Brook on the southern bank, was reviewed and compared to the hydraulic model. During Tropical Storm Irene floodwaters overtopped the banks of Black Falls Brook and flowed down Black Falls Road causing 1,200 linear feet of roadway damage. Hydraulic model results for the 50-year event show floodwaters flowing down an 1,100-foot section of Black Falls Road in the same location as the project worksheet, providing further agreement between modeled and documented conditions (Figure 16).

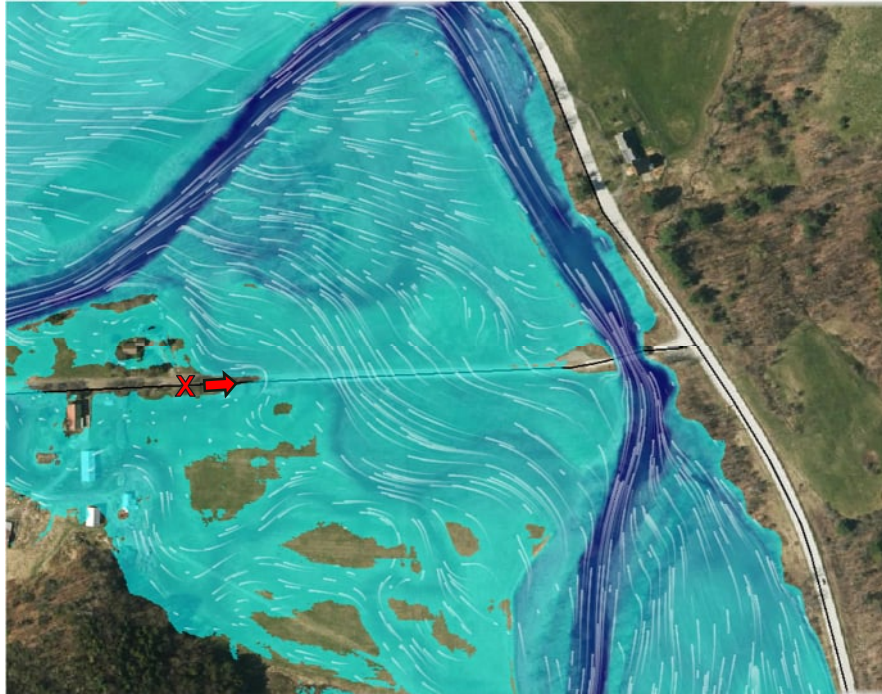
For the Halloween 2019 flood, flow data were not recorded on the Trout River. Damage data reported for Longley Bridge Road state that 630 linear feet of roadway washed out just west of the covered bridge (Figures 17 and 18). Hydraulic model results show this level of overtopping between the 10-year and 50-year events. Photos from the Halloween 2019 flood show floodwaters exiting the channel of West Hill Brook just upstream of the Route 118 Bridge on the west bank (Figures 19 and 20). The model shows overtopping in this location beginning in the 50-year storm.





**Figure 16.** Modeling shows floodwaters from Black Falls Brook flowing down Black Falls Road during the 50-year event.



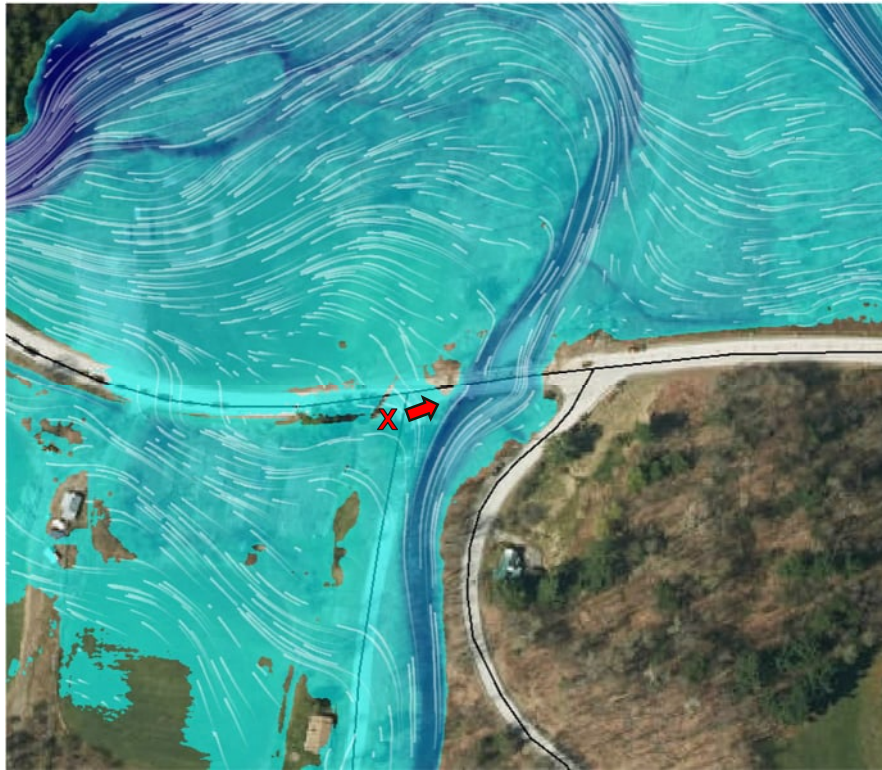


**Figure 17.** Modeling shows floodwaters from the Trout River overtopping Longley Bridge Road just west of the covered bridge during the 50-year event. Damage photo viewpoint denoted with red X.



**Figure 18.** Longley Bridge Road looking east toward the covered bridge at the damaged section of roadway following the Halloween 2019 flood.





**Figure 19.** Modeling shows floodwaters from West Hill Brook flowing out of the channel upstream of the Route 118 Bridge on the west bank during the 50-year event. Damage photo viewpoint denoted with red X.



**Figure 20.** Route 118 Bridge over West Hill Brook from intersection with West Hill Road following Halloween 2019 flood.



A National Weather Service report on the July 15, 1997 flood in Montgomery provides anecdotal information on flood damages as well as damage photos (National Weather Service). Extensive damages were reported throughout Montgomery and this flood remains the largest in recent decades. Montgomery Center reported major damages including flooding of homes and businesses all along North Main Street and the destruction of the North Main Street Bridge (Figures 21 and 22). Floodwaters appear to have exited the Trout River upstream of the North Main Street Bridge and flowed down North Main Street and across properties on Begnoche Farm Road (Figure 22). These flooding patterns best match the model results for the 500-year flood, which shows a substantial amount of water in the eastern portion of the Center. Photos from the 1997 flood show major damage on Longley Bridge Road just west of the covered bridge where floodwaters are known to overtop the roadway (Figure 23). Modeled flood depth mapping and flow vectors show floodwaters exiting the channel of the Trout River just upstream of the North Main Street Bridge and flowing westerly through the Center (Figure 24).



**Figure 21.** Looking northeast at the destroyed North Main Street Bridge in Montgomery Center following the 1997 flood.





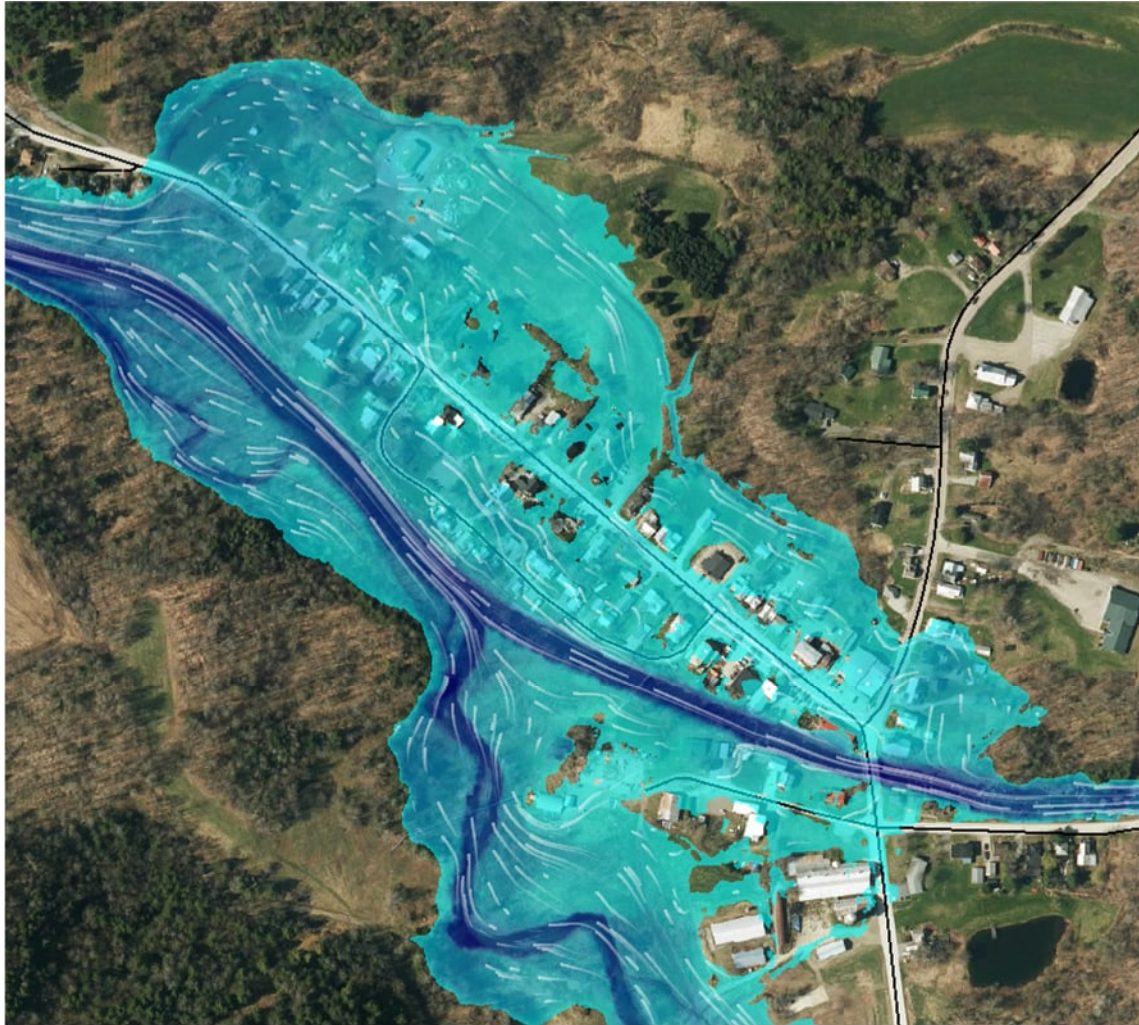
**Figure 22.** Looking south across the destroyed North Main Street Bridge following the 1997 flood.





**Figure 23.** Looking west at damage to Longley Bridge Road following the 1997 flood.





**Figure 24.** Hydraulic model results showing flooding patterns during the 500-year event in Montgomery Center.

The accuracy of the model is appropriate for evaluation of alternatives to understand relative changes to flood patterns associated with various flood mitigation options.

## 5.0 Alternatives Analysis and Hydraulic Evaluation

An alternatives analysis was performed to evaluate potential flood mitigation projects within the study area.

### 5.1 Introduction

The validated existing conditions model was used to evaluate potential flood mitigation alternatives. Numerous iterations of each alternative were modeled to maximize flood mitigation benefits to property and infrastructure, while also limiting construction impacts to the river channel and floodplain. The efficacy of alternatives at reducing potential flooding and flood related damages was evaluated primarily for the 100-year flood.



Sixteen alternatives are included in the analysis, as well as numerous additional strategies to promote community-wide flood resilience (Appendix B). Model outputs are shown on flood maps (Appendix F).

## 5.2 Floodplain Creation

Floodplain restoration areas were explored throughout the study area to increase storage for flood water, sediment, and debris. The possible reconnection areas were chosen based on existing topography and land use, field investigation, and location in relation to at-risk homes and properties. Different elevations and combinations of floodplain restoration areas were evaluated.

Over time floodplains have been encroached upon by development throughout the town, with the densest development in Montgomery Village and Montgomery Center. Floodplain area is occupied in these areas due to homes, businesses, and roads built along the Trout River and its tributaries. A series of alternatives were explored to restore floodplain that includes removal of fill, relocation of roads, and relocation/removal of buildings. Eight alternatives involve floodplain restoration.

Alternative 1 involves lowering of land at the confluence of Black Falls Brook and the Trout River. The property at 251 Fuller Bridge Road is owned by the Town that has expressed interest in completing a restoration project in this location. A larger (18 acres) and a smaller (4.5 acres) footprint of floodplain excavation were both tested in the hydraulic model (Appendix F, page 12). The land within these areas was lowered to approximately the bankfull elevation that represents connectivity at the 1- to 2-year flood. Model results for both scenarios yielded similar benefits for reduction in extent of floodwaters and reduction of in-channel water velocities along the Route 118 embankment that has been damaged during past flood events (Appendix G, pages 6 and 8).

Alternative 3 involves lowering of land along West Hill Brook in the vicinity of the Route 118 Bridge. The bridge is located in a highly depositional setting and fills with debris and sediment during flooding, sending floodwaters across West Hill Road and Route 118. Two configurations of floodplain restoration were tested, a 4.6-acre floodplain upstream of the Route 118 Bridge on the west side of the brook, and an overflow channel connecting West Hill Brook to the Trout River south of Route 118. Both floodplain restoration approaches reduce overtopping of Route 118 west of the bridge (Appendix F, pages 17 and 19). Model results show reduction of in-channel water depths of 2 to 4 feet for these alternatives just upstream of the bridge. It is recommended that this alternative also include raising a section of Route 118 between the Trout River and West Hill Brook Bridges roughly 400 feet in length to further prevent overtopping during flooding. Flood reduction benefits do not appear to extend upstream to the closest houses on West Hill Road. The floodplain option would involve realignment of approximately 880 feet of West Hill Road to outside of the footprint of excavation. The overflow channel would require construction of at least one new structure to convey the channel under West Hill Road, with either a second structure or ford just west at the location of the sugarhouse driveway.

Alternative 8 includes floodplain restoration in Montgomery Village immediately upstream of the Fuller Covered Bridge. The brook is encroached upon by Brook Road to the north and several homes and buildings and Black Falls Road to the south. In total, 3.2 acres of land on both sides of the brook were lowered to approximately the bankfull elevation (Appendix F, page 26). Hydraulic modeling results show that flood benefits are limited for implementing this alternative in isolation. This alternative would involve the relocation or acquisition of three mobile homes and one outbuilding.



Alternative 9 involves floodplain restoration on upper Black Falls Brook near the intersection of Black Falls Road and North Hill Road. In this section, the brook is encroached by Black Falls Road, which is located on the southern bank and parallels the brook. There is a large agricultural field on the opposite side of the road. This alternative looked at different sizes and configurations for floodplain reconnection on the agricultural field and includes realignment of a section of Black Falls Road behind the proposed floodplain excavation. A 10-acre and 4.7-acre footprint were evaluated in the hydraulic model. According to model results both sizes of floodplain are effective for reduction of flooding around more than 10 homes and businesses downstream in the Village (Appendix F, page 28).

Alternative 10 is a potential floodplain restoration project located along the Trout River near the Montgomery Recreation Center. The 7-acre area is on the west side of the river across from Route 118. The road embankment on the east side of the channel has had flood damages and at the time of field data collection appeared to have stability issues. Lowering the land on the opposite side of the river was found to have the potential to relieve pressure on the road embankment in small floods but not have much impact in larger floods (Appendix F, page 30).

Alternative 12 is a floodplain restoration project in Montgomery Center along the Trout River. Homes along River Street are some of the most floodprone in the Center and this alternative targets land across the river and just downstream from the street. A 4.1-acre area on the south side of the river and a 2.1-acre area on the north were lowered to the bankfull elevation separately and in combination in the hydraulic model. Based on the model results, reductions can be seen in the extent and depth of floodwaters around homes and businesses on River Street and North Main Street (Appendix F, page 33, Appendix G, page 23). Both areas are undeveloped and currently forested with likely areas of wetland.

Alternative 13 evaluates potential floodplain restoration along the South Branch of the Trout River just south of Montgomery Center. One potential floodplain restoration area is located at the confluence with the Trout River on the eastern side of the South Branch. A 5-acre area in this location was lowered to the bankfull elevation in the model to test flood reduction potential. A small reduction in flood extent and flood depths can be seen in the model results on the opposite side of the Trout River (Appendix F, page 35). A cluster of floodplain restoration areas farther upstream on the South Branch was also tested in the hydraulic model. In total, 32 acres of agricultural land on both sides of the river were lowered to the bankfull elevation. Model results for the upper South Branch floodplains show little flood reduction in the Center downstream. The lower South Branch floodplain restoration would involve the relocation or removal of a farm outbuilding.

Alternative 15 includes floodplain restoration in combination with replacement of two existing bridges in Montgomery Center (North Main Street and snowmobile bridge). The floodplain component involves lowering 2.8 acres of land on the south side of the Trout River between Hazens Notch Road and Begnoche Farm Road and the river. This alternative would involve the acquisition of five homes on Hazens Notch Road and Begnoche Farm Road (Appendix F, page 38).

Alternative 16 is a flood bypass channel that would carry floodwaters along the northern side of Montgomery Center through lands that are primarily open space. The channel would connect from the Trout River upstream of the North Main Street Bridge to the river near Mill Street downstream. Modeling shows that a flood bypass channel has the potential for some reduction in the extent and depth of floodwaters in the Center, but it would require construction of two new bridges and acquisition of two homes (Appendix F, page 43).



### 5.3 Bridge Replacement

Replacement of undersized bridges was considered in the alternatives analysis to reduce river-road-conflicts. Four bridge replacement projects were included in the alternatives analysis. The Route 118 Bridge over West Hill Brook has a history of flood damages and is located in a depositional setting. The bridge was rehabilitated in 2022 and requires regular sediment removal to reduce flood risk. One component of Alternative 2 includes replacement of the bridge with a new structure that has a longer span and higher clearance. The existing bridge is located near the confluence of West Hill Brook and the Trout River and just downstream of a major break in channel slope and change in valley width. Sediment and debris accumulate at the bridge during floods and have caused overtopping and damage to Route 118 and adjacent properties. In this alternative, the existing 160-foot bridge would be replaced with a 220-foot bridge that is raised 4 feet above the height of the current structure. The land just upstream and downstream of the bridge on the east side would be lowered to create an inset floodplain. The new structure would also only have one pier, while the current structure has two. The bridge replacement alternative also includes removal of accumulated sediment from just upstream of the bridge through the bridge to downstream where the wedge of accumulated sediment ends. Hydraulic modeling indicates that overtopping of Route 118 is reduced in the 100-year event, primarily because a section of the road would need to be raised to achieve the four-foot higher bridge deck. Depth of floodwaters in the model results is reduced upstream of the bridge by 1.5 to 2 feet, but effects do not carry far enough upstream to impact the homes along West Hill Brook (Appendix F, page 15). A new structure would greatly reduce the potential for blockage of the bridge with sediment and debris during flooding.

Alternative 5 includes bridge replacement on Vincent's Bridge Road. Following field reconnaissance and review of flooding patterns and history, replacement of Vincent's Bridge was determined to likely not have significant flood reduction benefits, thus this alternative was not modeled.

Alternative 15 includes the replacement of two bridges in Montgomery Center, the North Main Street Bridge and the Snowmobile Bridge, coupled with floodplain restoration on the south side of the Trout River. In this alternative, the 60-foot North Main Street Bridge would be replaced by a 155-foot bridge spanning the river and an inset floodplain. The existing 100-foot Snowmobile Bridge would be replaced with a 175-foot bridge spanning the river and inset floodplain. Hydraulic model results show this alternative reduces flood extent and depths in the eastern part of the Center. Water depths in the Trout River are decreased by 4 to 5 feet between the two bridges (Appendix F, page 39).

### 5.4 Overflow Culverts

In areas where inundation closes roadways to travel during flooding, installation of overflow culverts to keep the roadway dry can be a beneficial flood mitigation strategy. There are numerous historic covered bridges in Montgomery that were not sized to pass floods of current and potential future magnitudes when they were built in the 1800s. Overflow culverts can also be beneficial as a strategy to provide more capacity at undersized structures for which replacement is infeasible or deemed undesirable by the community.

Existing conditions modeling and reports from the Town and residents show that many bridges in Montgomery are impacted by overtopping and do not pass floods flows. Four alternatives test the installation of overflow culverts at existing bridges.

Alternative 2 focuses on the Route 118 Bridge over West Hill Brook. In addition to bridge replacement, installation of an overflow culvert with a flood bench was modeled to evaluate



potential flood mitigation benefits. The bridge is located between West Hill Road and Hill West Road and space for an overflow is limited. The hydraulic model was used to test the installation of a 35 by 10-foot overflow culvert on the eastern side of the existing bridge. Model results show a reduction in overtopping of Route 118 west of the bridge but reduction in flood depths does not carry upstream to the location of houses on West Hill Road (Appendix F, page 14).

Comstock Bridge is a historic covered bridge over the Trout River just south of Montgomery Village. Existing conditions modeling shows overtopping of Comstock Bridge Road just east of the bridge at the 50-year and higher event. Alternative 4 involved testing the installation of a 50-foot wide by 8-foot tall overflow culvert under the road on the eastern side of the covered bridge. Model results show a reduction in the extent of floodwaters around homes in the neighborhood near the bridge and a 0.5 to 1 foot reduction in water depths for the 100-year flood (Appendix F, pages 20 and 21).

Alternative 6 evaluates installation of an overflow dry bridge to reduce flooding at the Longley Covered Bridge on the Trout River. Existing conditions modeling shows some overtopping of Longley Bridge Road west of the covered bridge beginning at the 10-year flood. A 50-foot wide by 8-foot tall dry bridge was added to the model just west of the covered bridge. Results for the 100-year flood show slight reduction in floodwaters overtopping the road but the volume of water is too large to be conveyed by the overflow (Appendix F, page 23). With no buildings on this section of road, paving and/or reinforcing the road to withstand overtopping and reduce damages may be a more suitable alternative than installation of a dry bridge.

Alternative 7 includes installation of an overflow culvert at the historic Fuller Covered Bridge over Black Falls Brook in Montgomery Village. The covered bridge is undersized and modeling shows that floodwaters exit the channel on the upstream side of the bridge under some flow conditions. Space is limited due to Brook Road, Black Falls Road, and numerous homes and businesses surrounding the covered bridge. Flood mitigation benefits were evaluated by installing a 25-foot wide by 8-foot tall culvert on the southern side of Black Falls Brook with a small lowered floodplain between the brook and Black Falls Road. Model results show that the overflow culvert has the potential to prevent water from flooding out of the channel on the south side of the brook at the bridge but in isolation is not effective at reducing the overall extent of floodwaters in the Village. This alternative would involve the relocation or removal of two mobile homes and one outbuilding on the upstream side of the bridge (Appendix F, page 25).

## 5.5 Sediment Removal

Targeted sediment removal can be an effective short-term flood mitigation strategy when excessive amounts of sediment build up around infrastructure and cause or worsen flooding. Widespread sediment removal within a river system is not a recommended approach and often causes river stability issues and more river-infrastructure conflicts. In addition, sediment tends to accumulate in depositional areas in the next flood leading to an endless maintenance task that is costly and negatively impacts rivers.

Sediment management was considered in two discrete locations in Montgomery. Alternative 2 evaluates sediment removal at the Route 118 Bridge over West Hill Brook that is located in a highly depositional setting. The bridge has filled in with sediment and capacity for flow is reduced. In examining the longitudinal channel bed profile for West Hill Brook, a wedge of sediment can be seen in the vicinity of the bridge. Sediment removal through the bridge was evaluated in the hydraulic model and determined to have localized benefits. For the 100-year flood, overtopping of Route 118 west of the bridge is reduced and the water surface elevation is reduced by 1.5 feet at the bridge and for 300 feet upstream. Benefits do not extend upstream to the location of homes along West Hill Brook (Appendix G, page 11).



Sediment accumulation was also observed in the stretch of the Trout River immediately downstream of Montgomery Center. The river valley narrows and large boulder and bedrock in the channel create a constriction. A large amount of sediment has built up around the boulder and upstream of this location. Alternative 11 evaluated potential benefits of removing some of this sediment. Model results for the 100-year flood show no reduction in extent of flooding within the Center but a localized reduction in flood depths in the river channel upstream. These benefits do not reach homes and businesses in the Center (Appendix F, page 32).

## 5.6 Additional Flood Hazard Mitigation Strategies

There are many actions that can be implemented in the community of Montgomery to improve flood resilience in addition to the specific projects identified and evaluated in the alternatives analysis. Some examples of strategies include river corridor protection to limit future development in hazardous areas and allow rivers space to adjust over time, restoration of riparian buffers, reduction of road erosion due to stormwater, implementation of stormwater management best practices on public and private properties, floodproofing and elevation of floodprone buildings, and acquisition of at-risk properties. These strategies should be considered in conjunction with projects.

## 6.0 Concept Designs

Concept designs were prepared for a subset of alternatives based on hydraulic analysis and selected by community members at the November 6, 2024 public meeting. Concept design materials are included in Appendix C. Model results for concept designs for the 100-year flood are included in Appendix G.

### 6.1 Alternative 1

A concept design was prepared for Alternative 1 (Appendix C), floodplain restoration at 251 Fuller Bridge Road. The smaller footprint was selected to minimize project cost and because modeling shows benefits to be similar between the two footprints. The proposed floodplain restoration project involves excavation of 3 to 7 feet of material within a 4.5-acre footprint. Total sediment removal is estimated at 29,000 cubic yards of material. Project cost is estimated to be approximately \$1.1 million. Potential flood mitigation benefits (ecosystem services for riparian restoration) as valued by the FEMA benefit-cost analysis tool are \$2.6 million for this project.

### 6.2 Alternatives 7 & 9

The combination of alternatives 7 and 9 has been determined to be potentially effective for reduction of flood hazards in Montgomery Village based on hydraulic modeling. A concept design was prepared for these alternatives that includes installation of an overflow culvert at the Fuller Covered Bridge, creation of a small floodplain in the vicinity of the bridge, and larger floodplain restoration upstream along Black Falls Road (Appendix C). In the vicinity of the bridge, relocation of two mobile homes and one outbuilding and lowering of 0.3 acres of land by 5 to 7 feet is proposed with an overflow culvert on the south side of the covered bridge. Total sediment to be excavated for the floodplain at the bridge is estimated to be approximately 3,000 cubic yards. Upstream, 7 to 10 feet of excavation over 4.7 acres is proposed for a total estimated removal of approximately 61,000 cubic yards of sediment. The floodplain restoration also involves realignment of 1,400 feet of Black Falls Road from the intersection with North Hill Road to just east of 65 Black Falls Road. The concept design also includes riprap stabilization of side slopes at the back of the lowered floodplains along Black Falls Road. Hydraulic model



results for the 100-year flood show reduction of floodwaters around homes on Fuller Bridge Road, Deuso Road, On the Green, and Route 118 with implementation of the concept design (Appendix G, page 19). The estimated project cost is approximately \$34 million. Potential flood mitigation benefits (ecosystem services for riparian restoration) as valued by the FEMA benefit-cost analysis tool are \$3.6 million for this project.

### 6.3 Alternatives 12 & 15

A concept design was prepared for the combination of alternatives 12 and 15, targeted at reducing flood hazards in Montgomery Center. The proposed actions include floodplain restoration on the Trout River downstream of and across the river from River Street, replacement of the North Main Street and Snowmobile Bridges, and creation of a flood bench along Hazens Notch Road and Begnoche Farm Road. Three areas of floodplain excavation are included in the concept design. The north side of the Trout River includes 2.1 acres with a proposed 4 to 6 foot cut, yielding an approximate total 17,000 cubic yards of sediment removal (and additional flood storage). On the south side of the river, excavation of 2 to 7 feet of material is proposed across 4.1 acres for an approximate total 26,000 cubic yards of material. Upstream along Begnoche Farm Road and Hazens Notch Road, 2.8 acres excavation to a depth of 7 to 10 feet is proposed for an estimated 36,000 cubic yards of material to be removed. The existing North Main Street and Snowmobile Bridges would be removed and new structures constructed to span the channel and lowered floodplain. This upstream most floodplain would also involve the buy-out of five floodprone homes. Hydraulic model results show reduced flooding around homes on River Street and North Main Street for the 100-year flood (Appendix G, page 28). The estimated cost for this project is \$8 million. Potential flood mitigation benefits (ecosystem services for riparian restoration) as valued by the FEMA benefit-cost analysis tool are \$8.4 million for this project.

### 7.0 Next Steps

- Work with landowners on project implementation
- Seek grant funding to pay for project costs
- Final design, permitting, bidding, construction

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# Appendix A Existing Conditions

## Montgomery Flood Hazard Mitigation Study

Franklin County Natural Resources Conservation District

SLR Project No.: 146.13528.00001

December 27, 2024



Copyright SLR Consulting 2024

Date Saved: 12/20/2024

Document Path: Y:\13528.00001\Map\Montgomery\_RASresults\Montgomery\_RASresults.aprx



**Legend**

⚡ Road

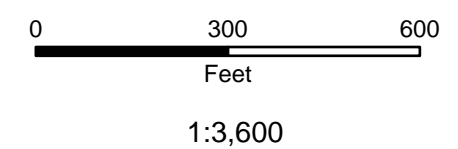
Water Depth (ft)

Value

Dark Blue	27.8
Light Blue	0.001

# MONTGOMERY CENTER EXISTING CONDITIONS - 50-YEAR FLOOD

MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



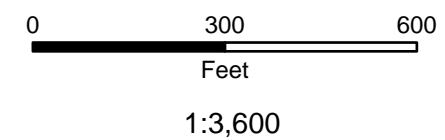
**SLR**

1 SOUTH MAIN STREET  
SECOND FLOOR  
WATERBURY, VT 05676  
802.882.8335



# MONTGOMERY VILLAGE EXISTING CONDITIONS - 50-YEAR FLOOD

MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



**Legend**

- Road
- Water Depth (ft)
- Value
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- 0.001

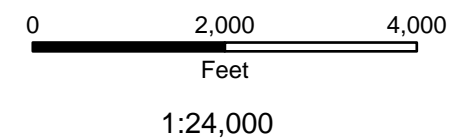


1 SOUTH MAIN STREET  
SECOND FLOOR  
WATERBURY, VT 05676  
802.882.8335



# EXISTING CONDITIONS - 100-YEAR FLOOD

MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



**Legend**

- HEC-RAS Model Extent
- Road
- Town Boundary
- Water Depth (ft)
- Value
- 28.6
- 0.001



1 SOUTH MAIN STREET  
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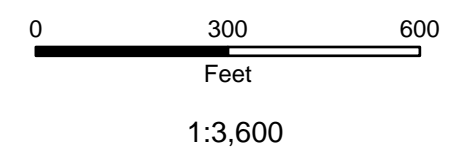
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# MONTGOMERY CENTER EXISTING CONDITIONS - 100-YEAR FLOOD

MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



**Legend**

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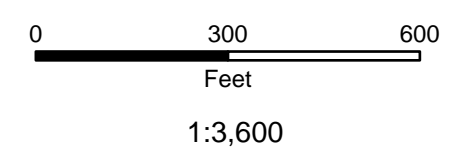
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1 SOUTH MAIN STREET  
 SECOND FLOOR  
 WATERBURY, VT 05676  
 802.882.8335



# MONTGOMERY VILLAGE EXISTING CONDITIONS - 100-YEAR FLOOD

MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



**Legend**

- Road
- Water Depth (ft)
- Value
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- 0.001

**SLR**

1 SOUTH MAIN STREET  
SECOND FLOOR  
WATERBURY, VT 05676  
802.882.8335

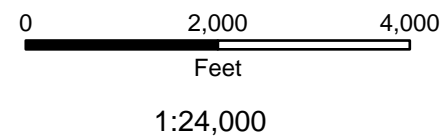
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**EXISTING CONDITIONS - 500-YEAR FLOOD**  
 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



**Legend**

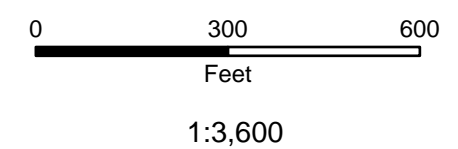
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- Town Boundary
- Water Depth (ft)
- Value
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- 0.001

**SLR**  
 1 SOUTH MAIN STREET  
 SECOND FLOOR  
 WATERBURY, VT 05676  
 802.882.8335



# MONTGOMERY CENTER EXISTING CONDITIONS - 500-YEAR FLOOD

MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



**Legend**

- Road
- Water Depth (ft)
- Value
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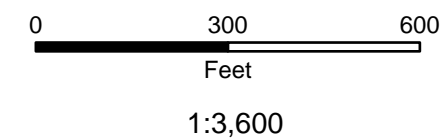
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WATERBURY, VT 05676  
802.882.8335






# MONTGOMERY VILLAGE EXISTING CONDITIONS - 500-YEAR FLOOD

MONTGOMERY FLOOD HAZARD MITIGATION STUDY

FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



**Legend**

-  Road
- Water Depth (ft)
- Value
-  30.5
-  0.001



1 SOUTH MAIN STREET  
 SECOND FLOOR  
 WATERBURY, VT 05676  
 802.882.8335



# Appendix B Alternatives Analysis

## Montgomery Flood Hazard Mitigation Study

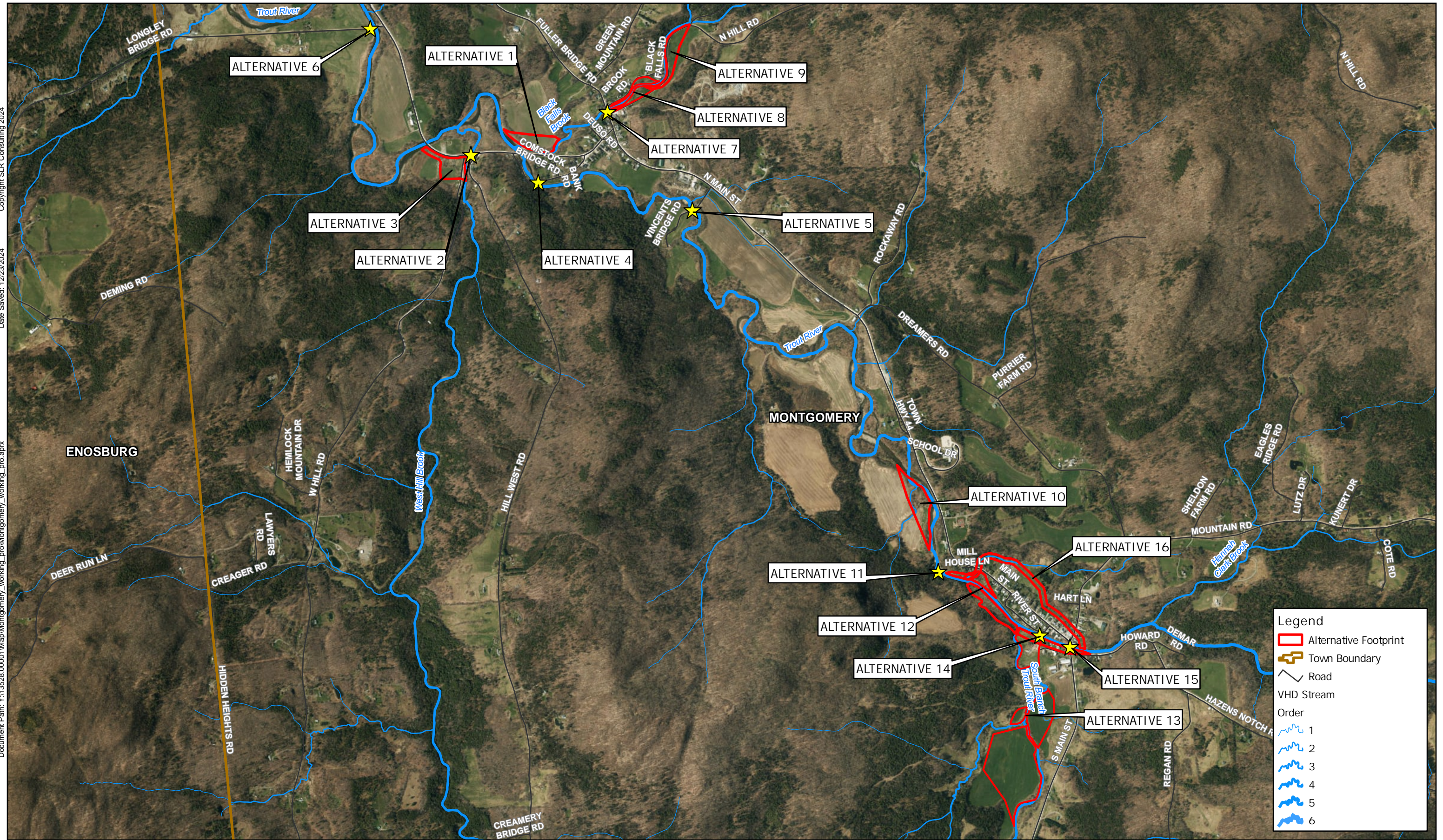
Franklin County Natural Resources Conservation District

SLR Project No.: 146.13528.00001

December 27, 2024

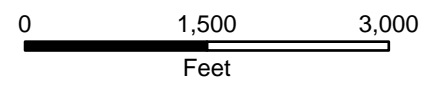


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# ALTERNATIVES

MONTGOMERY FLOOD HAZARD REDUCTION STUDY  
FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



Montgomery Flood Study  
 Mitigation Alternatives - Tested Alternatives  
 November 5, 2024

ID	Location	Description
1	Black Falls Brook Confluence with Trout River	Floodplain / Wetland Restoration at 251 Fuller Bridge Road
2	Route 118 at West Hill Brook	Bridge Alternatives / Sediment Management
3	West Hill Road at West Hill Brook	Floodplain Reconnection or Overflow Channel at Gardens
4	Comstock Bridge at Trout River	Overflow Capacity
5	Vincent's Bridge Road at Trout River	Bridge Replacement or Reinforced Overflow
6	Longley Bridge Road at Trout River	Overflow Capacity / Reinforced Overflow
7	Fuller Bridge at Black Falls Brook	Overflow Capacity / Regain Channel Capacity
8	Black Falls Road at Black Falls Brook	Regain Floodplain Access
9	Black Falls Road at Black Falls Brook	Move Road and Restore Floodplain
10	Trout River near Rec Center	Regain Floodplain Access at constriction
11	Trout River below Center	Remove gravel deposits around boulder / valley constriction
12	Trout River in Center	Floodplain reconnection on Trout River
13	South Branch	Floodplain Reconnection at South Branch
14	Snowmobile Bridge at Trout River	Snowmobile Bridge Replacement
15	Trout River in Center	Bridge Replacement and Restore Floodplain
16	Trout River in Center	Flood Bypass Channel North of Main Street

ID	Location	Description
Future Work	All river adjacent areas	Buffer with woody vegetation & Protect River Corridor
Future Work	All upstream areas	Reduce sediment from road runoff
Future Work	Upstream areas	Increase flood storage with floodplain connection, wetland restoration.
Future Work	Upstream areas	Stormwater Mitigation
Individual Action	Individual Properties - Not Specified	Floodproofing of buildings / filling basements / raising utilities / elevating buildings
Individual Action	Individual Properties - Not Specified	Buyouts of properties



# Appendix C Concept Designs

## Montgomery Flood Hazard Mitigation Study

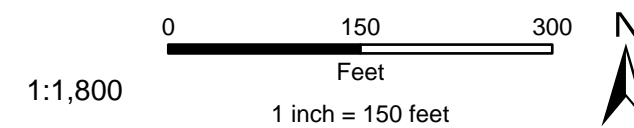
Franklin County Natural Resources Conservation District

SLR Project No.: 146.13528.00001

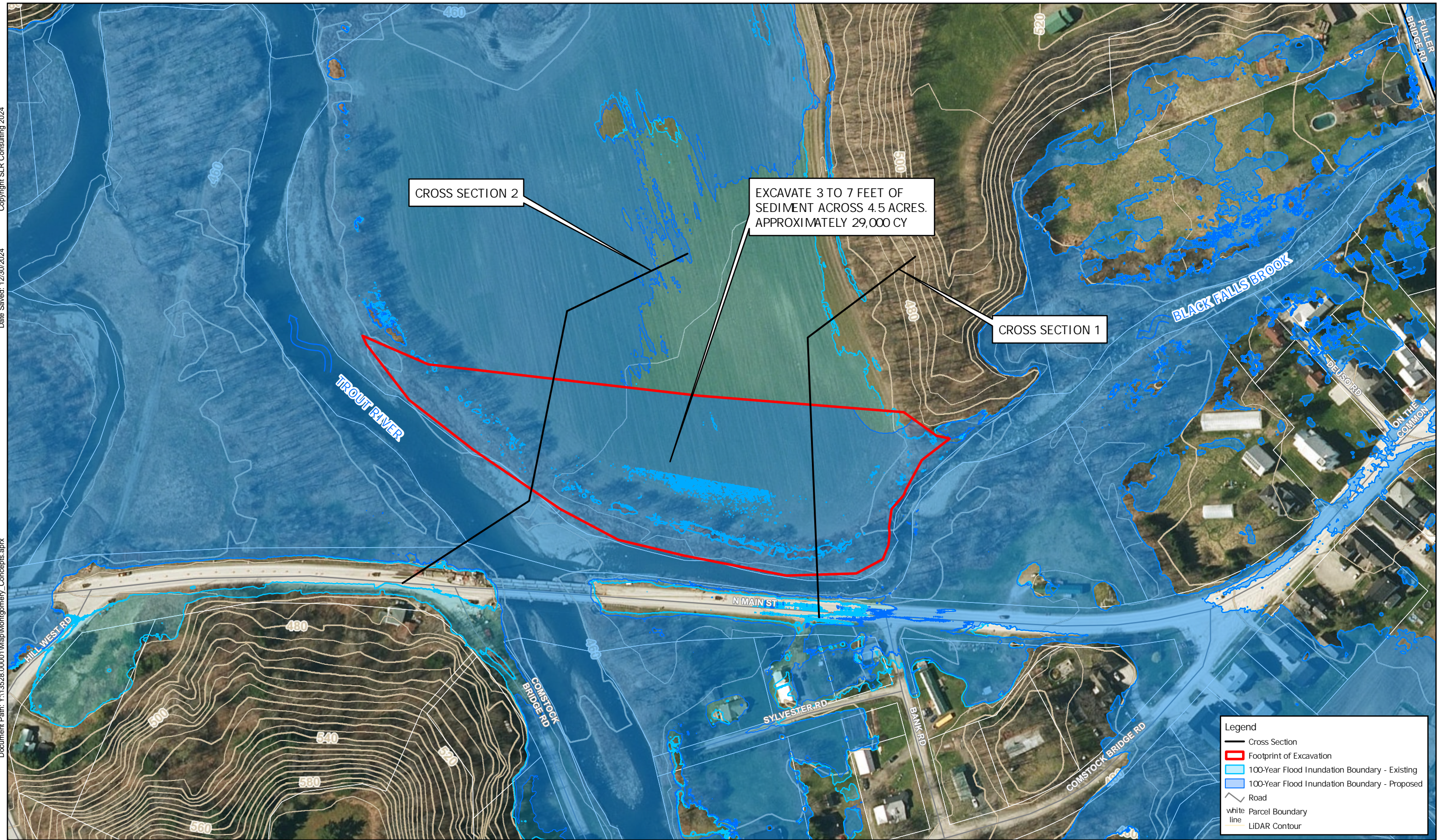
December 27, 2024



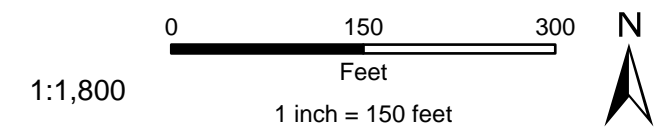
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 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



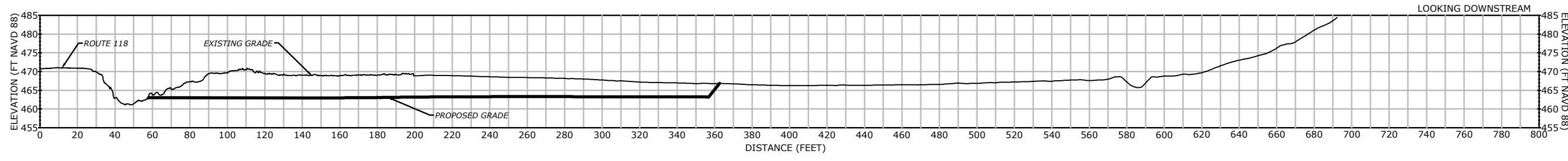
1 SOUTH MAIN STREET  
 SECOND FLOOR  
 WATERBURY, VT 05676  
 802.882.8335



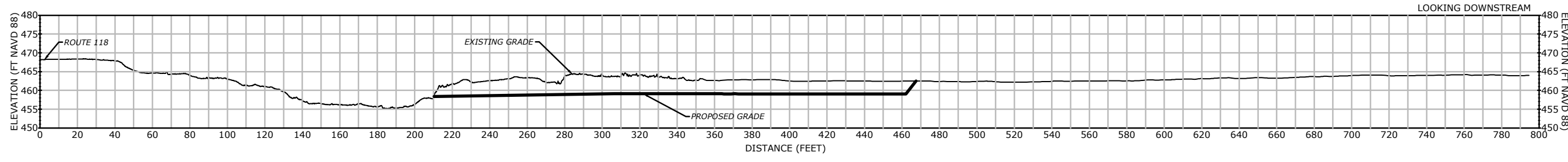
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 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



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ALTERNATIVE 1 CROSS SECTION 2  
SCALE: H: 1"=60', V: 1"=30'



1 SOUTH MAIN STREET  
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REVISIONS


TYPICAL SECTIONS - ALTERNATIVE 1

MONTGOMERY FLOOD HAZARD MITIGATION STUDY

251 FULLER BRIDGE ROAD  
MONTGOMERY, VERMONT

CONCEPT DESIGN

AOM DESIGNED	AOM DRAWN	JCL CHECKED
SCALE AS NOTED		
DATE DECEMBER 12, 2024		
PROJECT NO. 13528.00001		

**XS-1**

SHEET NO.

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CONCEPT DESIGN PROBABLE CONSTRUCTION COST  
FLOODPLAIN RESTORATION @ LOWER BLACK FALLS BROOK

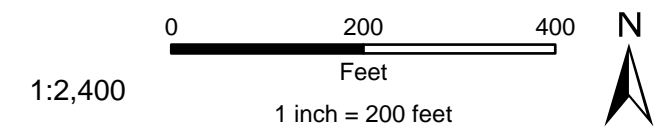
Montgomery, Vermont  
 SLR #13928.00007  
 December 12, 2024



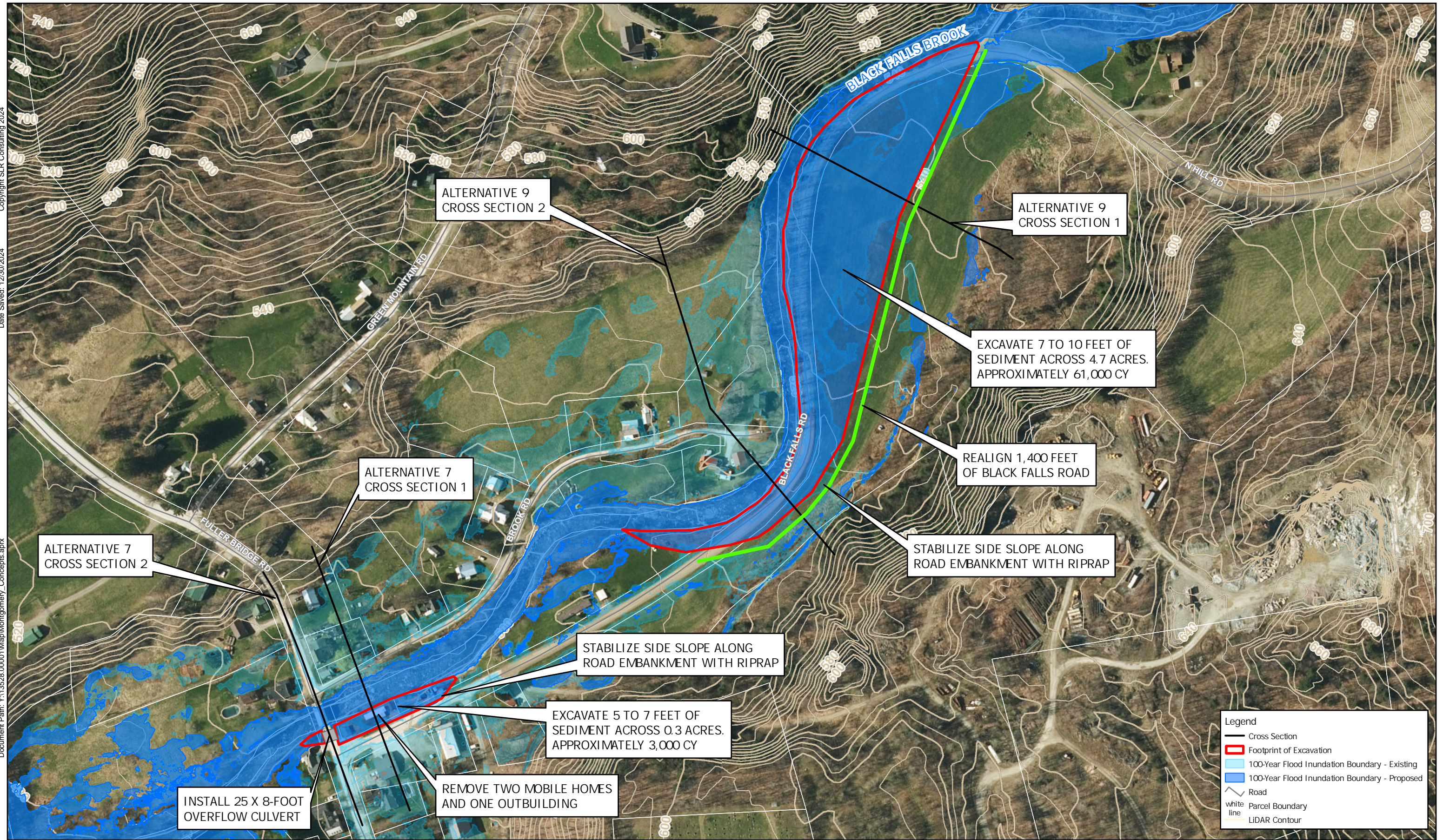
Item	ITEM/DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
<b>SITE PREPARATION</b>					
	Mobilization & Demobilization	LS	1	\$20,000	\$20,000
	Site Access	LS	1	\$20,000	\$20,000
	Erosion Control	LS	1	\$10,000	\$10,000
	Traffic Control and Signage	LS	1	\$5,000	\$5,000
<b>FLOODPLAIN RESTORATION</b>					
	Excavation & haul to restore floodplain	CY	29,000	\$20	\$580,000
	River Bed Restoration	LS	1	\$5,000	\$5,000
	Bank Stabilization	LS	1	\$50,000	\$50,000
	Restoration of Disturbed Areas	LS	1	\$10,000	\$10,000
	Riparian Plants and Planting Labor	LS	1	\$100,000	\$100,000
	Construction Subtotal				\$800,000
	Construction Contingency (15%)				\$120,000
	Data Collection				\$20,000
	Final Design				\$60,000
	Permitting				\$15,000
	Construction Oversight				\$55,000
	Project Management				\$10,000
	<b>TOTAL</b>				<b>\$1,080,000</b>



**ALTERNATIVES 7 & 9 - EXISTING CONDITIONS**  
 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT

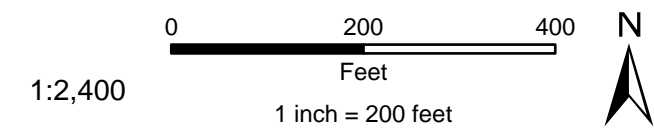


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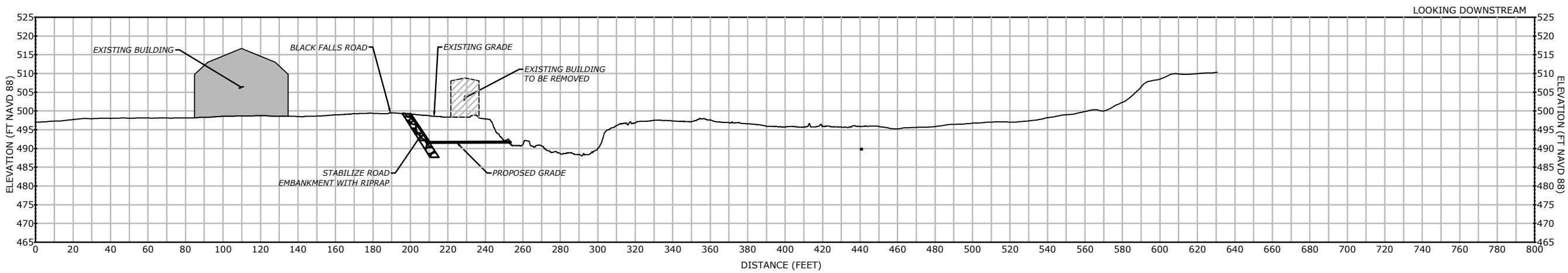


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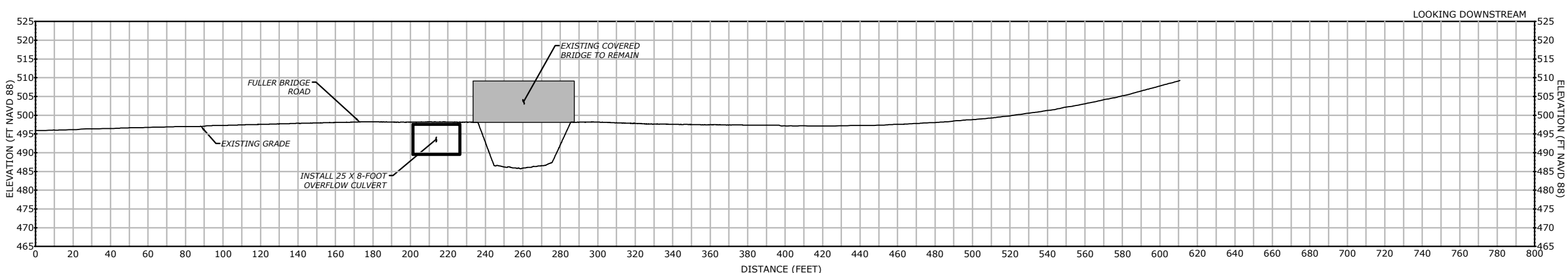
MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



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TYPICAL SECTIONS - ALTERNATIVE 7

MONTGOMERY FLOOD HAZARD MITIGATION STUDY

FULLER BRIDGE ROAD  
MONTGOMERY, VERMONT

CONCEPT DESIGN

AOM DESIGNED	AOM DRAWN	JCL CHECKED
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DATE: DECEMBER 12, 2024

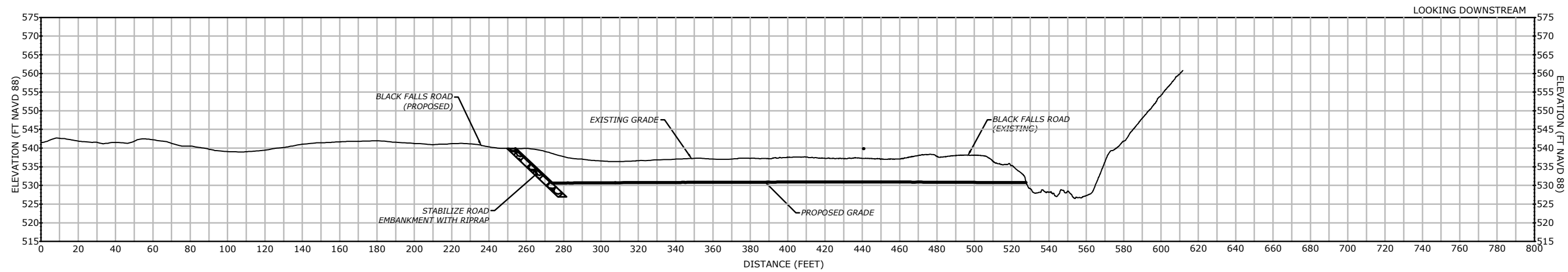
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SHEET NO: XS-1

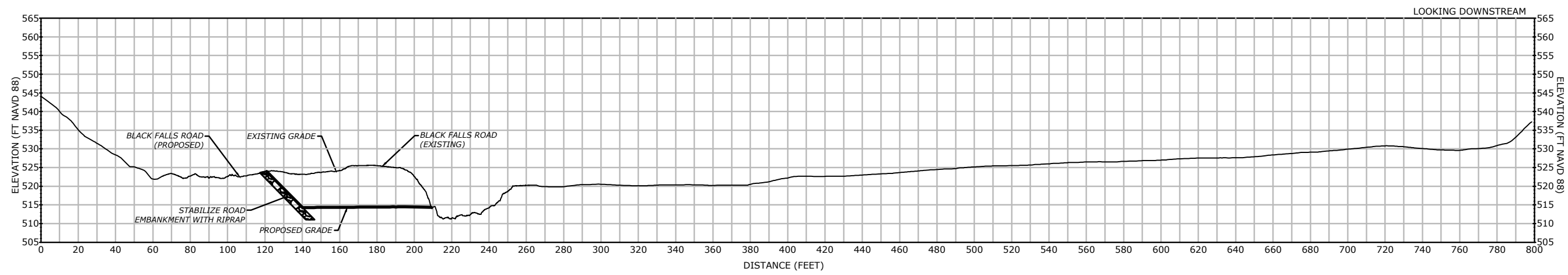
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SCALE: H: 1"=60', V: 1"=30'



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REVISIONS


TYPICAL SECTIONS - ALTERNATIVE 9

MONTGOMERY FLOOD HAZARD MITIGATION STUDY

BLACK FALLS ROAD  
MONTGOMERY, VERMONT

CONCEPT DESIGN

AOM DESIGNED	AOM DRAWN	JCL CHECKED
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AS NOTED

DATE  
DECEMBER 12, 2024

PROJECT NO.  
13528.00001

SHEET NO.  
**XS-1**

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CONCEPT DESIGN PROBABLE CONSTRUCTION COST  
FULLER BRIDGE ROAD - OVERFLOW CULVERT

Montgomery, Vermont  
 SLR #13928.00007  
 December 12, 2024



Item	ITEM/DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
<b>SITE PREPARATION</b>					
	Mobilization & Demobilization	LS	1	\$20,000	\$20,000
	Site Access	LS	1	\$20,000	\$20,000
	Erosion Control	LS	1	\$10,000	\$10,000
	Traffic Control and Signage	LS	1	\$15,000	\$15,000
<b>REMOVE BUILDINGS</b>					
	Structure Removal	EA	3	\$75,000	\$225,000
	Remove Site Amenities	EA	3	\$5,000	\$15,000
<b>FLOODPLAIN RESTORATION</b>					
	Excavation & haul to restore floodplain	CY	3,000	\$20	\$60,000
	River Bed Restoration	LS	1	\$5,000	\$5,000
	Bank Stabilization	LF	500	\$75	\$37,500
	Restoration of Disturbed Areas	LS	1	\$10,000	\$10,000
	Riparian Plants and Planting Labor	LS	1	\$25,000	\$25,000
<b>OVERFLOW CULVERT</b>					
	Excavation & haul	CY	600	\$20	\$12,000
	River Bed Restoration	LS	1	\$5,000	\$5,000
	Funish and install 25' x 8' box culvert	EA	1	\$200,000	\$200,000
	Restoration of Disturbed Areas	LS	1	\$50,000	\$50,000
	Bridge rails	LS	1	\$10,000	\$10,000
	Construction Subtotal				\$719,500
	Construction Contingency (15%)				\$108,000
	Data Collection				\$20,000
	Final Design				\$75,000
	Permitting				\$30,000
	Construction Oversight				\$60,000
	Project Management				\$20,000
	<b>TOTAL</b>				<b>\$1,032,500</b>

CONCEPT DESIGN PROBABLE CONSTRUCTION COST  
FLOODPLAIN RESTORATION @ UPPER BLACK FALLS BROOK

Montgomery, Vermont  
 SLR #13928.00007  
 December 12, 2024

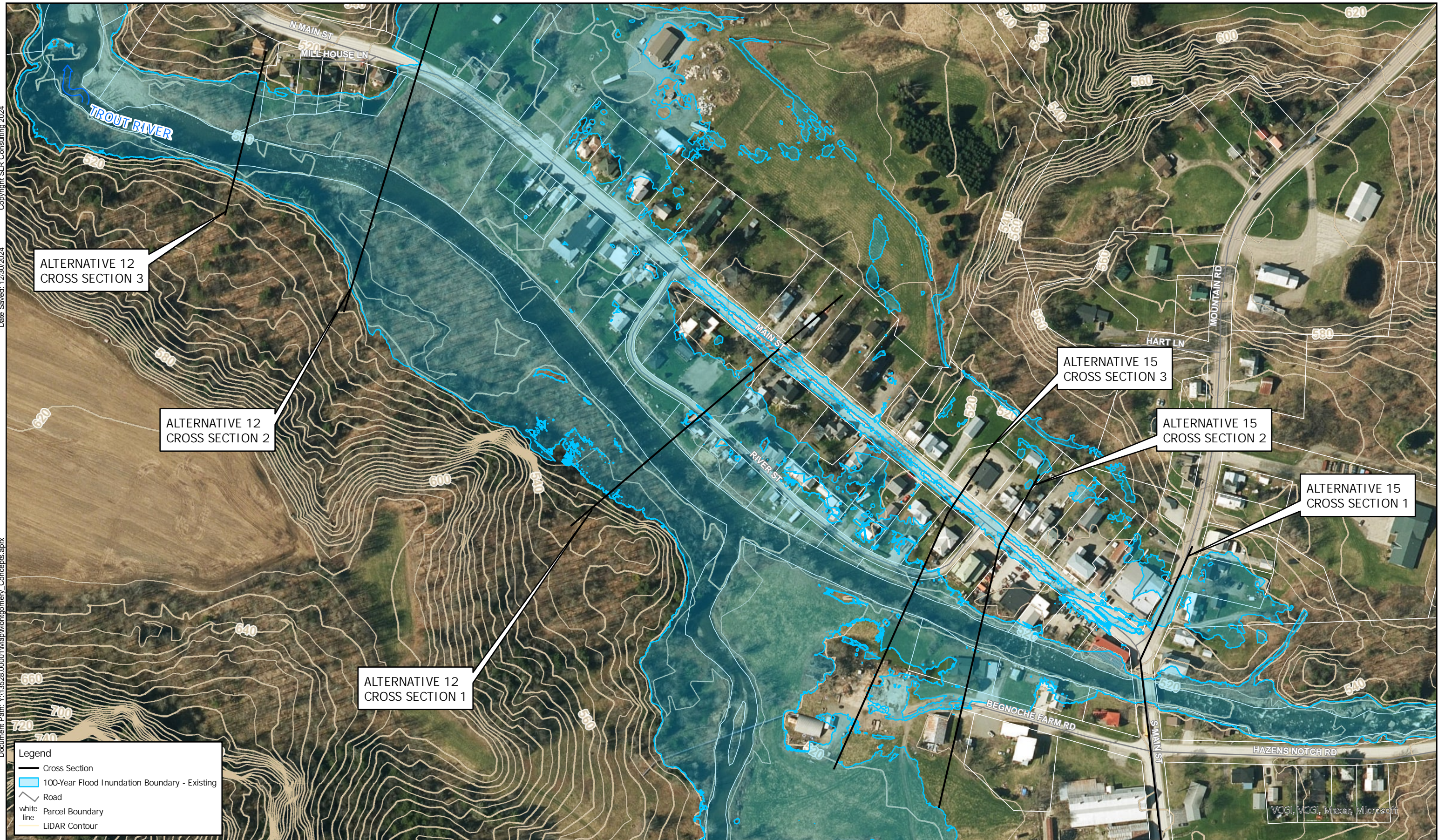


Item	ITEM/DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
<b>SITE PREPARATION</b>					
	Mobilization & Demobilization	LS	1	\$20,000	\$20,000
	Site Access	LS	1	\$20,000	\$20,000
	Erosion Control	LS	1	\$10,000	\$10,000
	Traffic Control and Signage	LS	1	\$15,000	\$15,000
<b>FLOODPLAIN RESTORATION</b>					
	Excavation & haul to restore floodplain	CY	61,000	\$20	\$1,220,000
	Bank Stabilization	LF	1,400	\$75	\$105,000
	Restoration of Disturbed Areas	LS	1	\$10,000	\$10,000
	Riparian Plants and Planting Labor	LS	1	\$100,000	\$100,000
<b>ROAD RELOCATION</b>					
	Road Relocation	LF	1,400	\$500	\$700,000
	Construction Subtotal				\$2,200,000
	Construction Contingency (15%)				\$330,000
	Data Collection				\$20,000
	Final Design				\$60,000
	Permitting				\$15,000
	Construction Oversight				\$55,000
	Project Management				\$10,000
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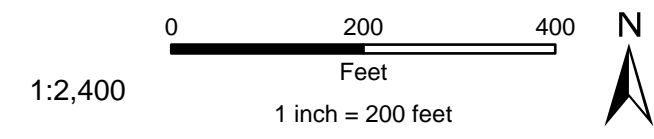
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**ALTERNATIVES 12 & 15 - EXISTING CONDITIONS**  
 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT

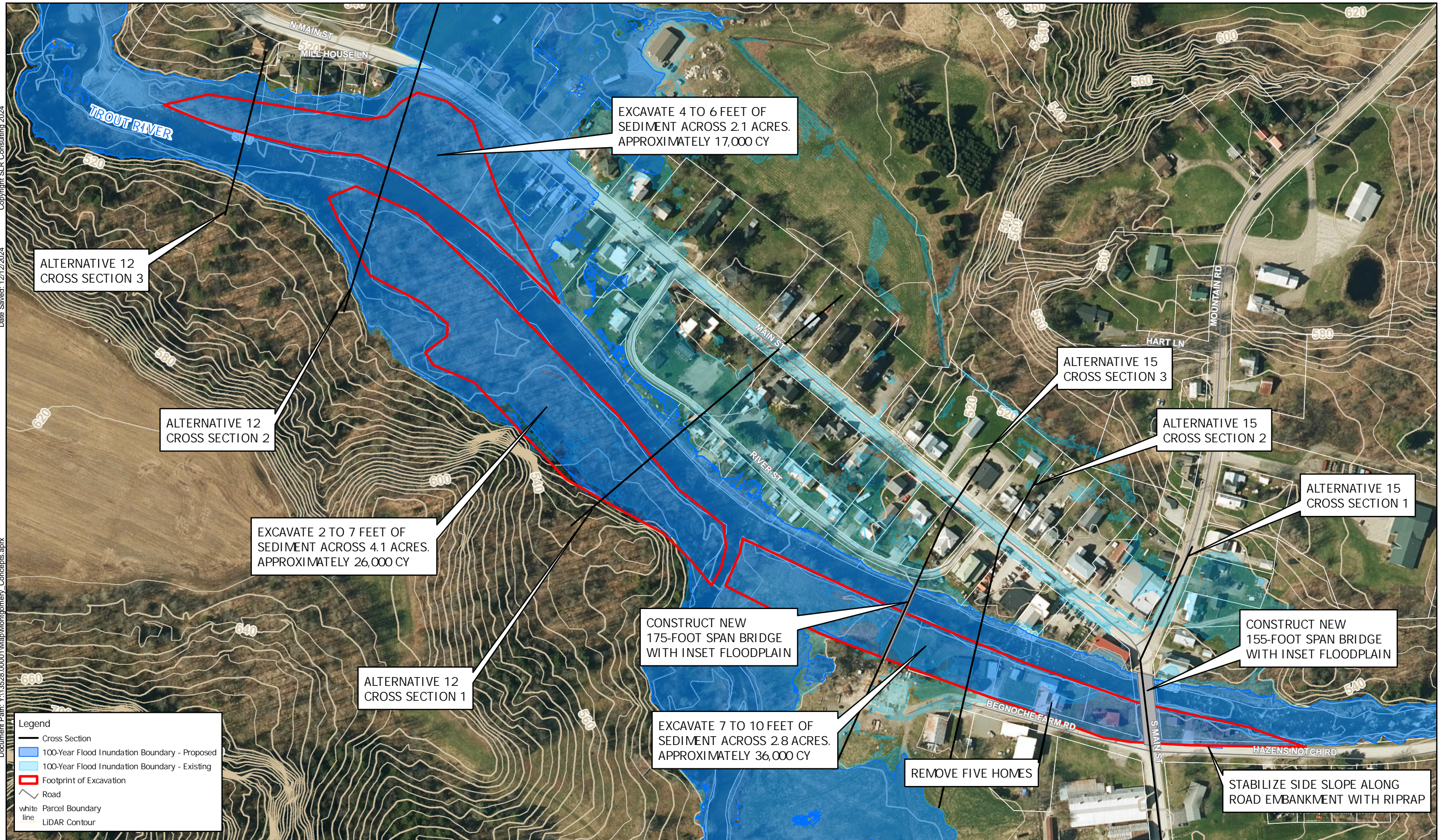


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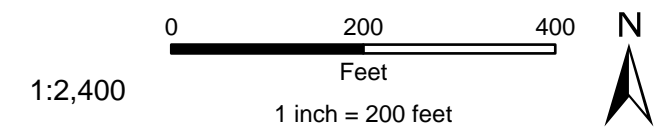
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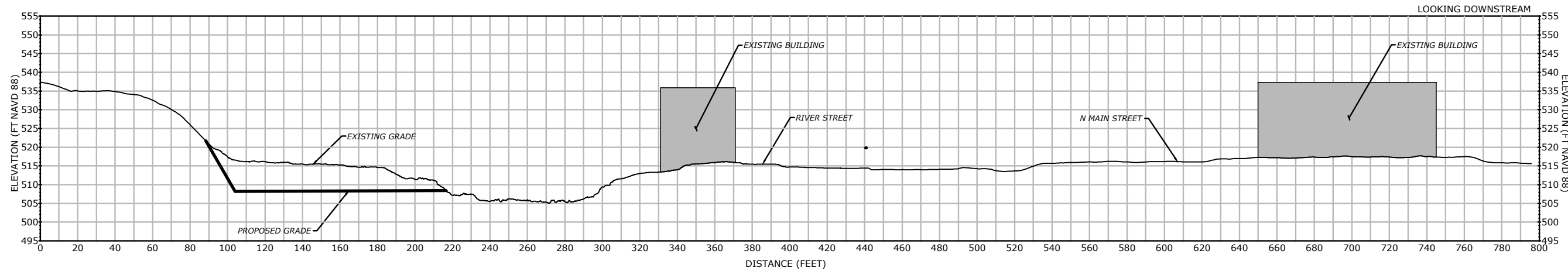
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MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT

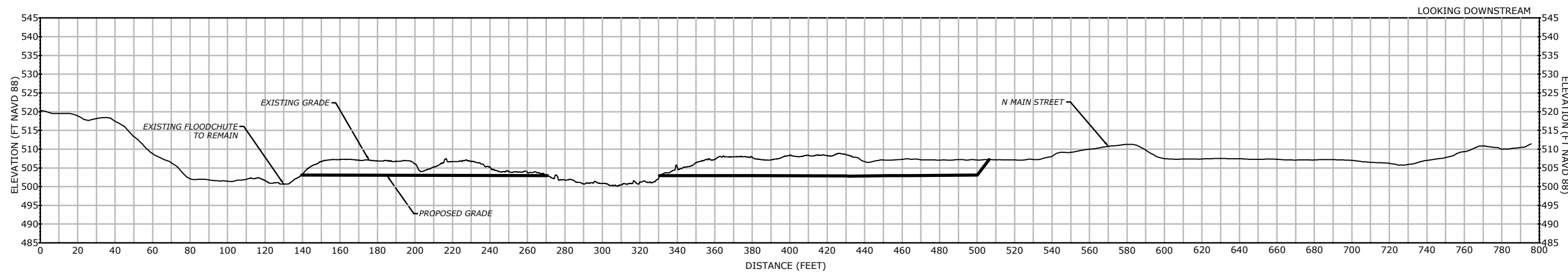


1 SOUTH MAIN STREET  
SECOND FLOOR  
WATERBURY, VT 05676  
802.882.8335

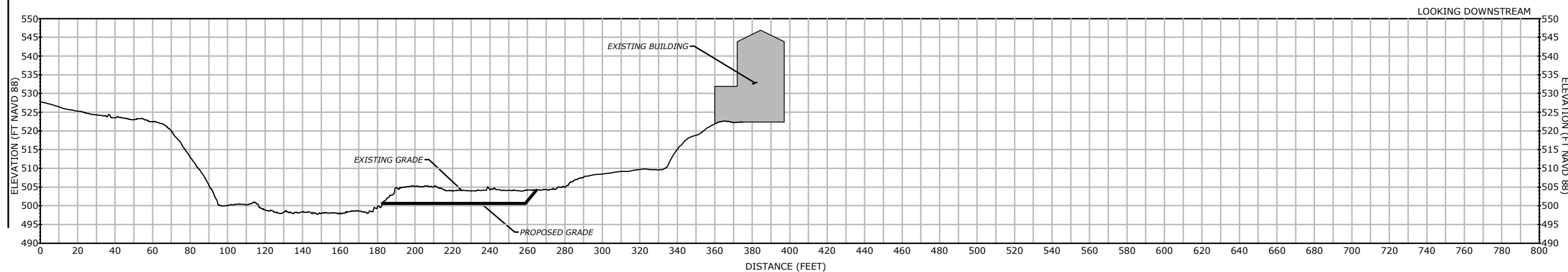
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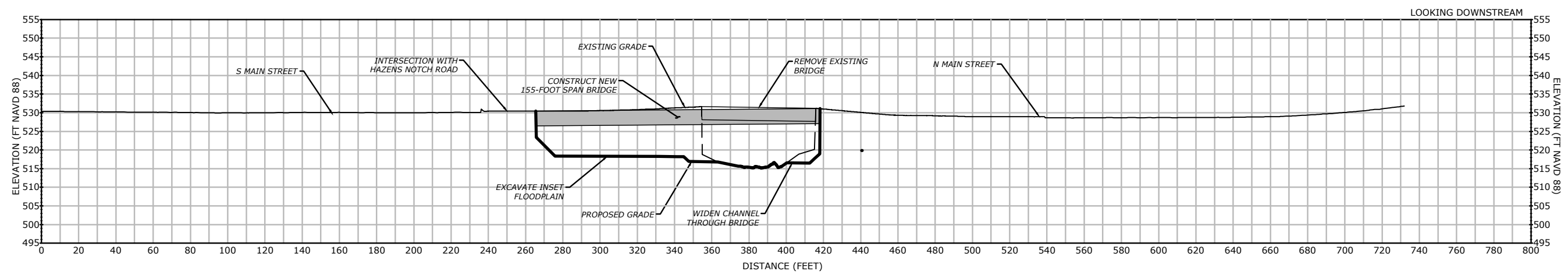
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 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 MONTGOMERY CENTER  
 MONTGOMERY, VERMONT

AOM DESIGNED	AOM DRAWN	JCL CHECKED
AS NOTED		
DATE DECEMBER 12, 2024		
PROJECT NO. 13528.00001		

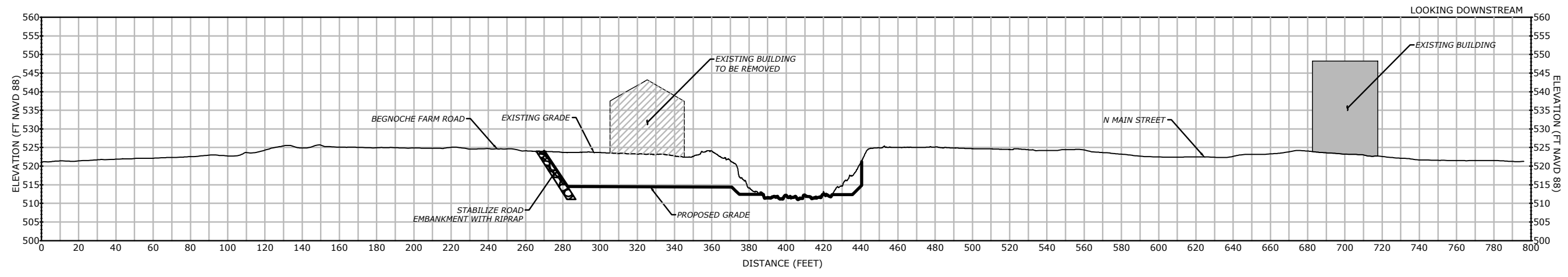
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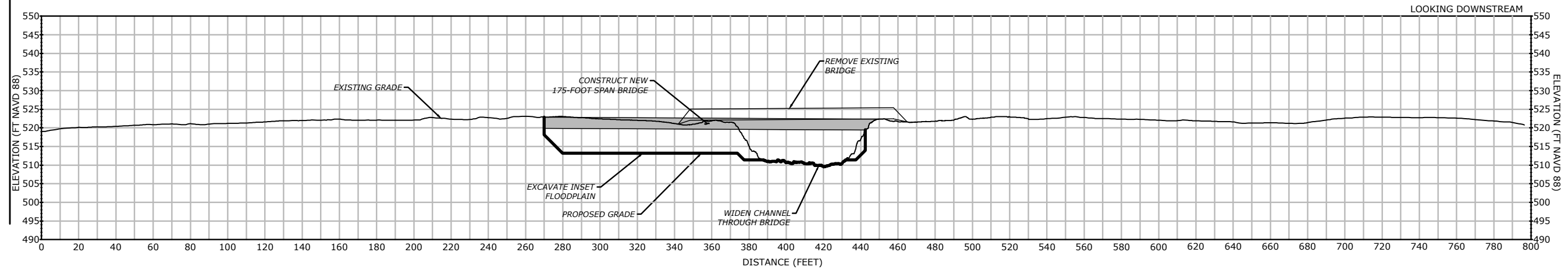
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REVISIONS

CONCEPT DESIGN

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 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 MONTGOMERY CENTER  
 MONTGOMERY, VERMONT

AOM DESIGNED	AOM DRAWN	JCL CHECKED
SCALE: AS NOTED		
DATE: DECEMBER 12, 2024		
PROJECT NO: 13528.00001		

SHEET NO: XS-1

CONCEPT DESIGN PROBABLE CONSTRUCTION COST  
FLOODPLAIN RESTORATION LOWER MONTGOMERY CENTER

Montgomery, Vermont  
 SLR #13928.00007  
 December 12, 2024



Item	ITEM/DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
<b>SITE PREPARATION</b>					
	Mobilization & Demobilization	LS	1	\$20,000	\$20,000
	Site Access	LS	1	\$20,000	\$20,000
	Erosion Control	LS	1	\$10,000	\$10,000
	Traffic Control and Signage	LS	1	\$5,000	\$5,000
<b>FLOODPLAIN RESTORATION</b>					
	Excavation & haul to restore floodplain	CY	43,000	\$20	\$860,000
	River Bed Restoration	LS	1	\$5,000	\$5,000
	Bank Stabilization	LS	1	\$50,000	\$50,000
	Restoration of Disturbed Areas	LS	1	\$10,000	\$10,000
	Riparian Plants and Planting Labor	LS	1	\$100,000	\$100,000
	Construction Subtotal				\$1,080,000
	Construction Contingency (15%)				\$162,000
	Data Collection				\$20,000
	Final Design				\$60,000
	Permitting				\$15,000
	Construction Oversight				\$55,000
	Project Management				\$10,000
	<b>TOTAL</b>				<b>\$1,402,000</b>

CONCEPT DESIGN PROBABLE CONSTRUCTION COST  
SOUTH MAIN STREET & SNOWMOBILE BRIDGES AND FLOODPLAIN

Montgomery, Vermont  
 SLR #13928.00007  
 December 12, 2024



Item	ITEM/DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COST
<b>SITE PREPARATION</b>					
	Mobilization & Demobilization	LS	1	\$20,000	\$20,000
	Site Access	LS	1	\$20,000	\$20,000
	Erosion Control	LS	1	\$10,000	\$10,000
	Traffic Control and Signage	LS	1	\$15,000	\$15,000
<b>REMOVE BUILDINGS</b>					
	Structure Removal	EA	5	\$75,000	\$375,000
	Remove Site Amenities	EA	3	\$5,000	\$15,000
<b>FLOODPLAIN RESTORATION</b>					
	Excavation & haul to restore floodplain	CY	36,000	\$20	\$720,000
	River Bed Restoration	LS	1	\$5,000	\$5,000
	Bank Stabilization	LF	1,000	\$75	\$75,000
	Restoration of Disturbed Areas	LS	1	\$10,000	\$10,000
	Riparian Plants and Planting Labor	LS	1	\$25,000	\$25,000
<b>S MAIN STREET BRIDGE</b>					
	Temporary Crossing	LS	1	\$40,000	\$40,000
	Remove Existing Structure	LS	1	\$50,000	\$50,000
	Procure & Install Crossing Structure, 155 ft	EA	1	\$3,000,000	\$3,500,000
	Restoration of Disturbed Areas	LS	1	\$50,000	\$50,000
	Bridge rails	LS	1	\$10,000	\$10,000
<b>SNOWMOBILE BRIDGE</b>					
	Remove Existing Structure	LS	1	\$30,000	\$30,000
	Procure & Install Crossing Structure, 155 ft	EA	1	\$500,000	\$600,000
	Restoration of Disturbed Areas	LS	1	\$50,000	\$50,000
	Bridge rails	LS	1	\$2,000	\$2,000
	Construction Subtotal				\$5,622,000
	Construction Contingency (15%)				\$843,000
	Data Collection				\$40,000
	Final Design				\$160,000
	Permitting				\$60,000
	Construction Oversight				\$120,000
	Project Management				\$40,000
	<b>TOTAL</b>				<b>\$6,885,000</b>



# **Appendix D    Public Presentation – Kickoff**

## **Montgomery Flood Hazard Mitigation Study**

**Franklin County Natural Resources Conservation District**

SLR Project No.: 146.13528.00001

December 27, 2024



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# Montgomery, Vermont Flood Hazard Modeling & Project Identification

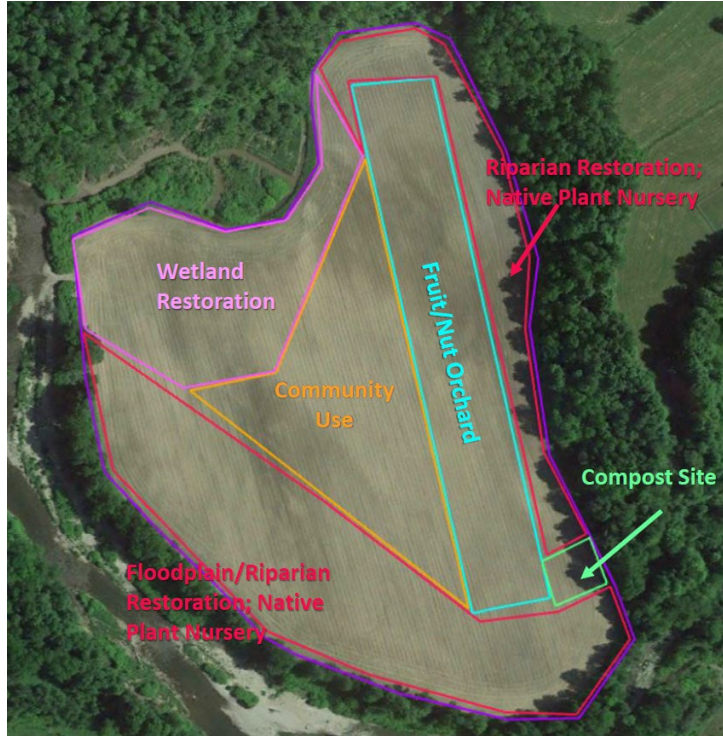
Jessica Louisos, PE, MS & Roy Schiff, PE, PhD  
Water Resource Engineer & Scientists - SLR

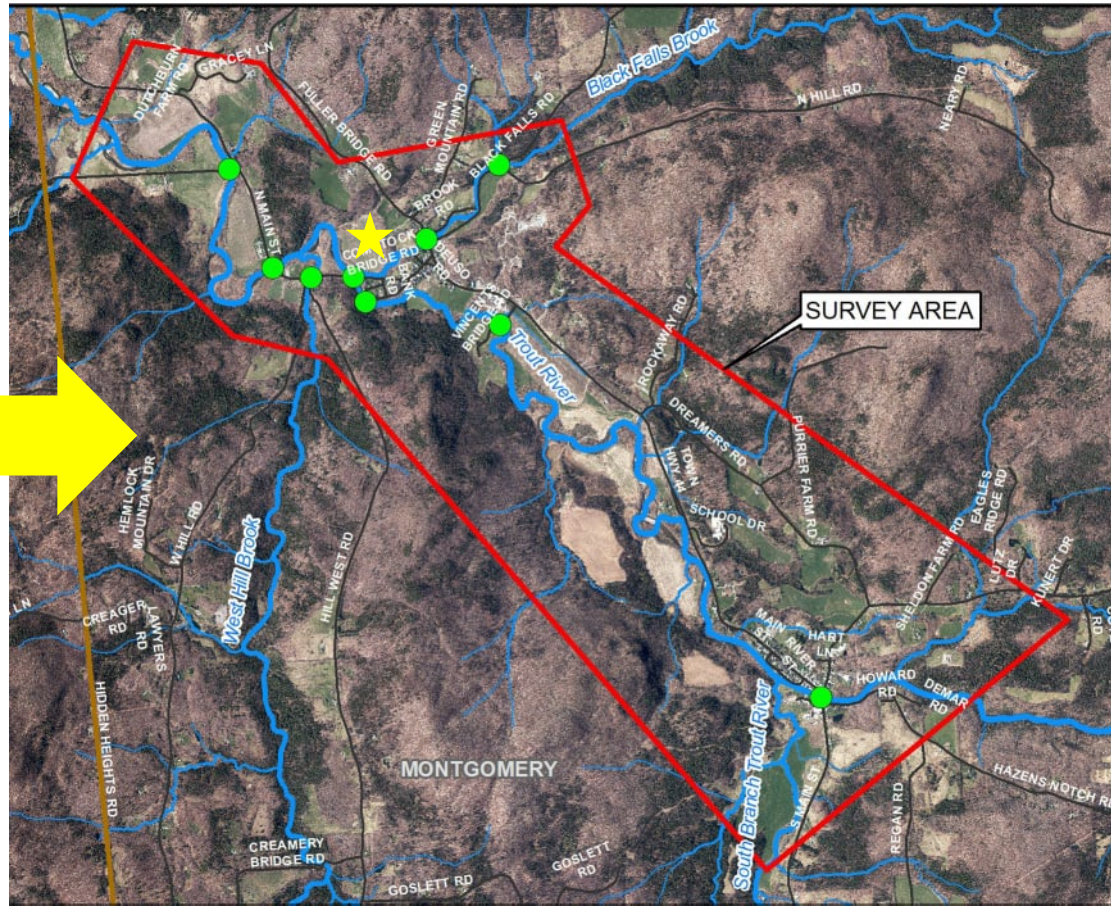
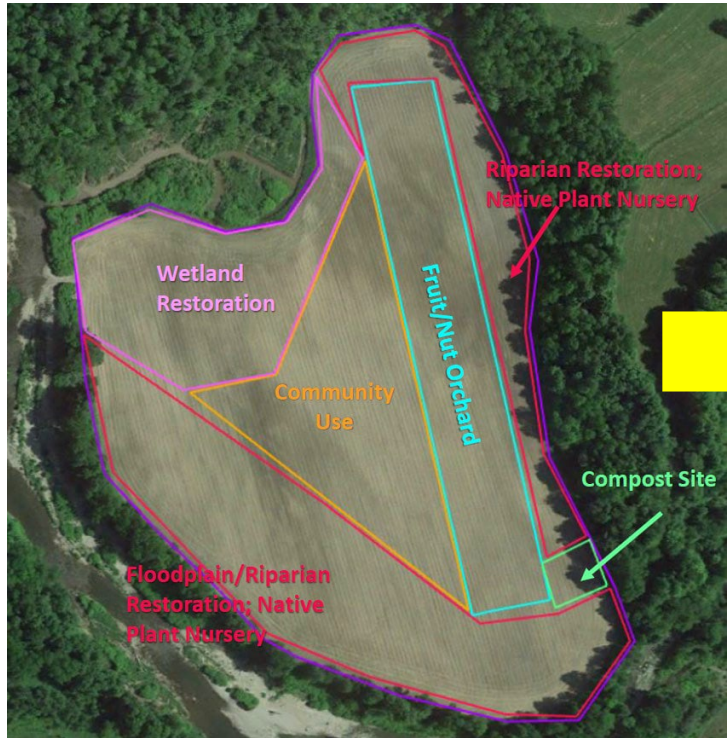
Lauren Weston

District Manager – Franklin County NRC

March 18, 2024





















# Flood Hazard Modeling & Project Identification

## Understand Flood Issues and Patterns

- Aerial survey – begins April 21
- Bridge surveys
- Hydraulic models

## Identify Possible Mitigation Projects

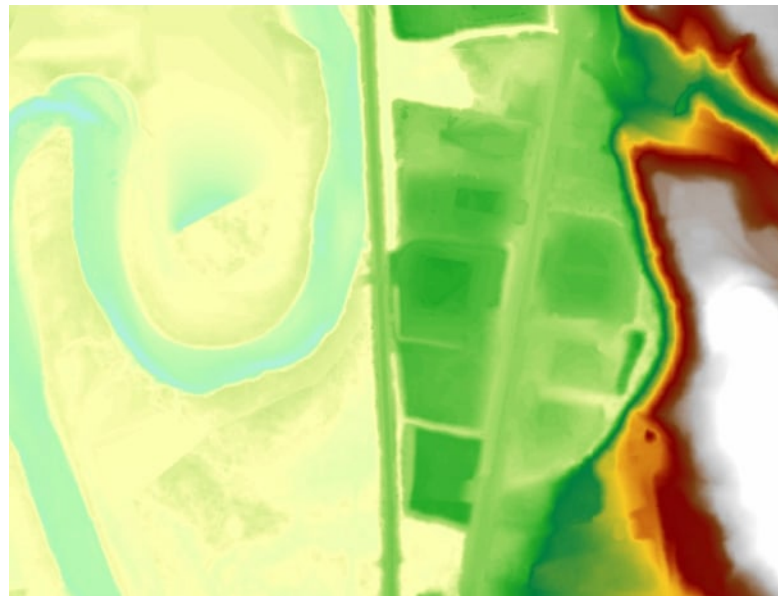
- Visit sites
- Collect ideas from residents

## Test Identified Alternatives

- Model possible projects in hydraulic model
- Consider constraints and project goals

## Concept Design

- Develop the top 5 projects to start the design process

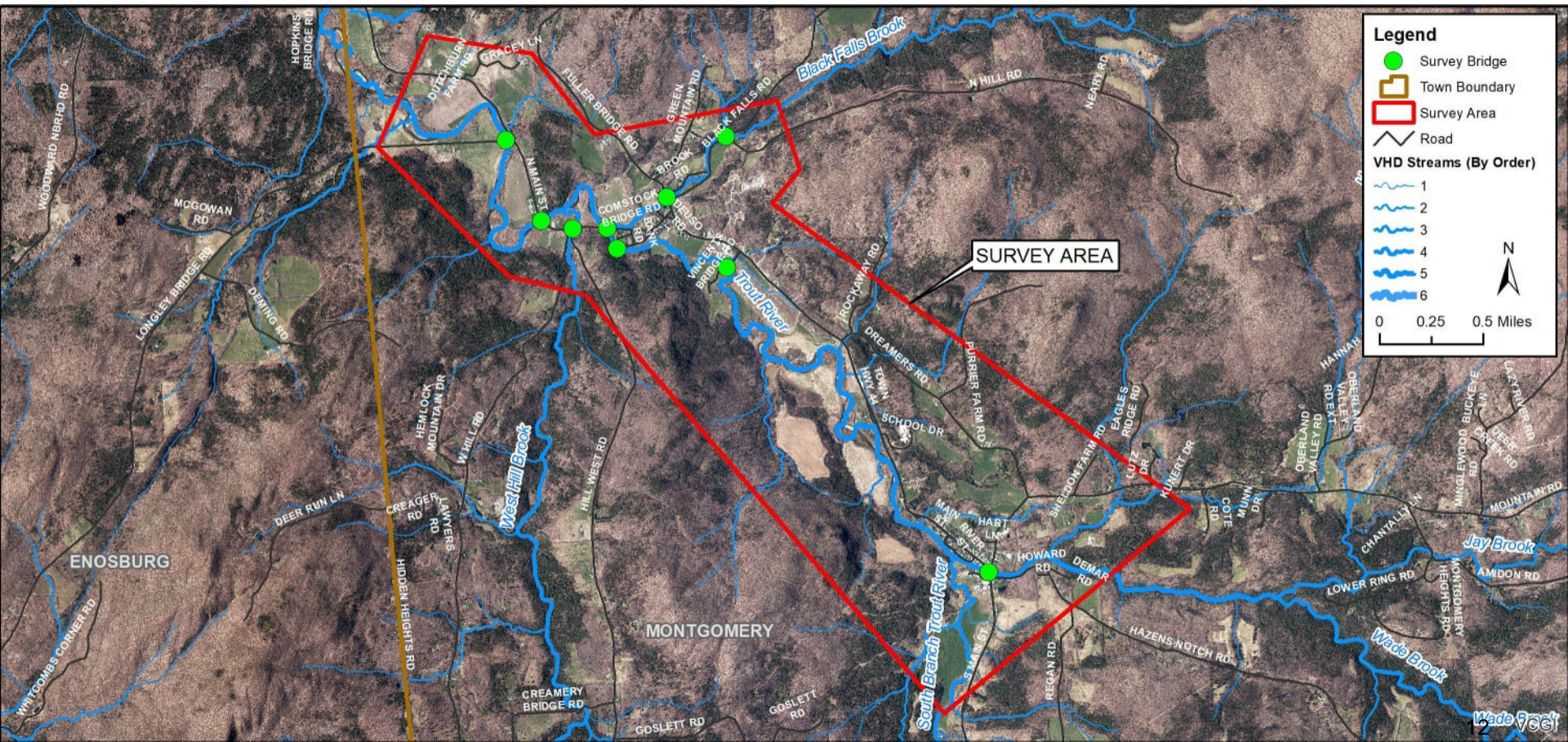




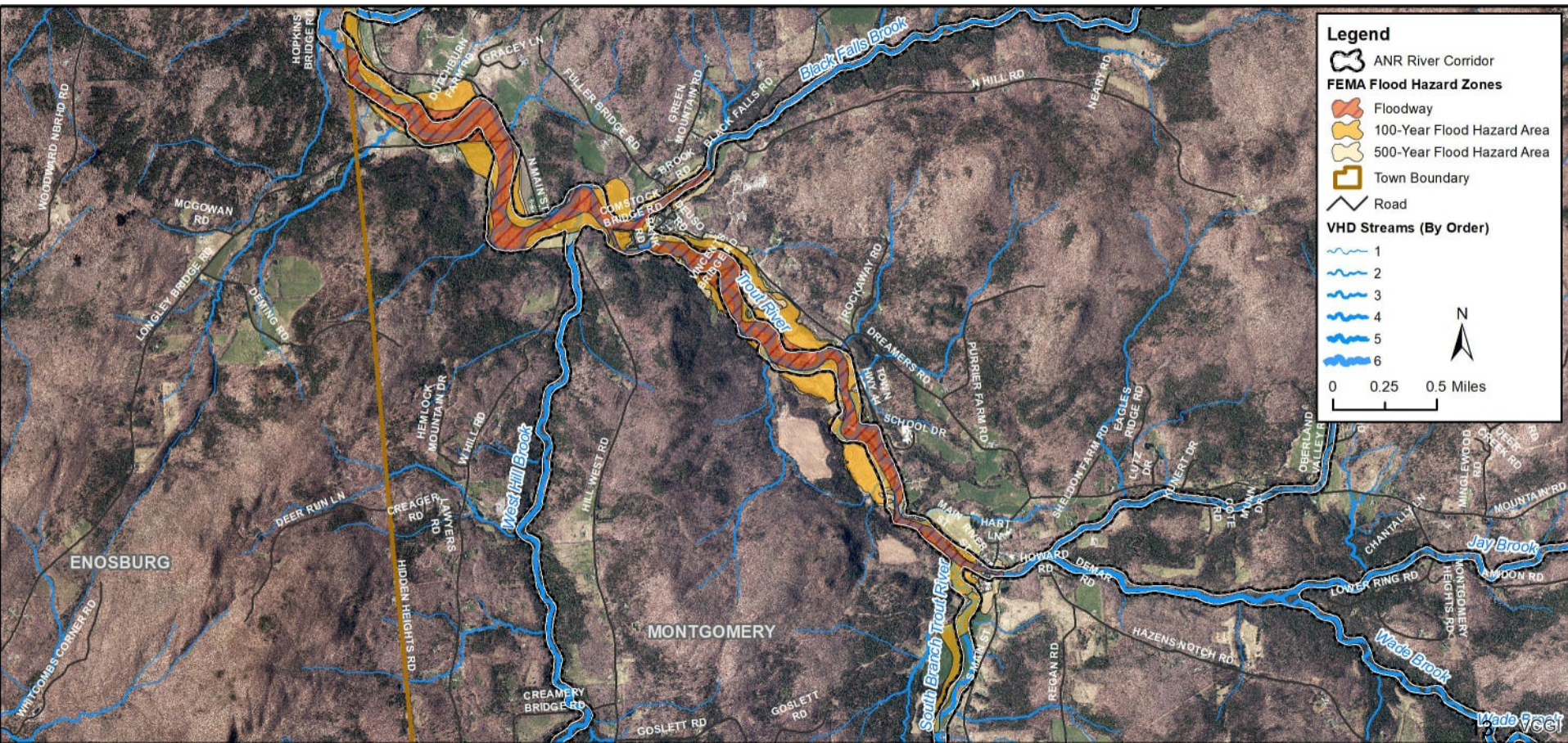
# Tasks & Schedule

		2024											
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
<b><u>Task 1. – Data Collection &amp; Project Initiation</u></b>													
1.1	Project Kickoff Meeting #1		■										
1.2	Data Review	■	■	■									
1.3	GIS basemap	■	■	■	■								
1.3	Site Visit, RAPID Geomorphic Assessment		■	■	■								
1.4	Field Survey		■	■	■								
<b><u>Task 2. – Hydraulic Modeling</u></b>													
2.1	Hydraulic Model with LIDAR and Survey	■	■	■	■	■							
2.2	Model Validation			■	■	■							
2.3	Existing Conditions and Hydraulics Memo			■	■	■							
2.4	Initial list of alternatives			■	■	■	■						
2.5	Meeting #2					■							
<b><u>Task 3. – Alternatives Analysis</u></b>													
3.1	Explore Restoration and Flood Mitigation Alternatives					■	■	■					
3.2	Flood Path and Velocity Mapping						■	■	■				
3.3	Alternatives Matrix to Summarize Results						■	■	■				
3.4	Meeting #3								■				
3.5	Concept Design (30%)								■	■	■	■	
<b><u>Task 4. – Reporting &amp; Presentations</u></b>													
4.1	Draft Report				■	■	■	■	■	■	■	■	
4.2	Meeting #4											■	
4.3	Final Report											■	■
4.4	Meeting #5												■

# Project Area



# Project Area – Flood Hazard Zones



# Dog River Floodplain Restoration – Northfield



## Removing buildings & people & infrastructure from most vulnerable locations

- Remove 10 damaged homes
- Remove 9,000 CY fill in floodplain & lower land average 4 feet
- Remove berm
- Plant restored 3-acre floodplain with native vegetation





# Greenway Trail Bridge Replacement– Jeffersonville

before



## Removed constriction

- An undersized bridge and unused abutments were removed
- Larger bridge installed
- Opened up floodplain under bridge

after





# Melrose Terrace, Brattleboro – Overflow culvert at bridge

10/28/2020



Pre-construction

6/19/2023



Post-construction

# Melrose Terrace, Brattleboro – Floodplain



## Removing buildings & people & infrastructure from most vulnerable locations

- Remove 11 buildings
- Relocate road
- Relocate sewer main / utilities

## Increase floodplain storage capacity

- Remove 28,000 CY fill in floodplain & lower land average 5 feet
- Plant restored 4.4-acre floodplain with native vegetation



# Flood Mitigation Analysis / Project Identification



## Constrictions

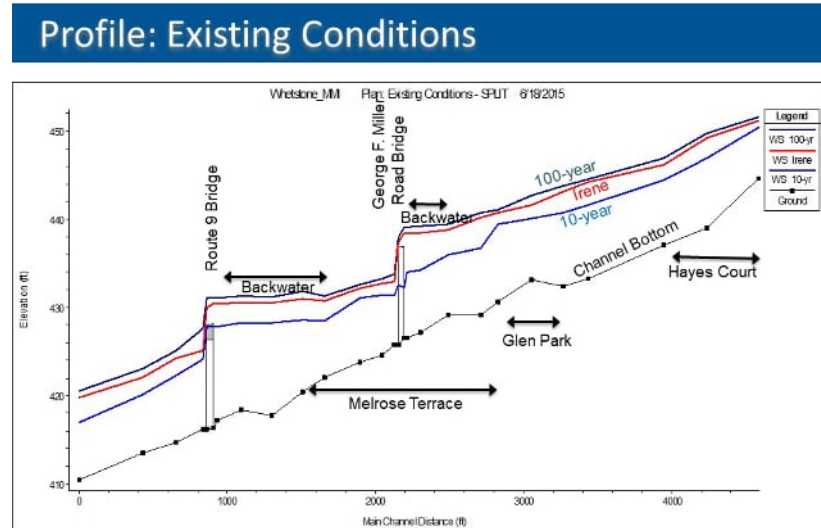
- Bridges, culverts, or other structures that pinch the river
- Natural narrow spots
- Fill or buildings constraining the river

## Fill or High Land

- Are there areas where the river could be given more space to hold flood waters

## Areas with Prior Damage

- Where has repeated damages occurred?
- Road washouts
- Buildings flooded
- Ongoing erosion damage



We need your input, as you have lived through floods.



# We know about some past damage/changes...

- Flooding in July 1997: Damage extended from upstream of Montgomery Center to downstream of Longley Bridge Road
  - NRCS has record of 10 federal contracts covering 26 projects paid out over \$501,610 in Montgomery (according to NRCS Emergency Watershed Protection Program Engineer Michel Lapointe). High water mark at 427.9 ft (NGVD29).
    - Several streambank projects along West Hill Brook and on the Trout River
    - Riprapping sections to protect Black Falls Road upstream of the covered bridge and downstream of the covered bridge
    - A project upstream of Vincent's Bridge Road on Trout River
    - A \$86,000 gabion project to protect Hill West Road
    - A riprap project on West Hill Brook to protect a residence
    - A round of Vermont Emergency Management Mitigation Buyouts.
  - 2019 flooding: the Montgomery Town Clerk reported that Total costs included: \$216,017.62 for repairs of which FEMA contributed \$193,860.58 and Montgomery provided \$22,157.04 in match. Included rebuilding of the Recreation Field.
  - Longley Bridge project





# But we really want to hear from you!



Experiences with past flooding (where/when?)

Ideas that might help improve flooding or water quality?

Want us to check out your property?

Any questions or concerns?

Anything else we should know or people we should talk to?



# Appendix E    Public Presentation – Existing Conditions

## Montgomery Flood Hazard Mitigation Study

Franklin County Natural Resources Conservation District

SLR Project No.: 146.13528.00001

December 27, 2024



# Montgomery, Vermont Flood Hazard Modeling & Project Identification

Jessica Louisos, PE, MS – Water Resource Engineer

Alex Marcucci, CFM – Water Resource Scientist

Lauren Weston – District Manager, Franklin County NRCD

August 6, 2024





# Flood Hazard Modeling & Project Identification

## Understand Flood Issues and Patterns

- Aerial survey – Done
- Bridge surveys - Done
- Hydraulic models – Existing Done

## Identify Possible Mitigation Projects

- Visit sites
- Collect ideas from residents

## Test Identified Alternatives

- Model possible projects in hydraulic model
- Consider constraints and project goals

## Concept Design

- Develop the top 5 projects to start the design process



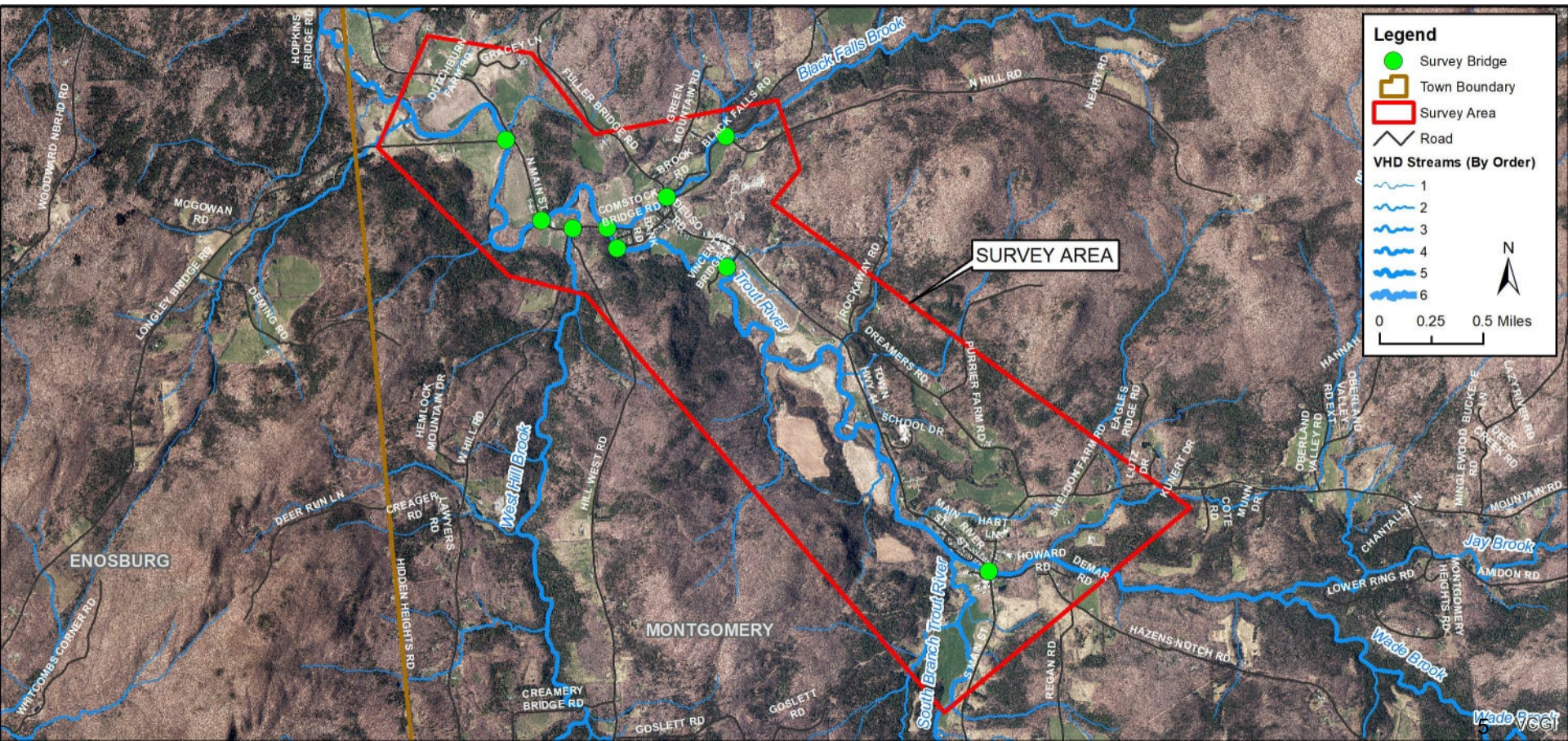
Whiteout Solutions – UAS Collection



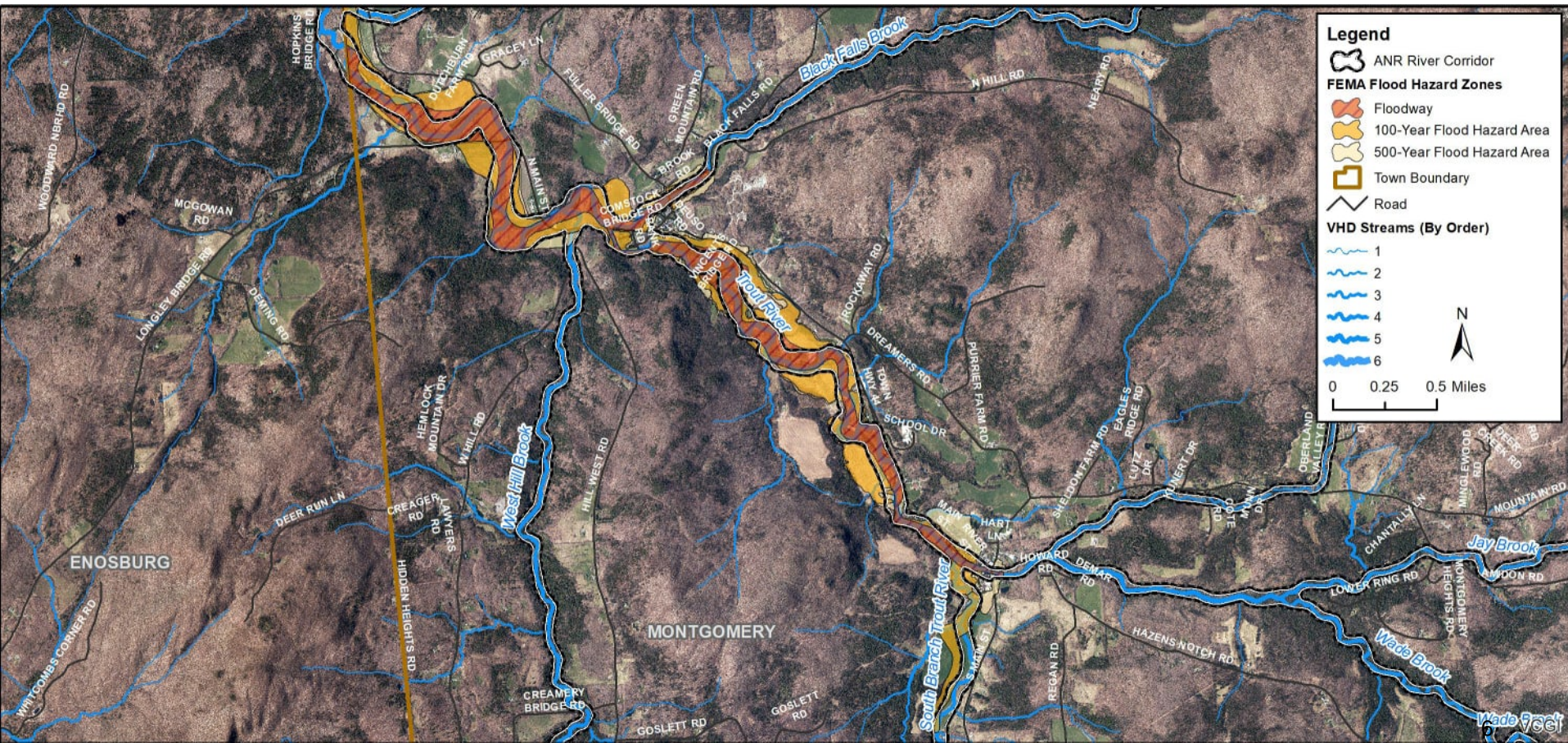
# Tasks & Schedule

		2024											
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
<b>Task 1. – Data Collection &amp; Project Initiation</b>													
1.1	Project Kickoff Meeting #1		■										
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4.2	Meeting #4										■	■	
4.3	Final Report										■	■	■
4.4	Meeting #5												■

# Project Area



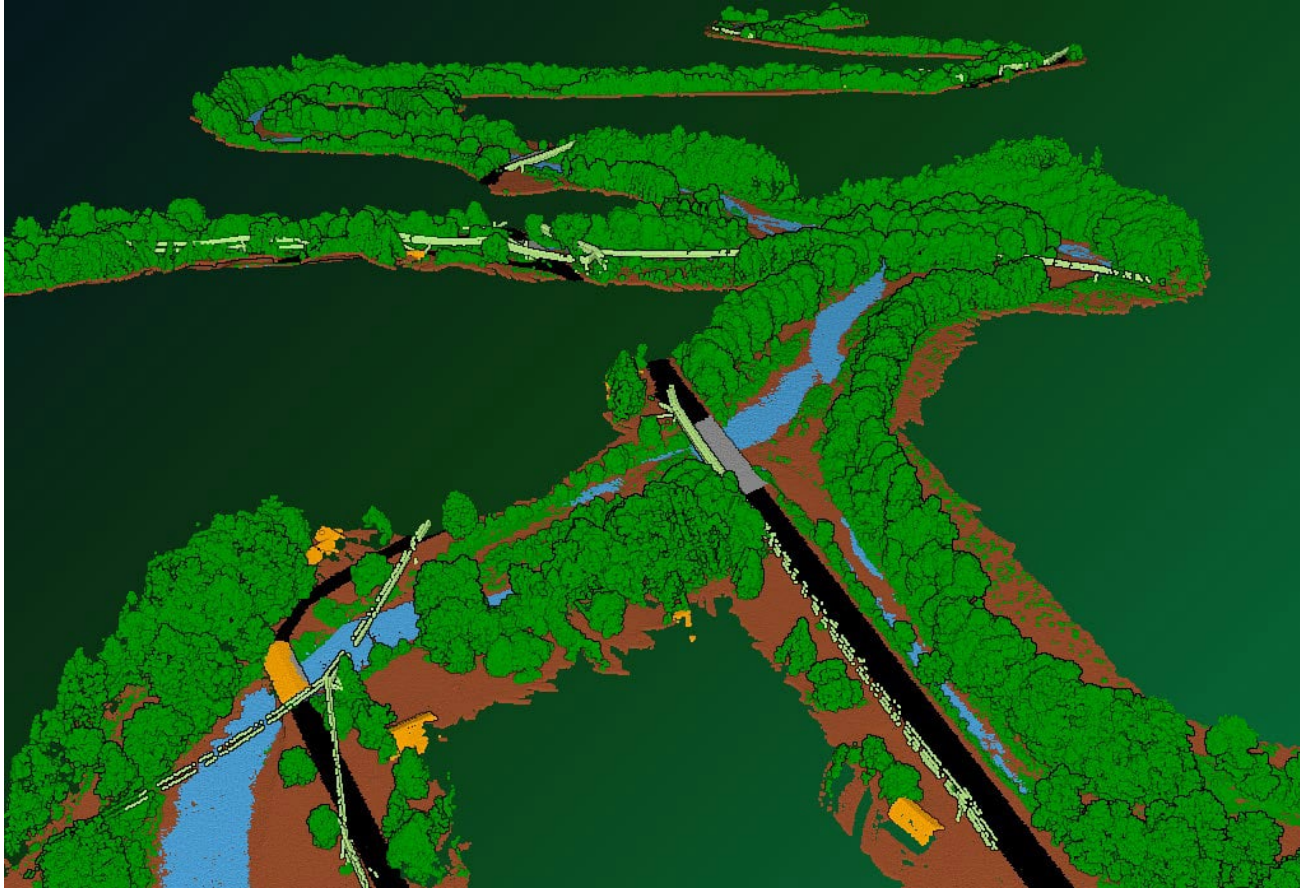
# Project Area – Flood Hazard Zones



# Data Collection

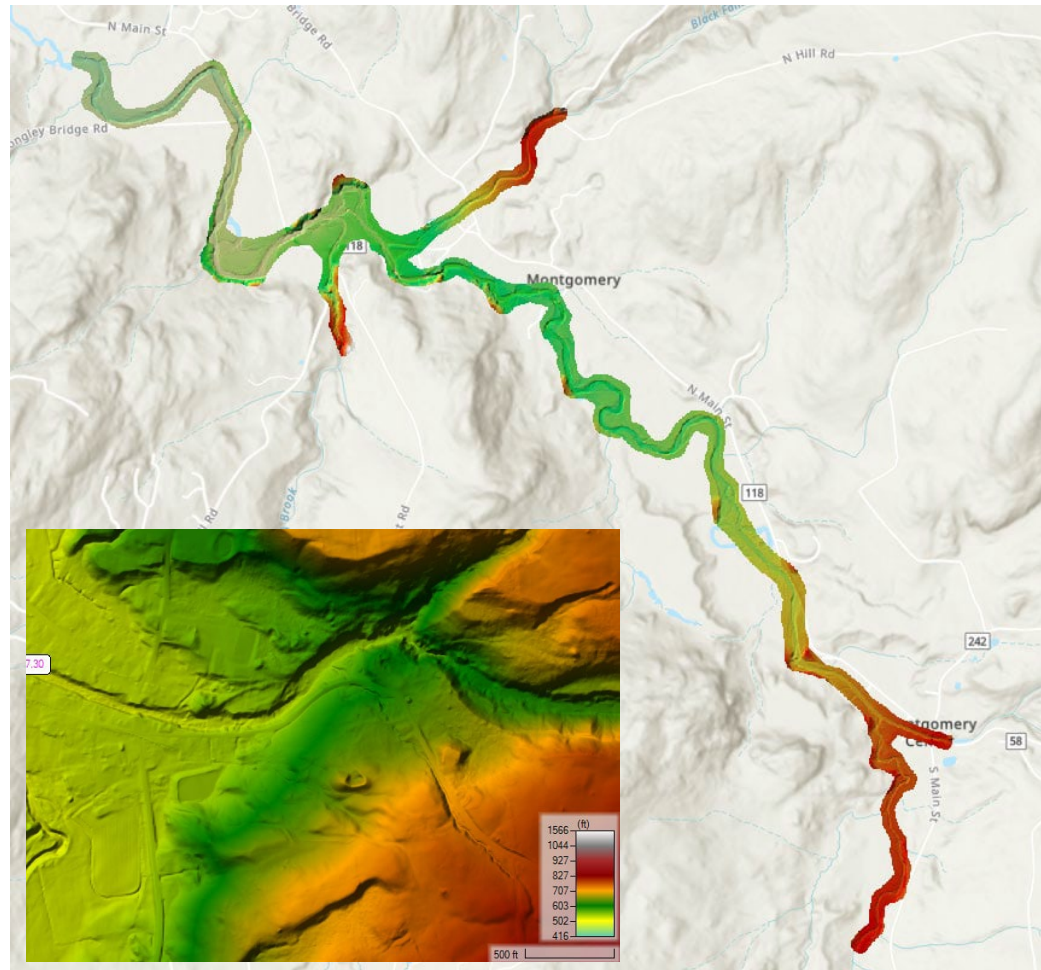


# Data Collection



# Data Collection

- UAS topobathymetric LiDAR collects 200+ elevation points per square meter
- Up to 3cm vertical accuracy
- UAS data post-processing included use of traditional survey points for ground control



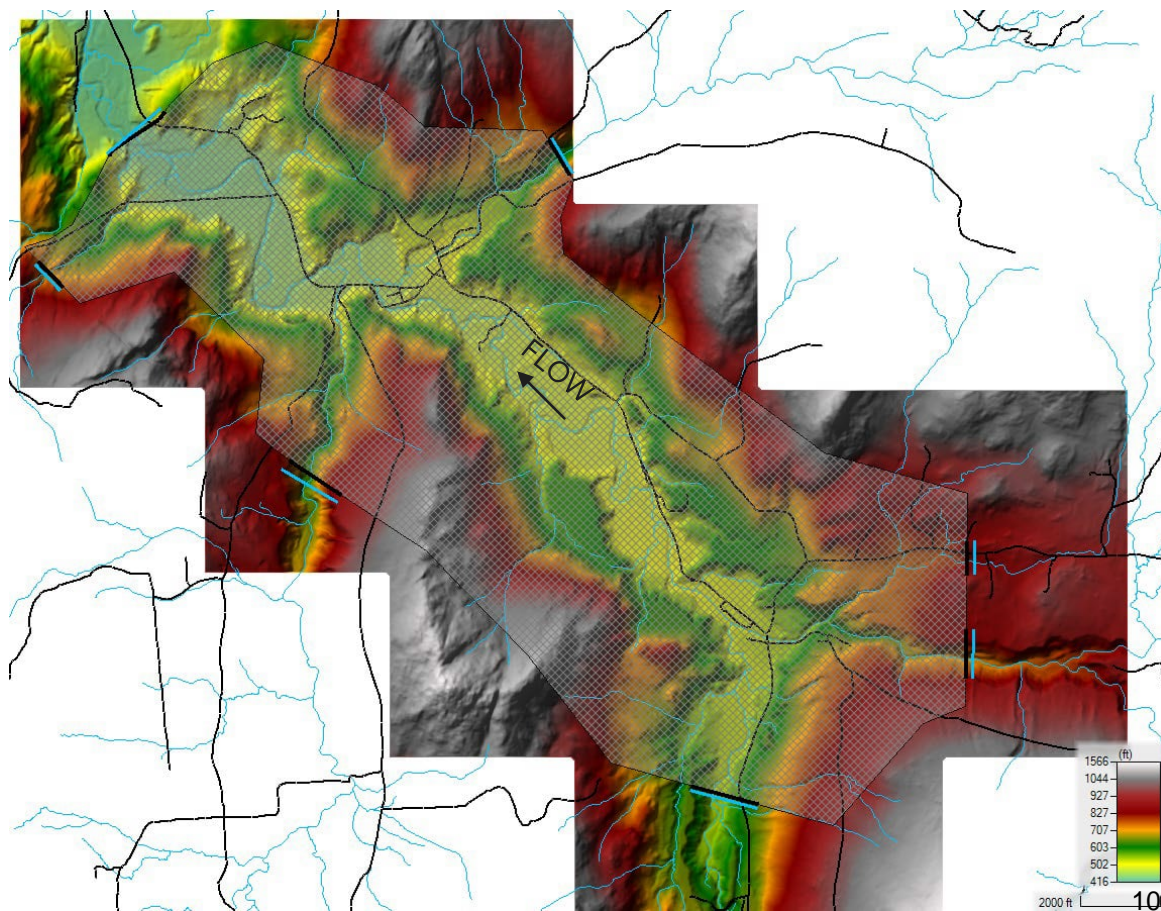


# Existing Conditions Hydraulic Modeling

- Model encompasses over 7 square miles
- >250,000 cells with base cell size of 50x50 feet

## 6 Flow Inputs

- Trout River
- South Branch Trout River
- Hannah Clark Brook
- Black Falls Brook
- West Hill Brook
- Longley Bridge Tributary

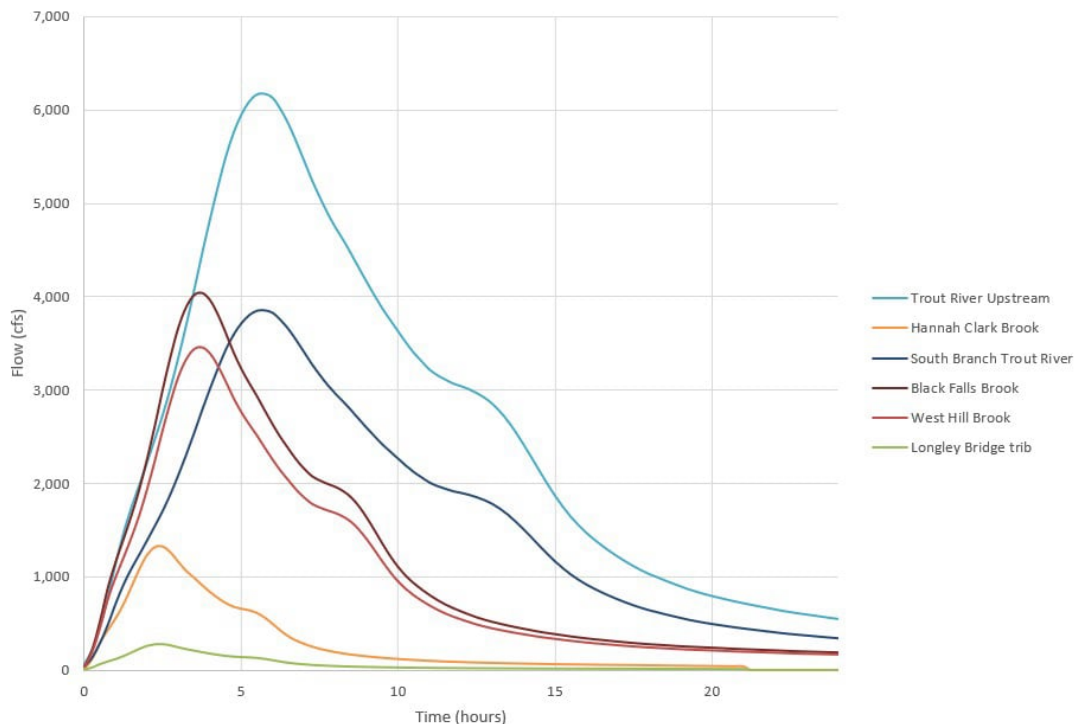




# Hydrology

- USGS gage analysis performed
- Model uses flows from FEMA flood insurance study supplemented with regional regression equation

Flow Input	Flow (cubic ft/s)			
	10- Year	50- Year	100- Year	500- Year
Trout River US	2,878	4,980	6,250	9,490
Hannah Clark Brook	672	1,120	1,350	2,010
South Branch	2,550	3,800	3,900	5,500
Black Falls Brook	1,900	3,400	4,100	5,900
West Hill Brook	1,800	3,000	3,500	5,000
Longley Bridge Trib	140	234	282	417



# Model Setup

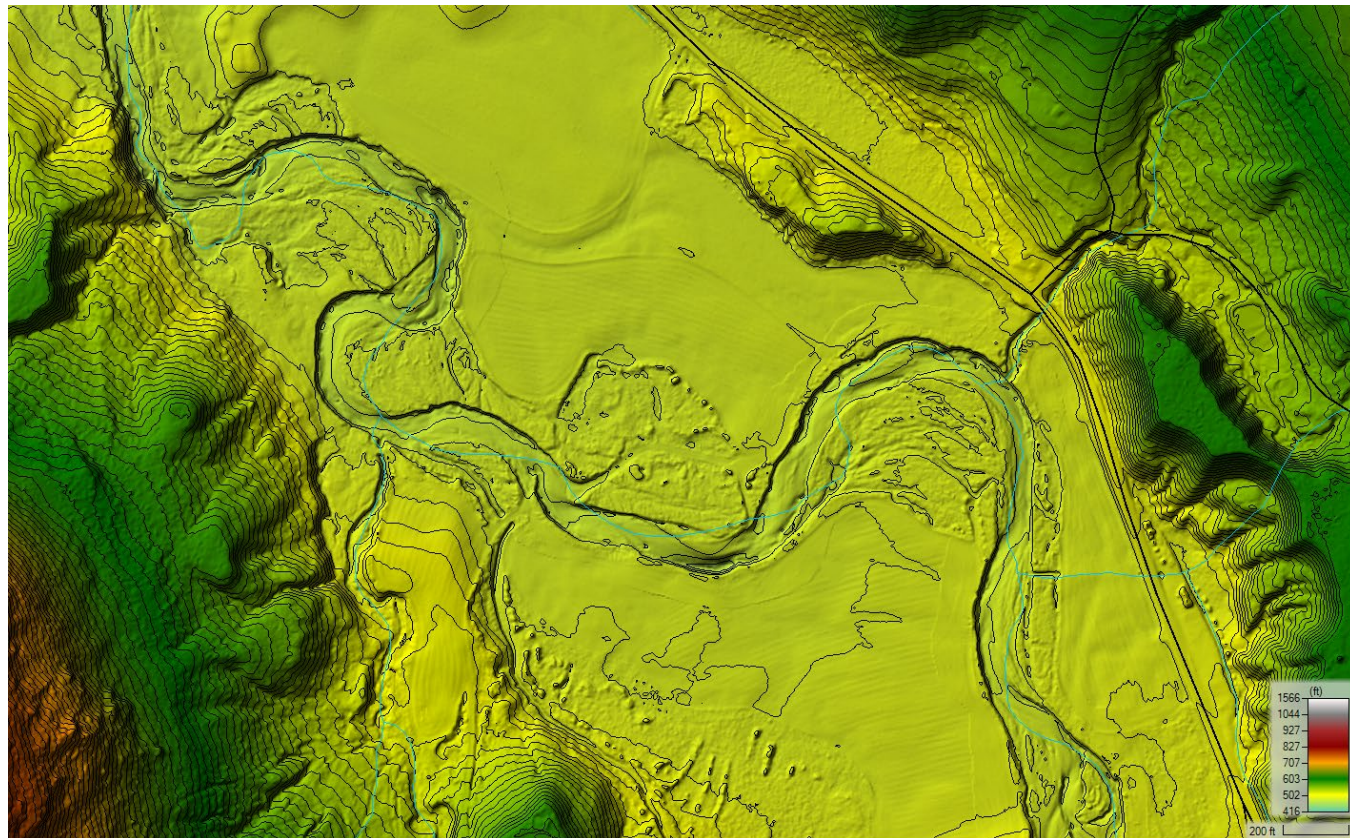
- Land use used as roughness values
- 2016 high resolution land cover (UVM) verified with field observations





# Model Setup

- High resolution LiDAR digital elevation model (2017)
- UAS topobathymetric LiDAR digital terrain model (2024) to capture changes and elevations below water



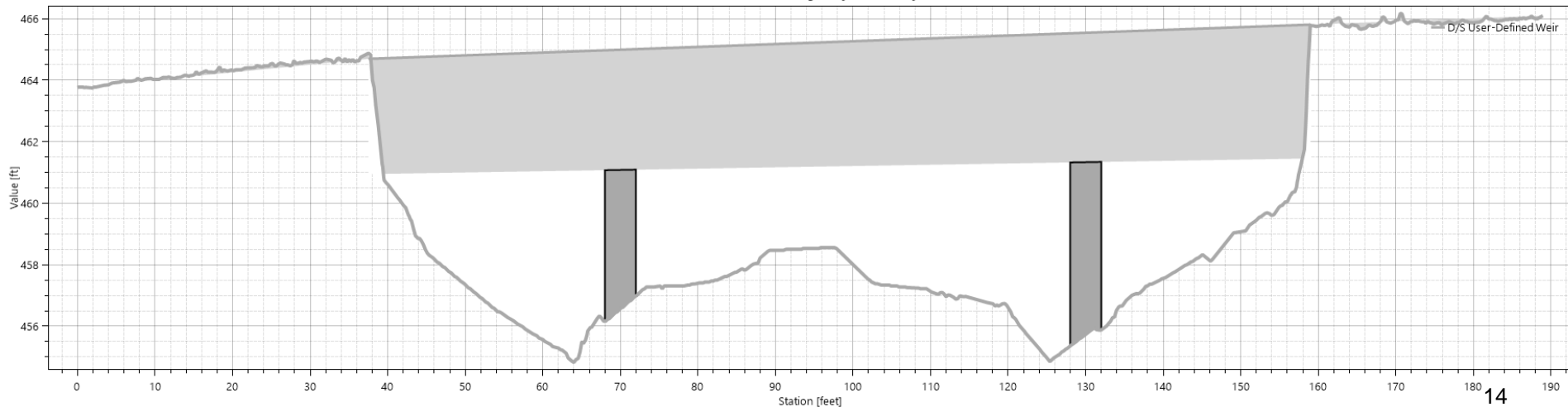


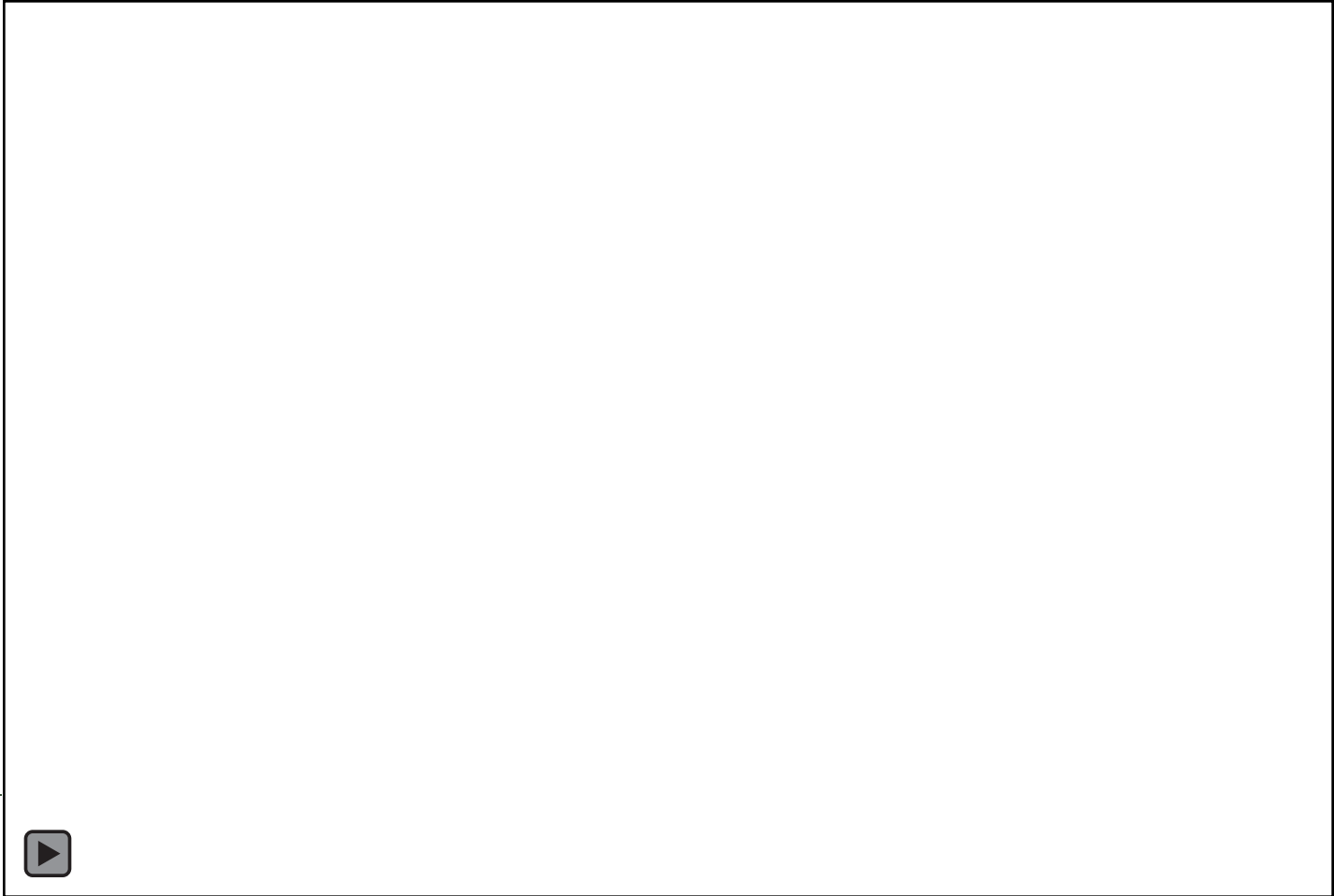
# Model Setup

- Model mesh refined to accurately show berms, road edges, channel
- Bridges and culverts inserted using survey data, collected LiDAR, and high accuracy GPS data



SA2D Conn: WestHillBrookBri (Montgomery\_2DGeometry) (Downstream)

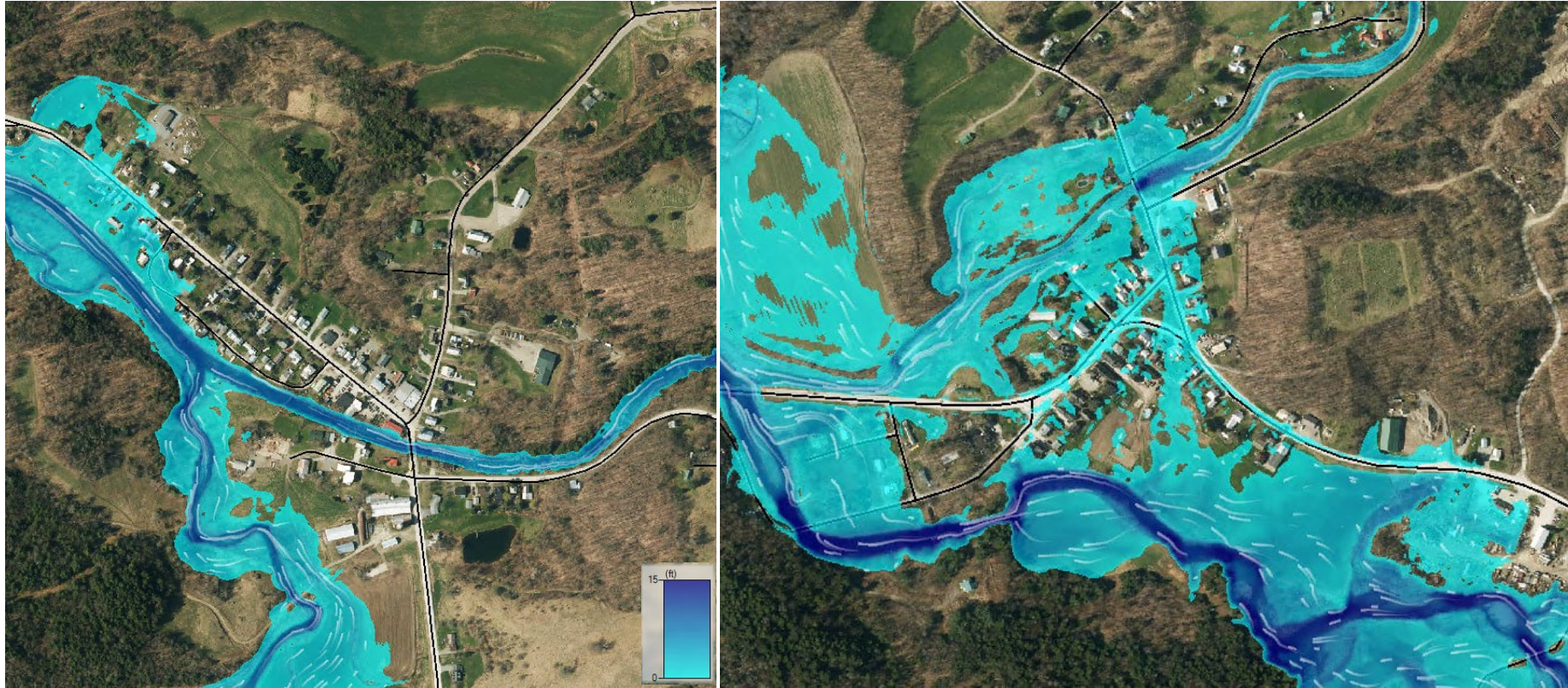




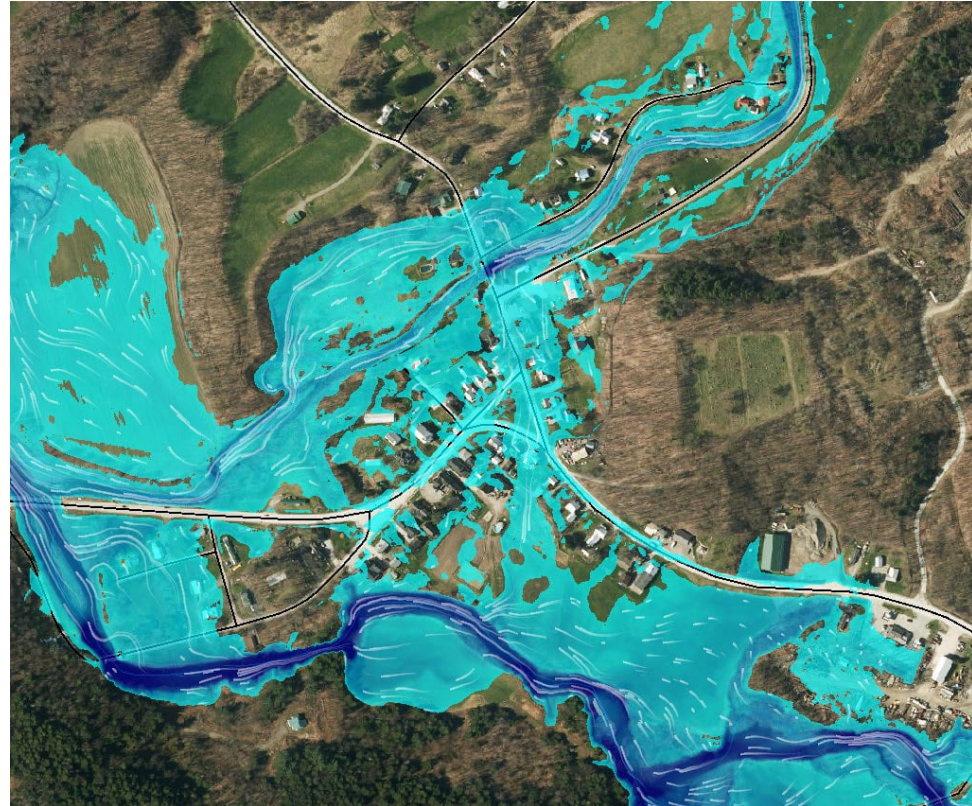
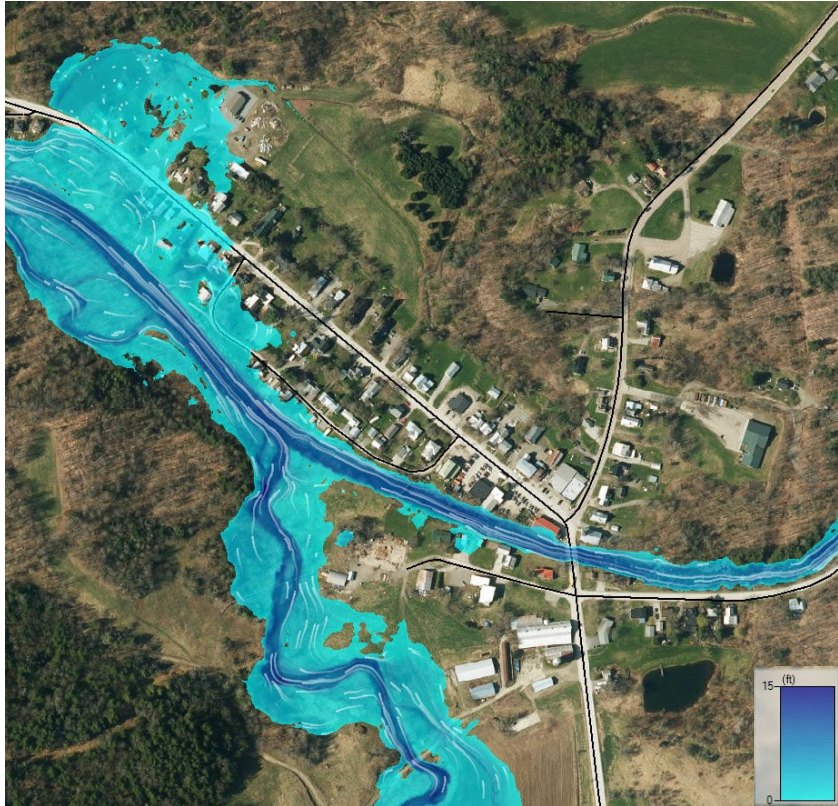
Model Results  
Medium Flood

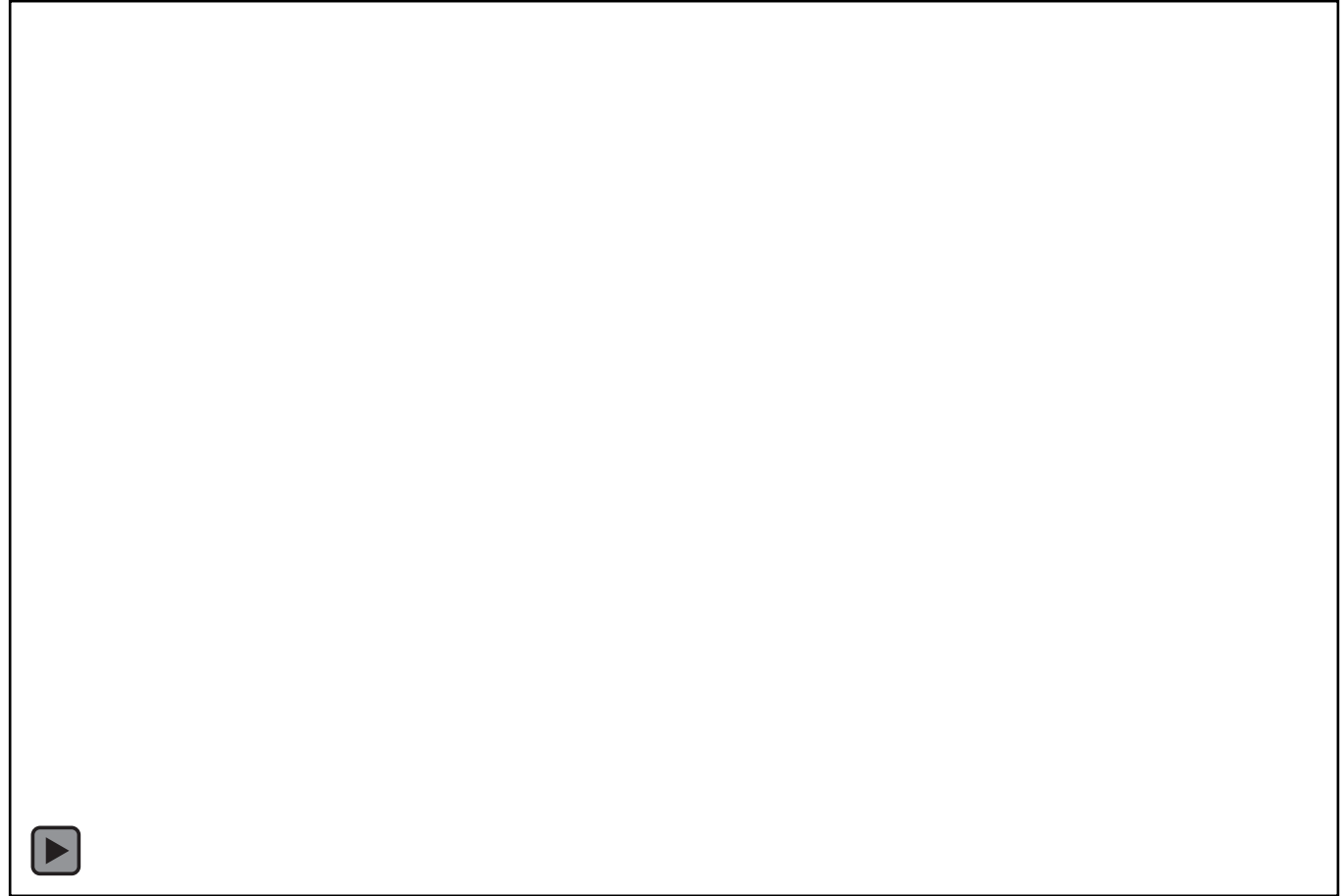


# Model Results – Small Flood



# Model Results – Medium Flood



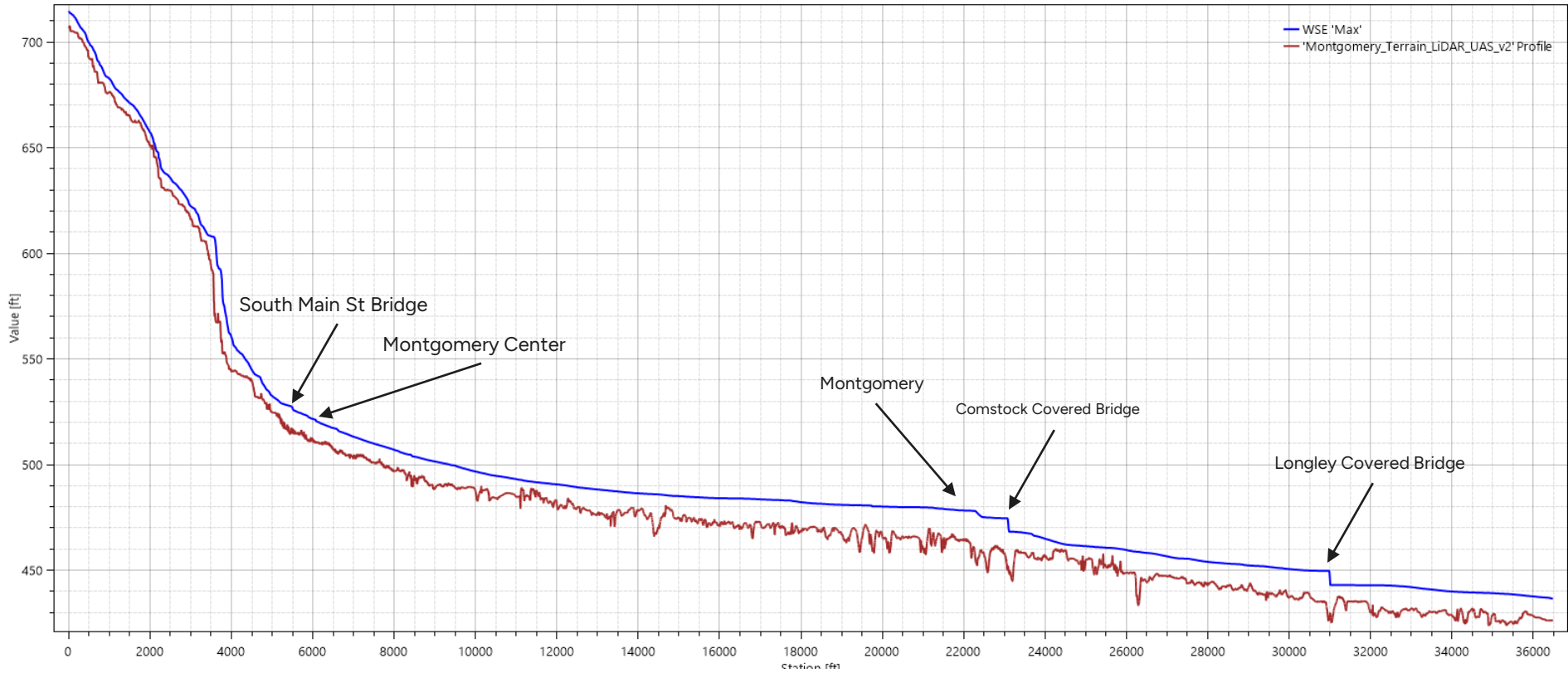


Model Results –  
Medium Flood

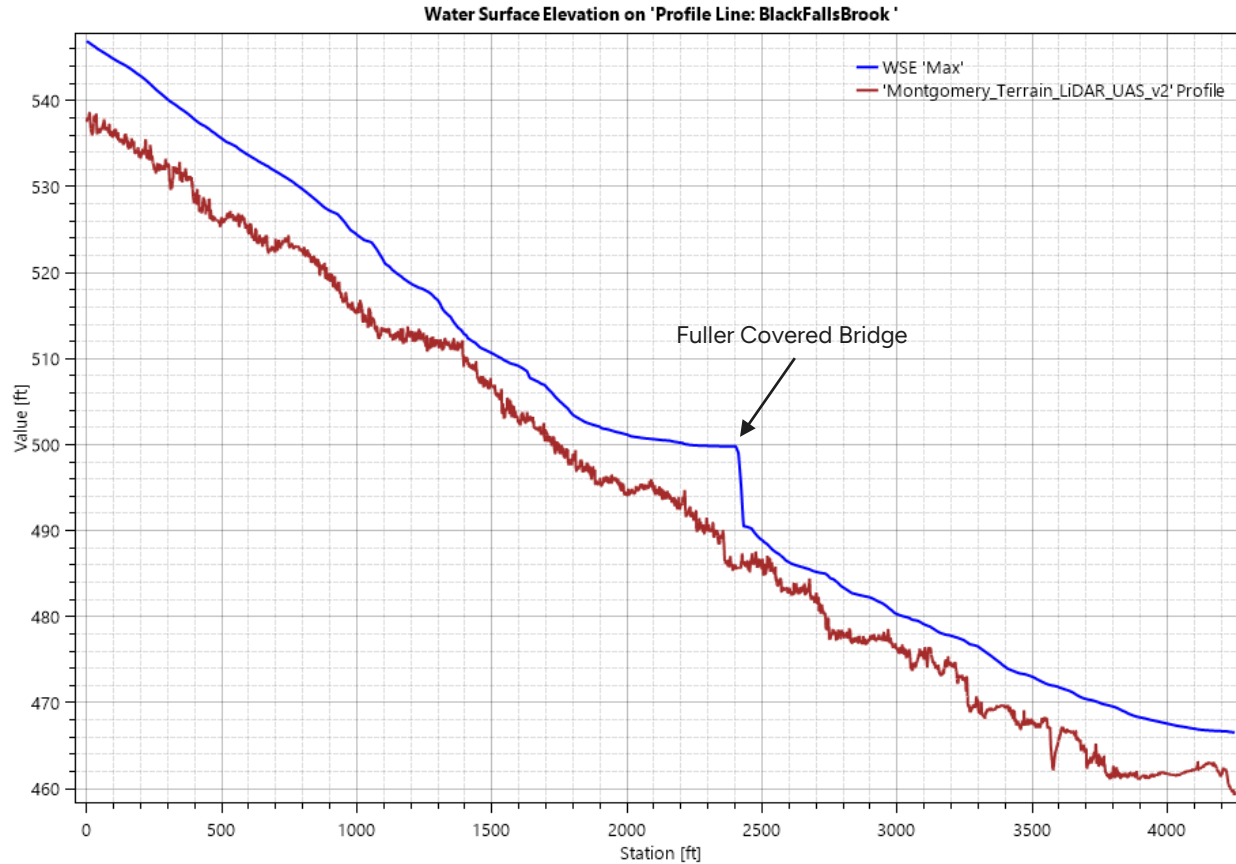
# Model Results – Medium Flood



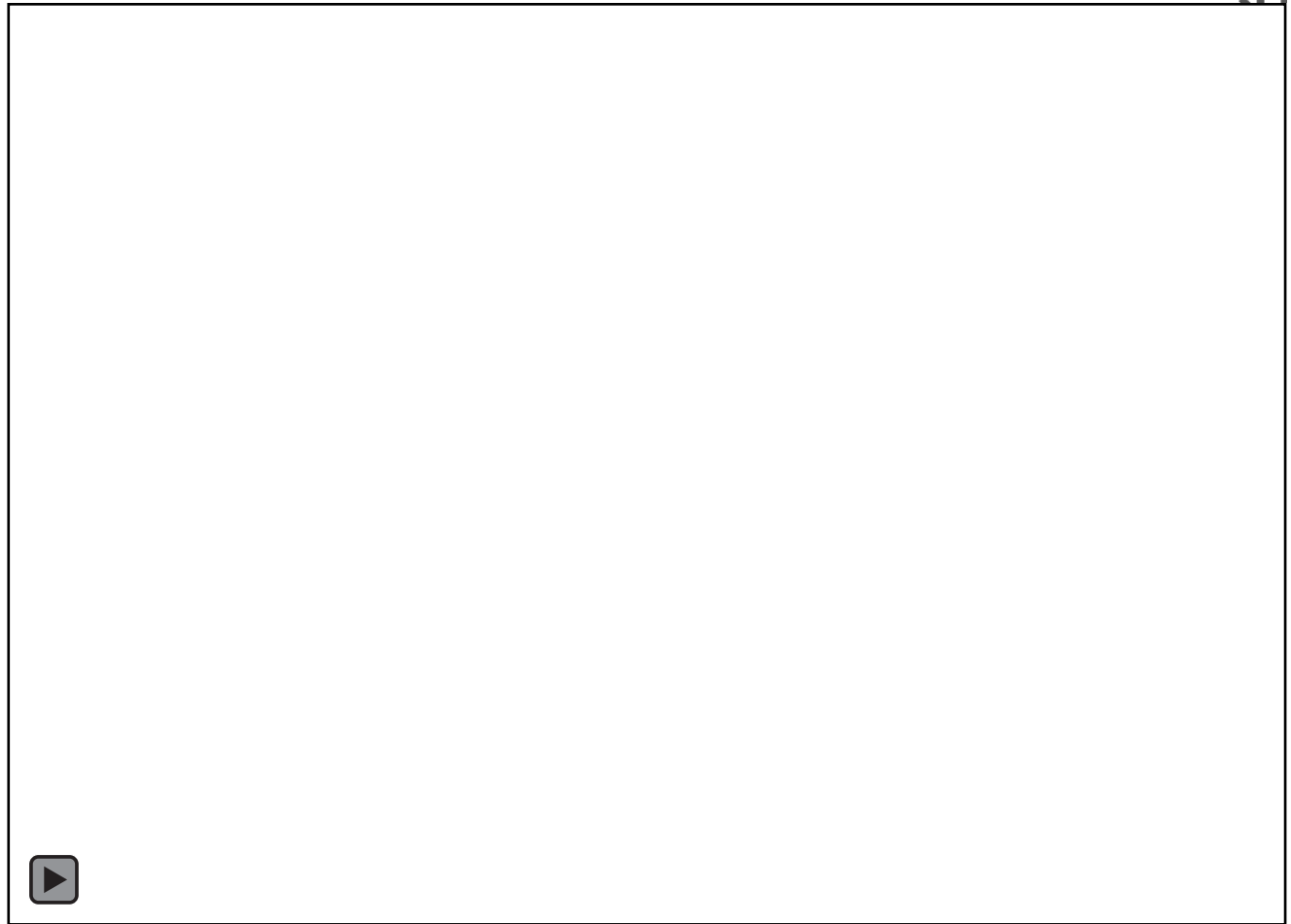
Water Surface Elevation on 'Profile Line: TroutRiverProfile'



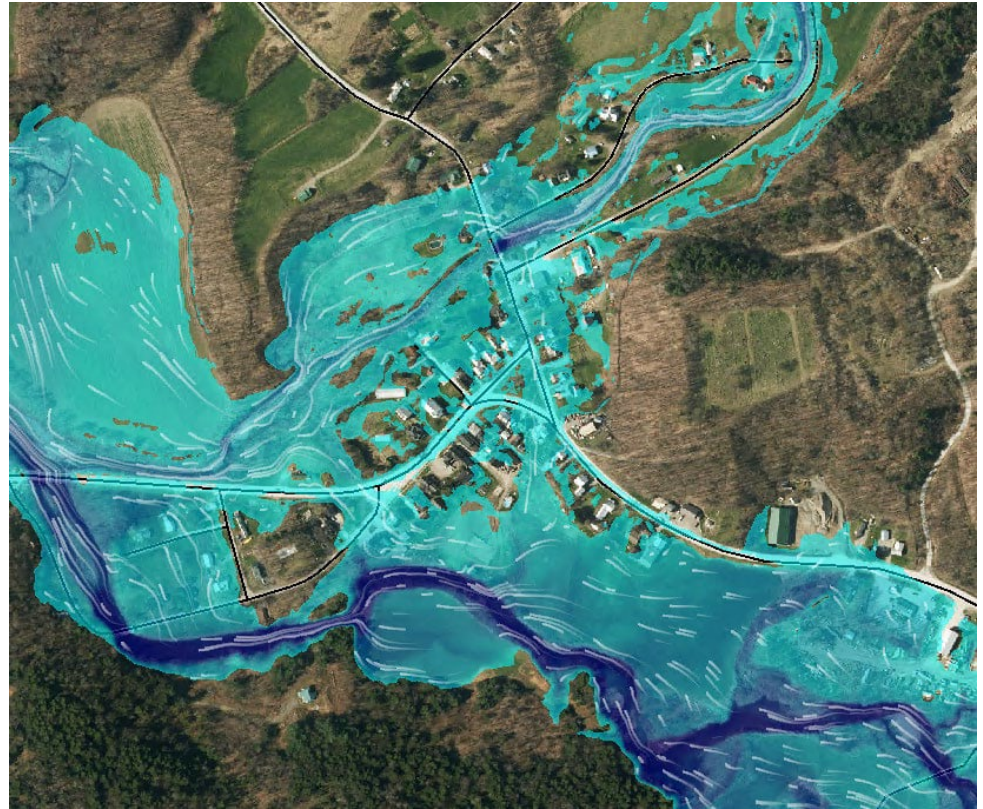
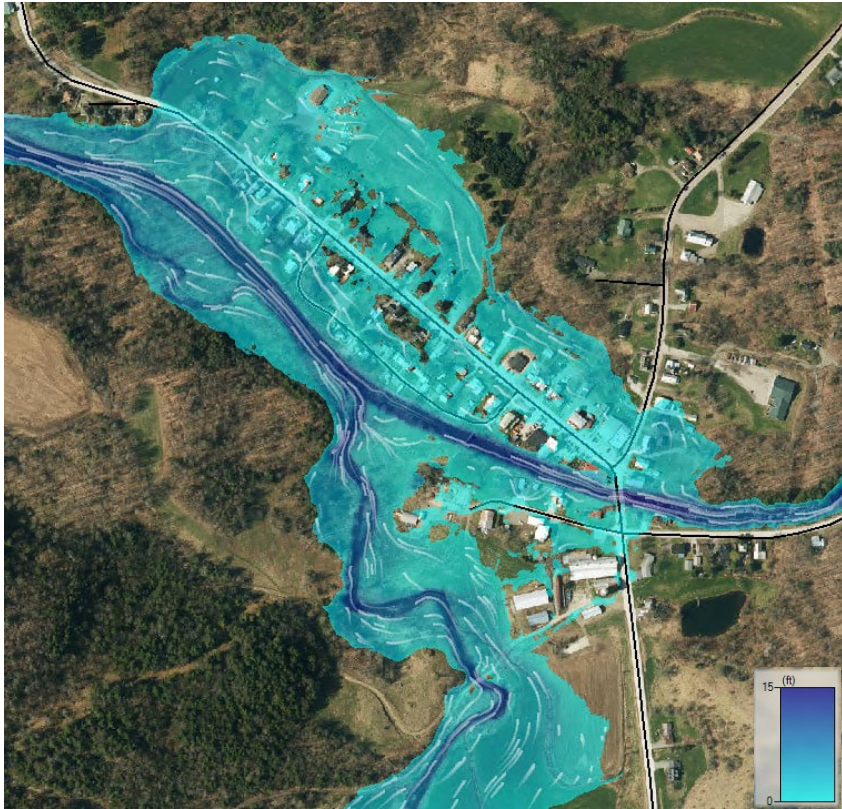
# Model Results – Medium Flood



# Model Results – Large Flood



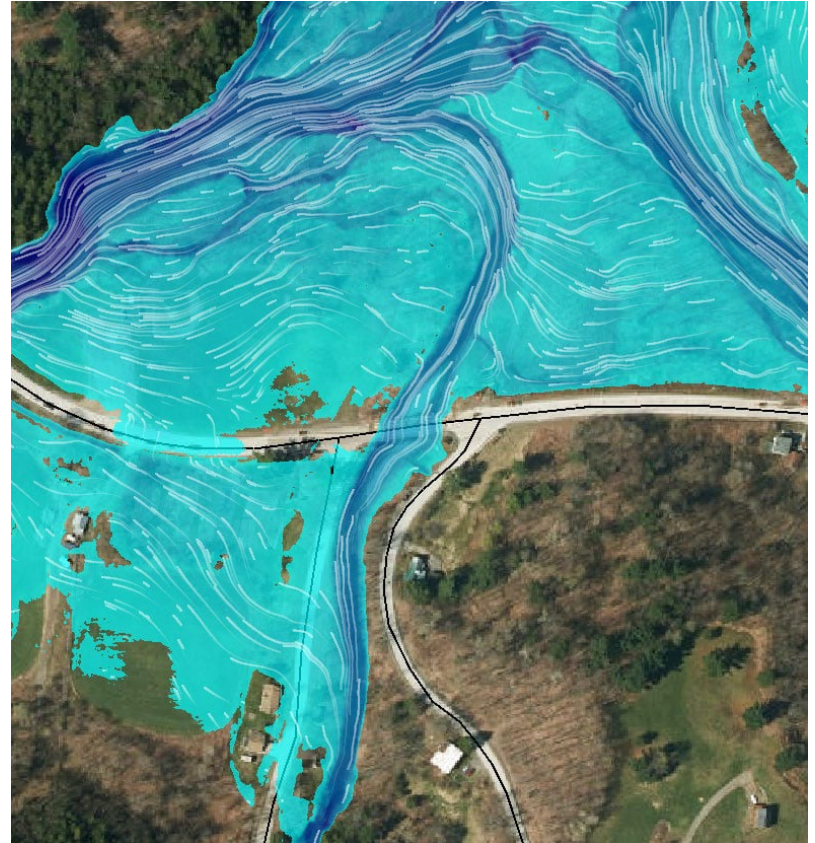
# Model Results – Large Flood



# Model Validation



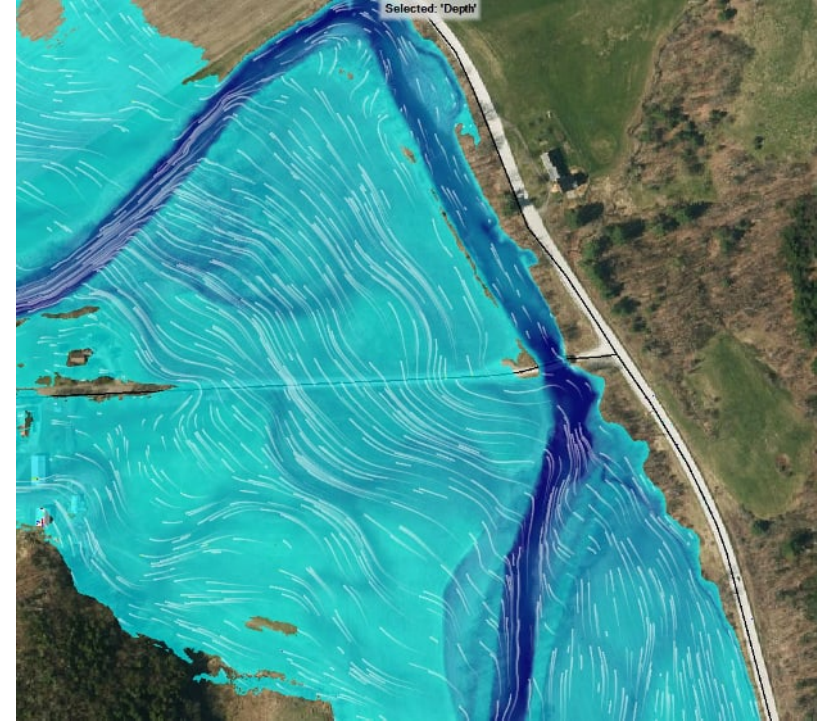
North Main and West Hill Road  
Following Halloween 2019 Flood



# Model Validation



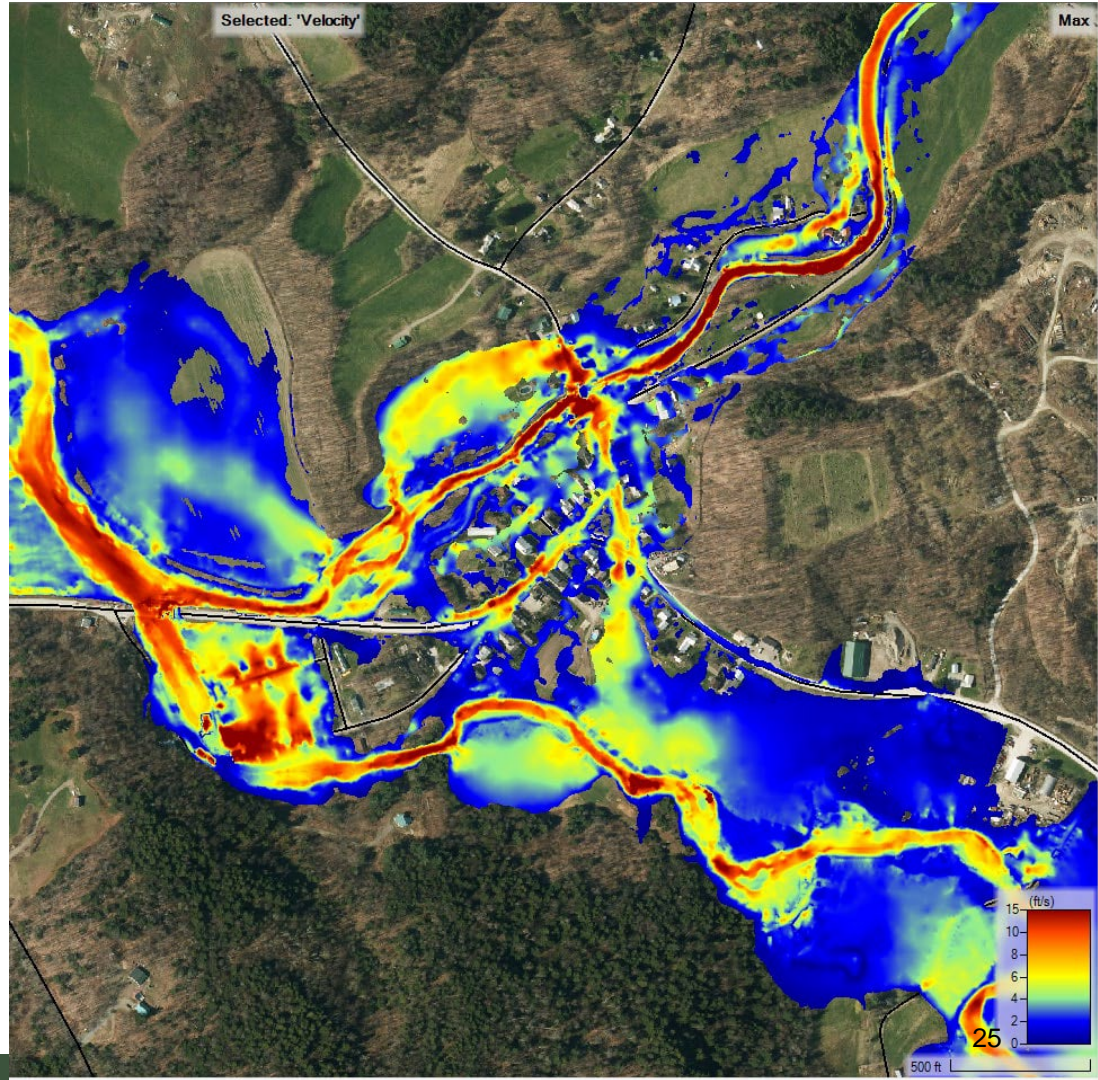
Longley Bridge Road  
Following Halloween 2019 Flood



# Model Validation



Brook Road  
Following Halloween 2019 Flood



# Flood Mitigation Analysis / Project Identification



## Constrictions

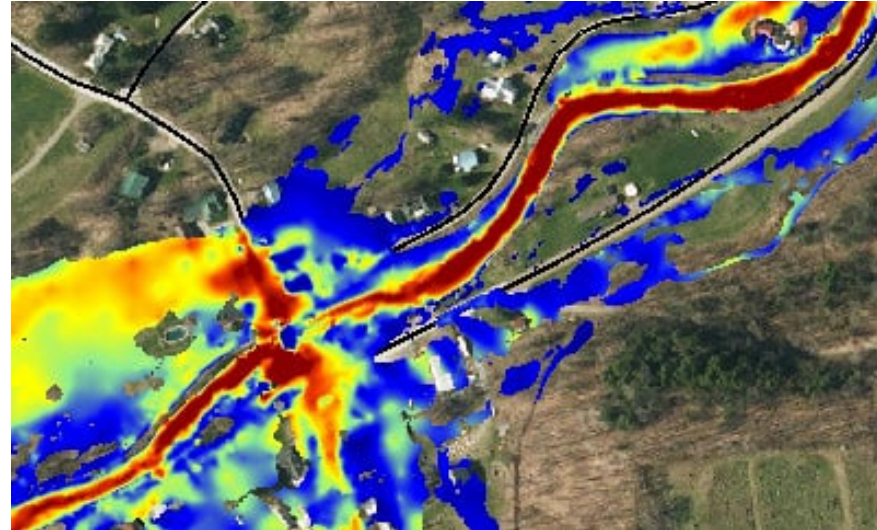
- Bridges, culverts, or other structures that pinch the river
- Natural narrow spots
- Fill or buildings constraining the river

## Fill or High Land

- Are there areas where the river could be given more space to hold flood waters?

## Areas with Prior Damage

- Where have repeated damages occurred?
- Road washouts
- Buildings flooded
- Ongoing erosion damage



We need your input.



# Flood Mitigation Analysis / Project Identification

## Past Damage

- The community has flooded multiple times
- Both erosion and inundation damages.

## Post-Flood Fixes

- Band-aid approach to address specific damage locations
- Focuses on repairs

## Proactive Resiliency Projects

- Identify and explore bigger picture projects
- Increase resiliency and reduce future damage



We need your input.



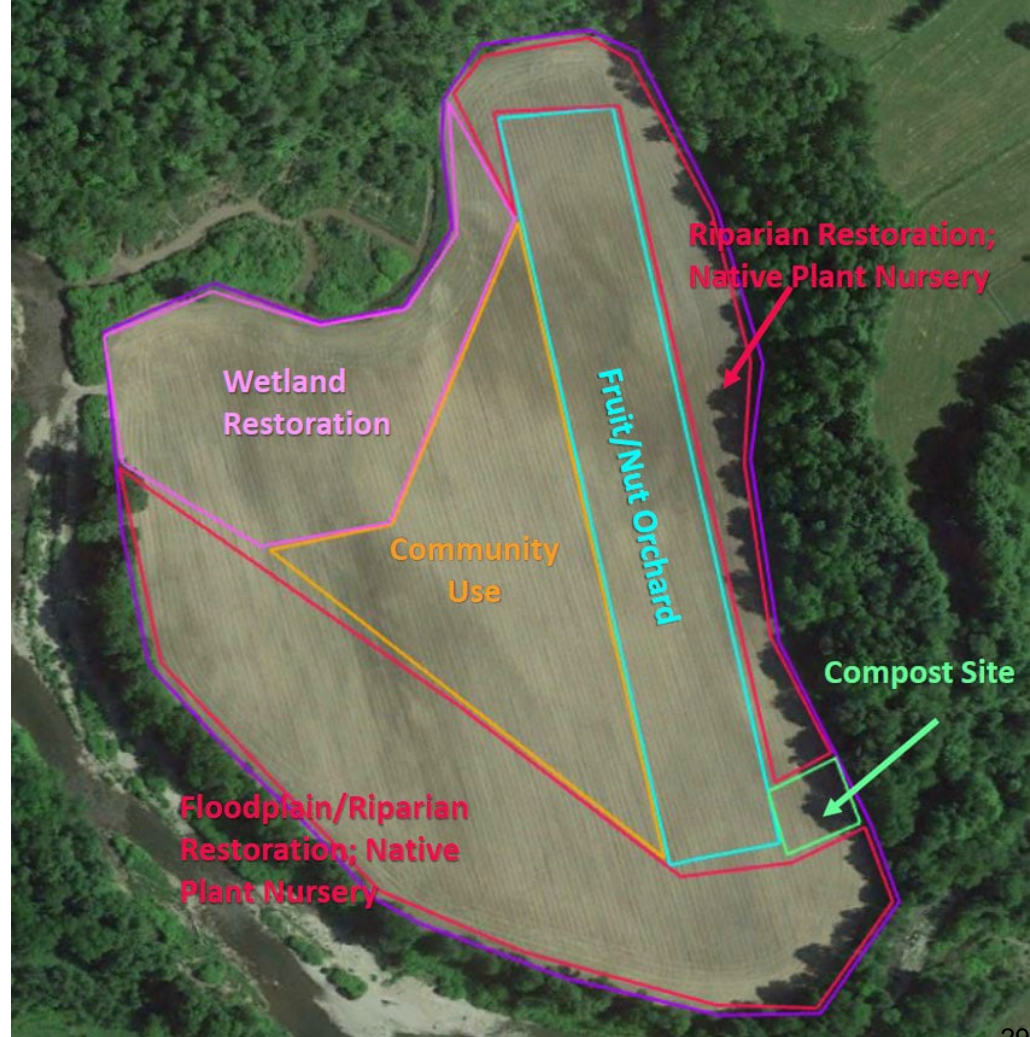
# Alternative 1

- Floodplain and Wetland Restoration at 251 Fuller Bridge Road
- Various size footprints and flood storage options
- Black Falls Brook Confluence



# Alternative 1

- Prior conversations with FCNRCD, Conservation Commission, and Selectboard
- NRCDC has done education at the land already



# Alternative 2



- Route 118 at West Hill Brook



# Alternative 2

- Route 118 at West Hill Brook
- Bridge Replacement
- Sediment and debris management
- Increase transport





# Alternative 3

- Realign West Hill Road farther to West at West Hill Brook
- Floodplain Restoration to lower land at gardens (prior buyouts)





# Alternative 4

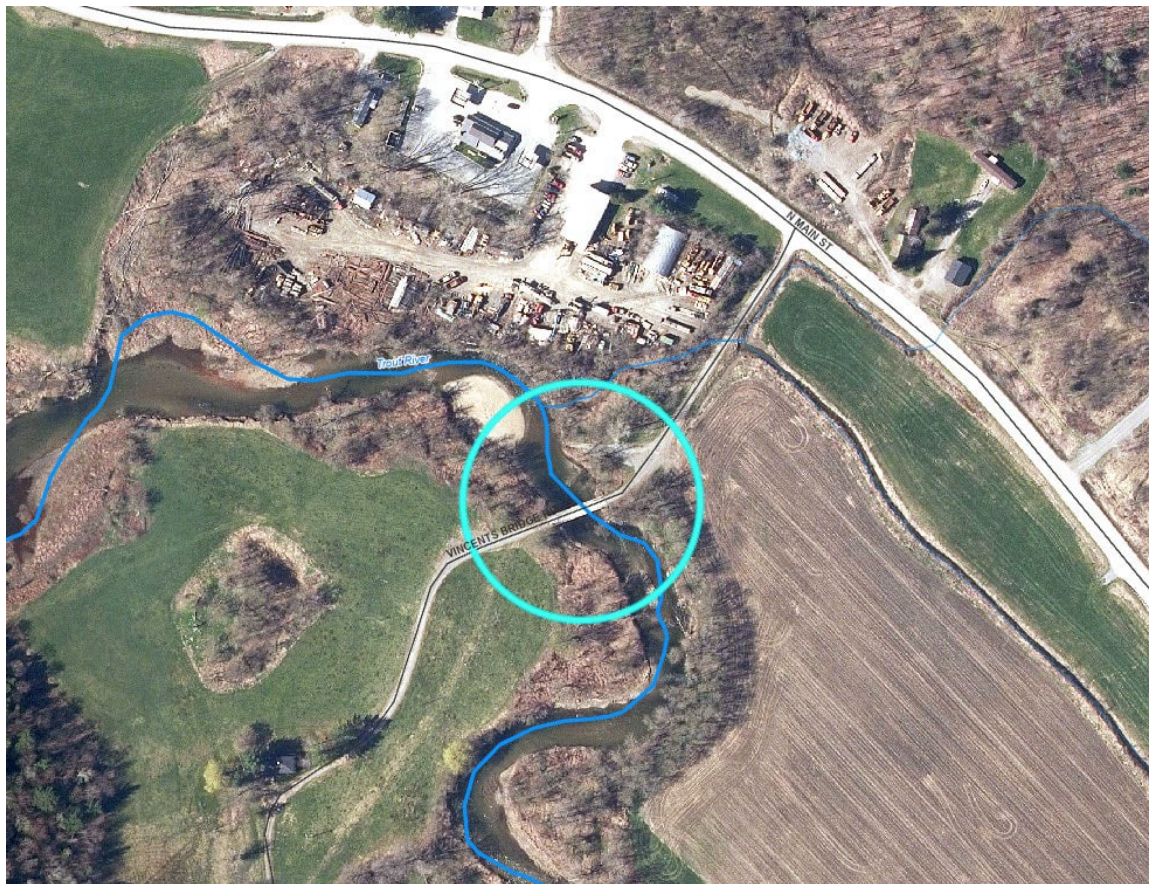
- Comstock Bridge at Trout Brook
- Bridge Replacement
- Reinforced Overflow





# Alternative 5

- Vincent's Bridge at Trout Brook
- Bridge Replacement
- Reinforced Overflow





# Alternative 6

- Longley Bridge Road at Trout Brook
- Reinforced Overflow
- Historic Bridge
- Road damage at Irene



Halloween 2019 – from Town

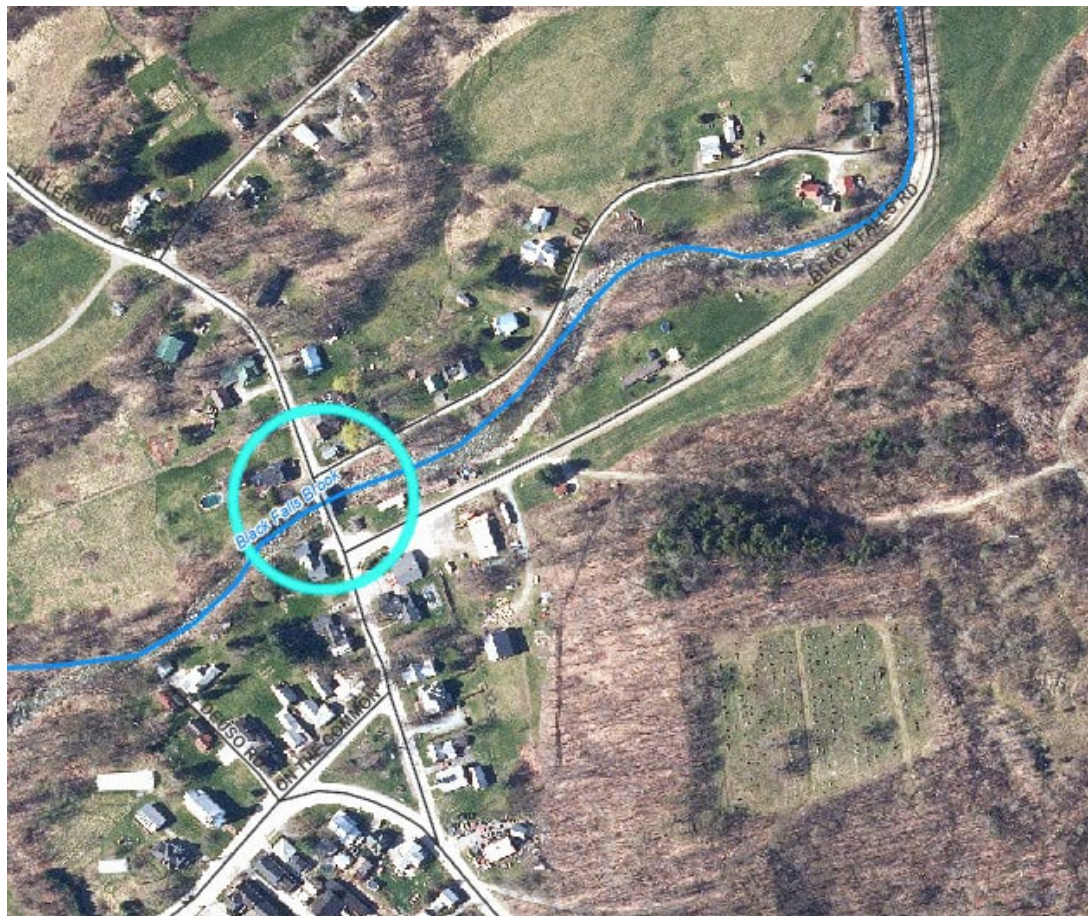


# Alternative 7

- Fuller Covered Bridge at Black Falls Brook
- Reinforced Overflow
- Historic Bridge
- Road damage multiple times

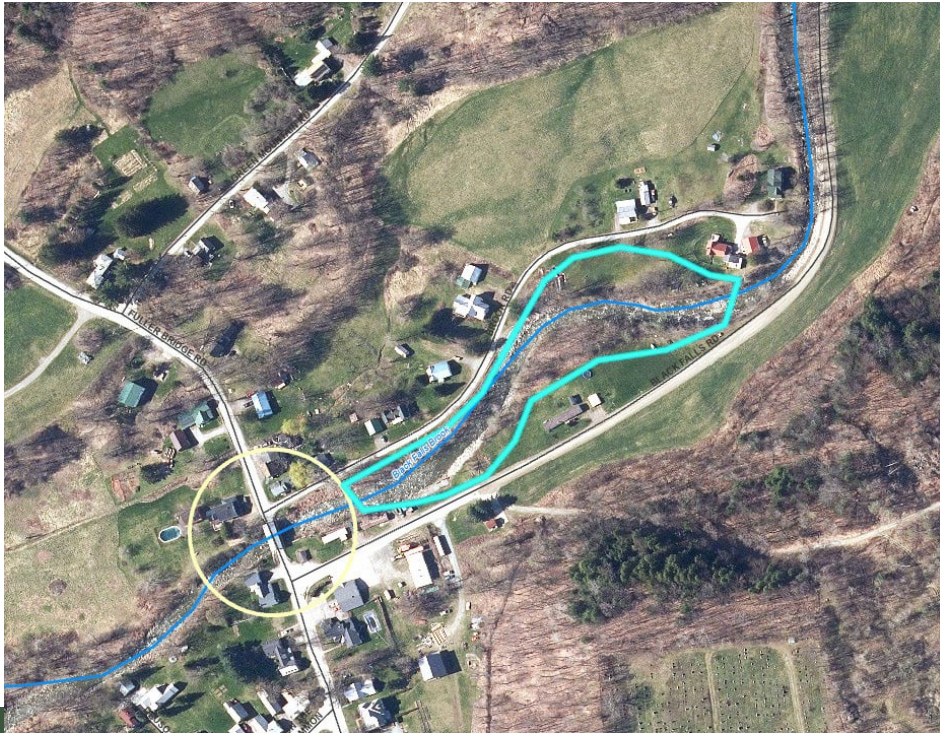


East elevation (1974)



# Alternative 8

- Black Falls Brook is confined along Black Falls Road and Brook Road
- Lower land to regain floodplain access



Halloween 2019 – from Town

# Alternative 9

- Black Falls Brook is confined along Black Falls Road and Brook Road
- Move Black Falls Road & lower floodplain



# Alternative 10

- Trout River at Route 118 embankment across from the Rec Center
- Floodplain lowering





# Alternative 11

- Constriction below Village
- Remove deposition filling channel around bedrock
- Trout River – narrow valley



# Alternative 12

- Floodplain access in Center



# Alternative 13

- Floodplain access in Center
- South Branch Trout River





# Alternative 14

- Snowmobile Bridge on Trout River in Center
- Increase conveyance





# Alternative 15

- Center Village area has flooded
- River confined by walls and buildings
- Change in slope from steep upstream channel



1997 Flash Flood – from Town



# Alternative 15

- Consider alternatives to increase conveyance
- Increase bridge capacity
- Overflow paths for when walls can not carry flow
- Floodplain access





# Alternative 15

- South Branch Trout River
- Flood storage





# Initial Flood Mitigation Project Identification

ID	Location	Description
1	Confluence of Black Falls Brook	Floodplain / Wetland Restoration at 251 Fuller Bridge Road
2	Route 118 at West Hill Brook	Bridge Alternatives / Sediment Management
3	West Hill Brook / West Hill Road	Floodplain Reconnection at Gardens
4	Comstock Bridge at Trout River	Overflow Capacity / Reinforced Overflow
5	Vincent's Bridge Road at Trout River	Bridge Replacement or Reinforced Overflow
6	Longley Bridge Road at Trout River	Overflow Capacity / Reinforced Overflow
7	Fuller Bridge / Black Falls Brook	Overflow Capacity / Reinforced Overflow
8	Black Falls Brook	Regain Floodplain Access
9	Black Falls Brook	Move Road and Restore Floodplain
10	Trout River near Rec Center	Regain Floodplain Access at constriction
11	Trout River below Center	Remove gravel deposits around boulder / valley constriction
12	Center Village	Floodplain reconnection on Trout River
13	Center Village	Floodplain Reconnection at South Branch
14	Center Village	Snowmobile Bridge Replacement
15	Center Village	Consider Options for Increasing Conveyance

We need your input.

# Initial Flood Mitigation Project Identification



ID	Location	Description
Future Work	All river adjacent areas	Buffer with woody vegetation & Protect River Corridor
Future Work	All upstream areas	Reduce sediment from road runoff
Future Work	Upstream areas	Increase flood storage with floodplain connection, wetland restoration.
Future Work	Upstream areas	Stormwater Mitigation
Individual Action	Individual Properties - Not Specified	Floodproofing of buildings / filling basements / raising utilities / elevating buildings
Individual Action	Individual Properties - Not Specified	Buyouts of properties

We need your input.



Do you  
have any  
questions?



# Appendix F    Public Presentation – Alternatives

## Montgomery Flood Hazard Mitigation Study

Franklin County Natural Resources Conservation District

SLR Project No.: 146.13528.00001

December 27, 2024



# Montgomery, Vermont Flood Hazard Modeling & Project Identification

Jessica Louisos, PE, MS – Water Resource Engineer

Alex Marcucci, CFM – Water Resource Scientist

Lauren Weston – District Manager, Franklin County NRCD

November 6, 2024





# Flood Hazard Modeling & Project Identification

## Understand Flood Issues and Patterns

- Aerial survey
- Bridge surveys
- Hydraulic models

DONE

## Identify Possible Mitigation Projects

- Visit sites
- Collect ideas from residents

DONE

## Test Identified Alternatives

- Model possible projects in hydraulic model
- Consider constraints and project goals

DISCUSS  
TODAY

## Concept Design

- Develop the top 5 projects to start the design process

GOAL FOR TODAY





# Tasks & Schedule

		2024											
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
<b>Task 1. – Data Collection &amp; Project Initiation</b>													
1.1	Project Kickoff Meeting #1		█										
1.2	Data Review	█	█										
1.3	GIS basemap	█		█	█								
1.3	Site Visit, RAPID Geomorphic Assessment		█	█									
1.4	Field Survey		█	█	█								
<b>Task 2. – Hydraulic Modeling</b>													
2.1	Hydraulic Model with LIDAR and Survey	█	█	█	█								
2.2	Model Validation				█	█							
2.3	Existing Conditions and Hydraulics Memo					█	█						
2.4	Initial list of alternatives				█	█	█						
2.5	Meeting #2						█						
<b>Task 3. – Alternatives Analysis</b>													
3.1	Explore Restoration and Flood Mitigation Alternatives					█	█	█					
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3.3	Alternatives Matrix to Summarize Results							█	█				
3.4	Meeting #3								█				
3.5	Concept Design (30%)								█	█	█		
<b>Task 4. – Reporting &amp; Presentations</b>													
4.1	Draft Report				█	█	█	█	█	█	█	█	
4.2	Meeting #4											█	
4.3	Final Report											█	█
4.4	Meeting #5												█

Model Results –  
Medium Flood

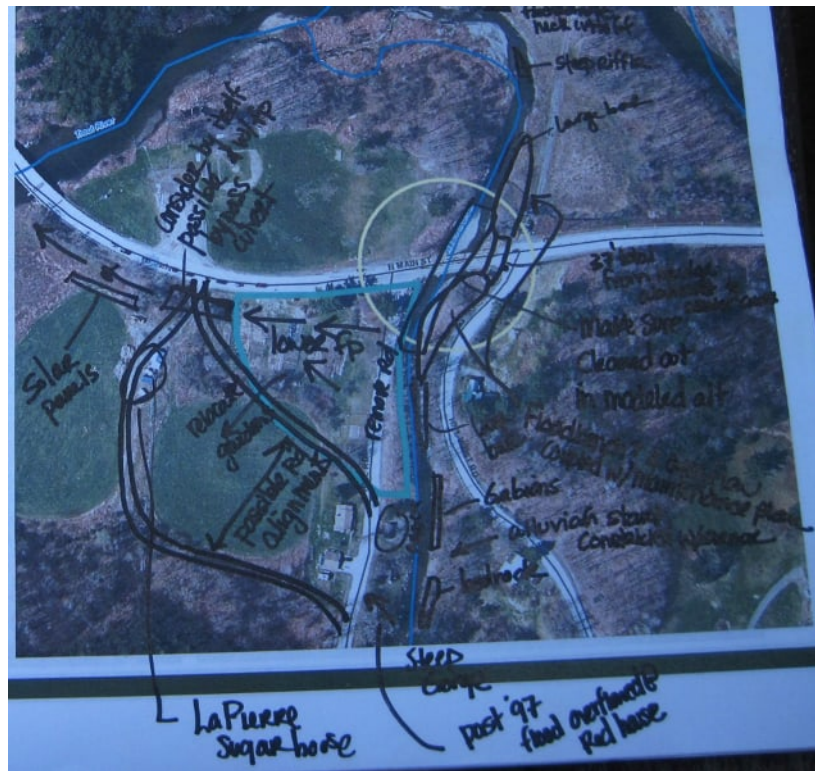




# Data Collection for Alternatives

## Scope Possible Mitigation Projects

- Visited sites
- Reviewed past data
- Identified constraints





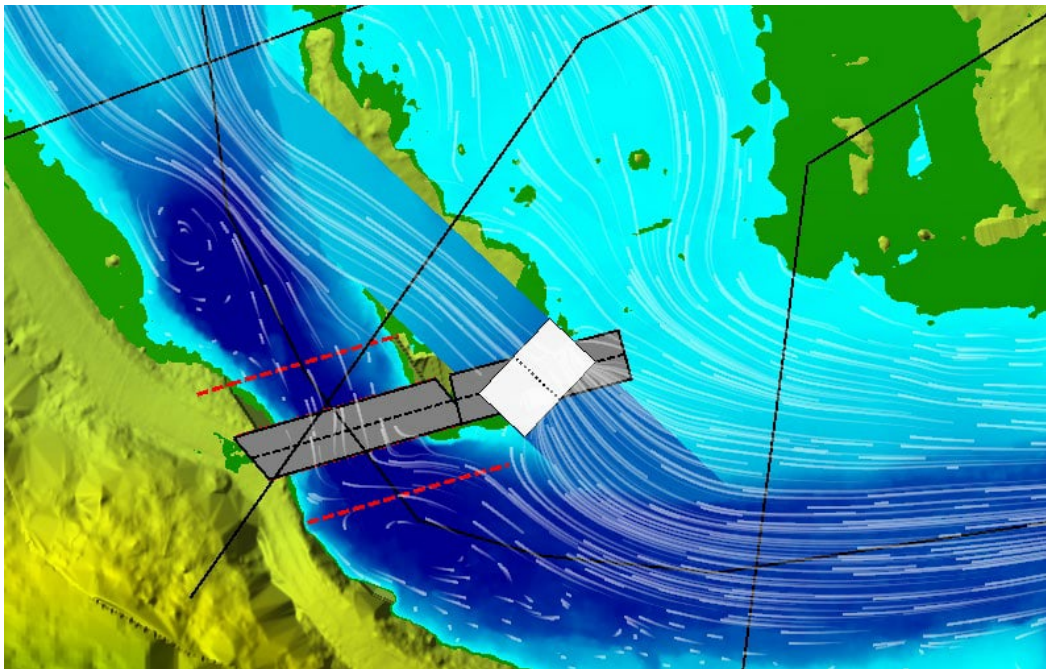
# Alternative Testing

## Refine Scope of Alternatives

- Determined locations, footprints, elevations, dimensions

## Test Identified Alternatives

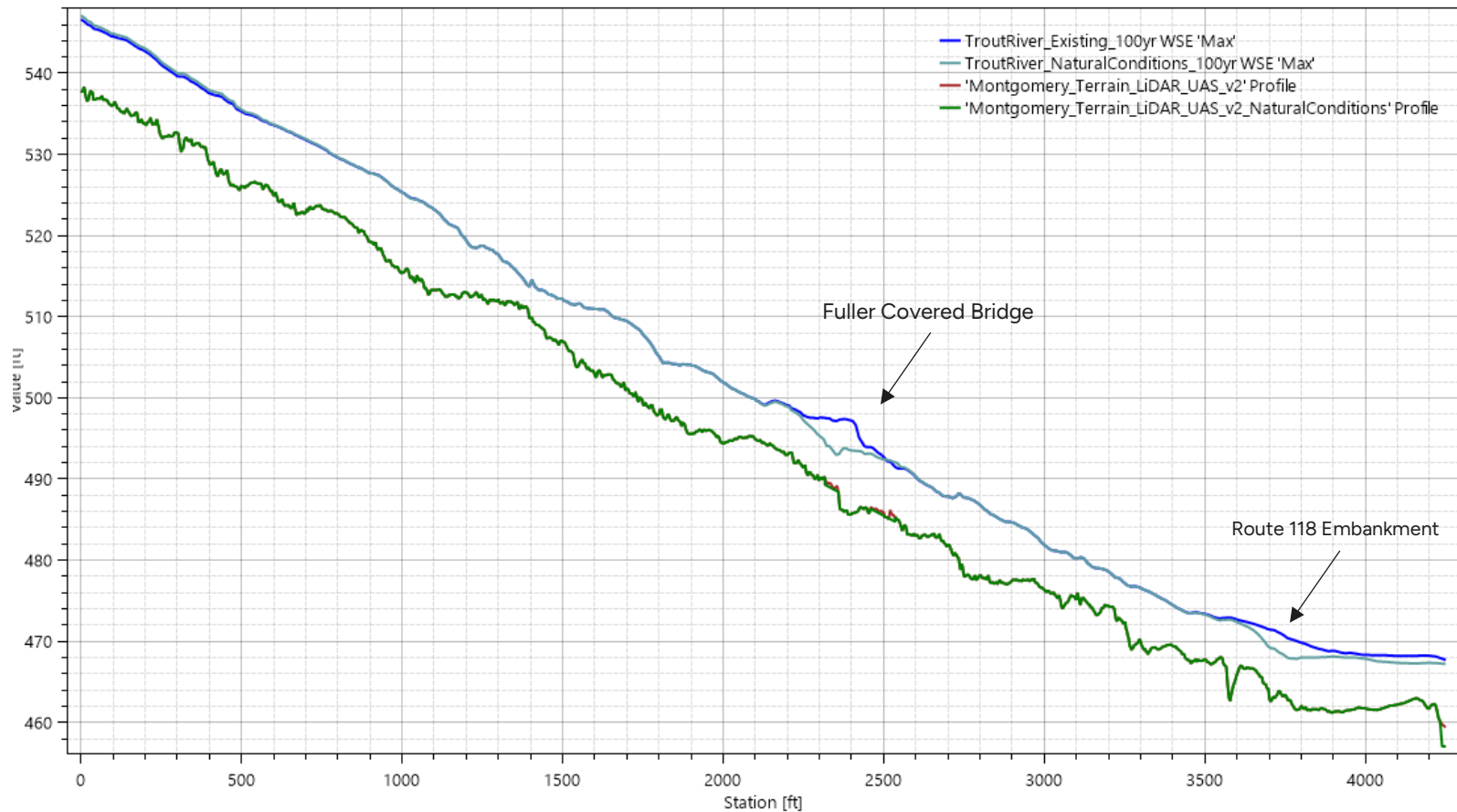
- Modeled possible projects in hydraulic model
- Reviewed initial results
- Modeled variations of same alternative
- Modeled combinations that affect each other





# Model Results – Medium Flood – Natural Conditions

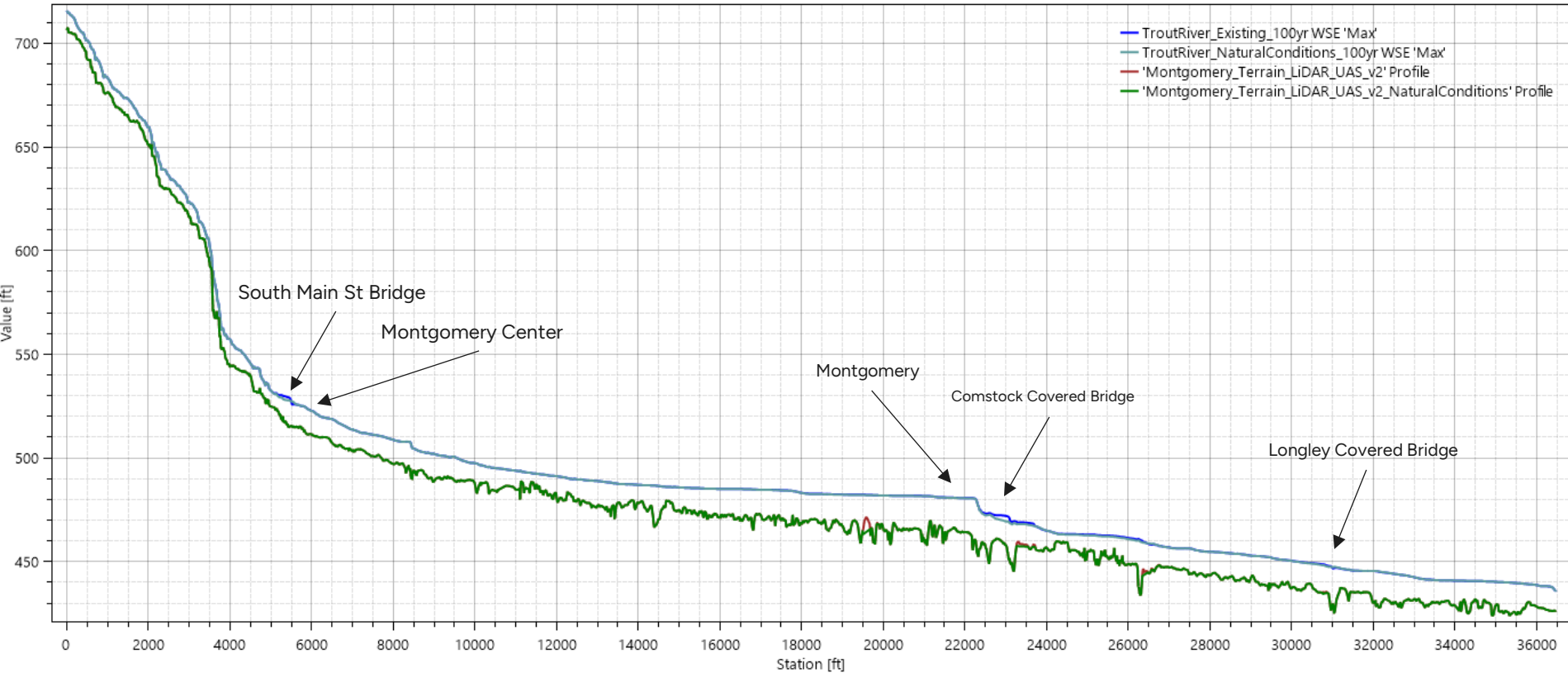
Water Surface Elevation on 'Profile Line: BlackFallsBrook'



# Model Results – Medium Flood – Natural Conditions



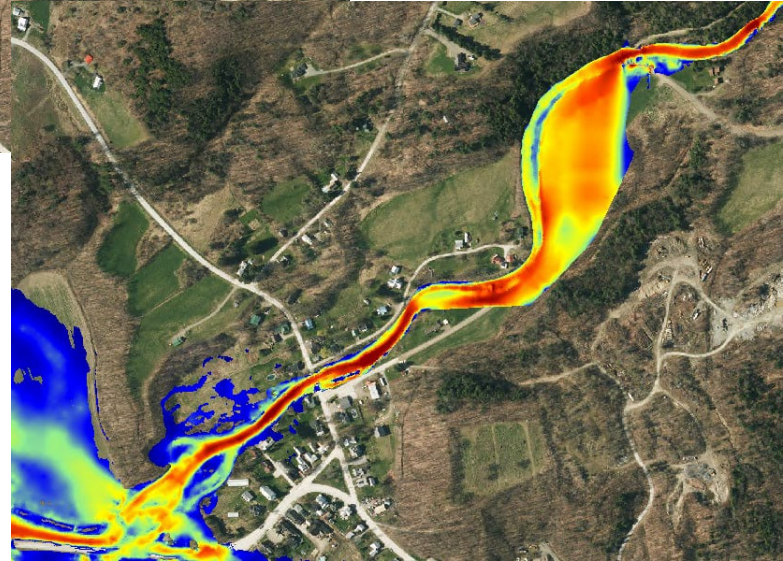
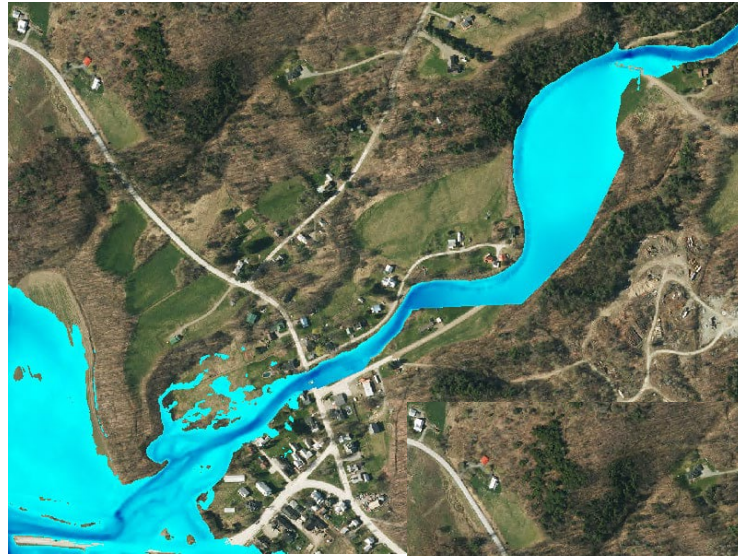
Water Surface Elevation on 'Profile Line: TroutRiverProfile'



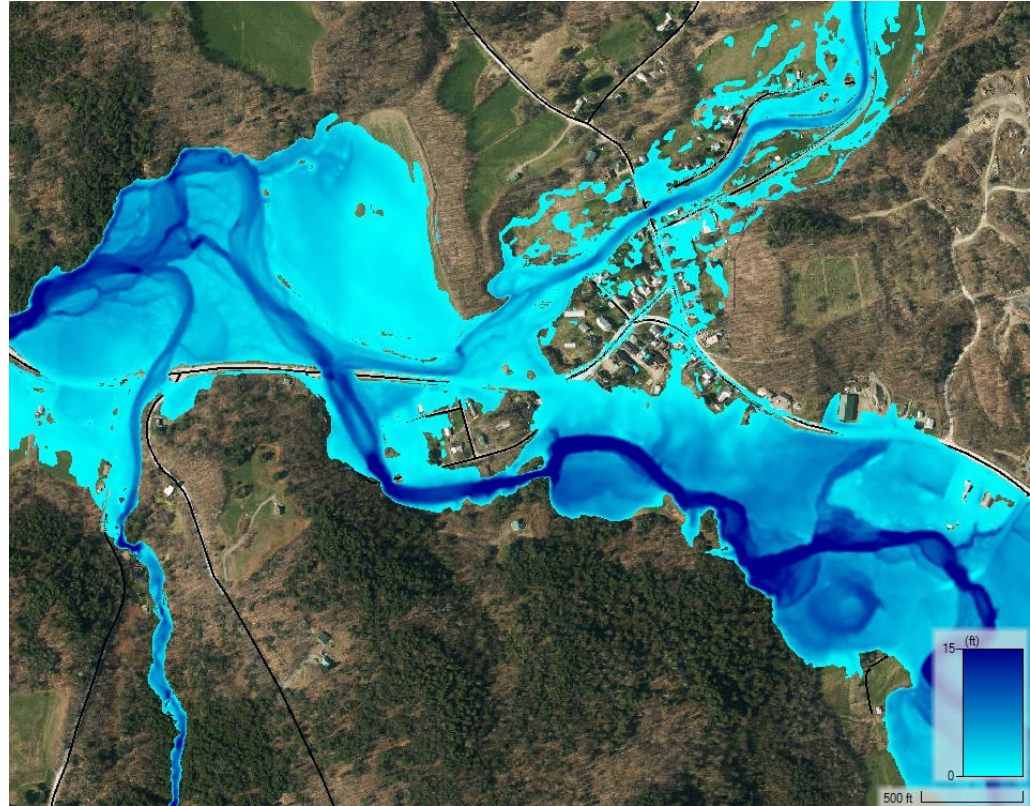
# Review of Results

## Model Output

- Floodplain extent
- Depth of water
- Velocity



# Model Results – Medium Flood



# Flood Mitigation Project Alternatives



ID	Location	Description
1	Black Falls Brook Confluence with Trout River	Floodplain / Wetland Restoration at 251 Fuller Bridge Road
2	Route 118 at West Hill Brook	Bridge Alternatives / Sediment Management
3	West Hill Road at West Hill Brook	Floodplain Reconnection or Overflow Channel at Gardens
4	Comstock Bridge at Trout River	Overflow Capacity
5	Vincent's Bridge Road at Trout River	Bridge Replacement or Reinforced Overflow
6	Longley Bridge Road at Trout River	Overflow Capacity / Reinforced Overflow
7	Fuller Bridge at Black Falls Brook	Overflow Capacity / Regain Channel Capacity
8	Black Falls Road at Black Falls Brook	Regain Floodplain Access
9	Black Falls Road at Black Falls Brook	Move Road and Restore Floodplain
10	Trout River near Rec Center	Regain Floodplain Access at constriction
11	Trout River below Center	Remove gravel deposits around boulder / valley constriction
12	Trout River in Center	Floodplain reconnection on Trout River
13	South Branch	Floodplain Reconnection at South Branch
14	Snowmobile Bridge at Trout River	Snowmobile Bridge Replacement
15	Trout River in Center	Consider Options for Increasing Conveyance
16	Trout River in Center	Flood Bypass Channel North of Main Street

The next slides will walk through each alternative and results



# Alternative 1 – Floodplain & Wetland Restoration

- Floodplain and Wetland Restoration at 251 Fuller Bridge Road
- Minimal change in flood extent
- Reduction of in-channel velocities from 10-13 ft/s to 4-9 ft/s along road embankment
- Small footprint recommended





# Alternative 2 – West Hill Brook Bridge

Scenarios – all include dredging of channel through bridge to establish more natural channel profile

- No change to bridge
- No change to bridge, overflow culvert installed with flood bench
- New larger bridge installed, inset floodplain created

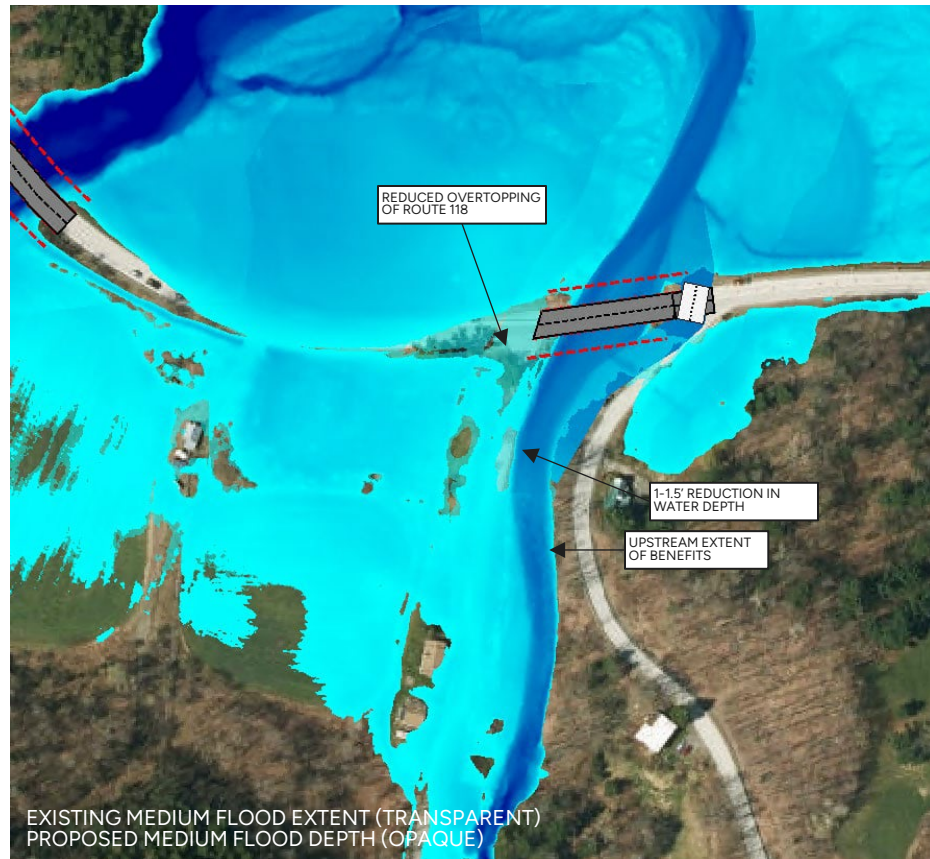




# Alternative 2 – West Hill Brook Bridge

## Overflow Culvert

- Installed 35-foot x 10-foot tall overflow culvert to east
- Overtopping of Route 118 reduced but not eliminated
- Benefits do not extend upstream to location of homes





# Alternative 2 – West Hill Brook Bridge

## New Bridge

- Replace bridge with 220-ft span
- Overtopping of Route 118 reduced but not eliminated
- Benefits do not extend upstream to location of homes
- Benefits not substantially better than overflow culvert





# Alternative 3 – West Hill Brook Overflow Channel

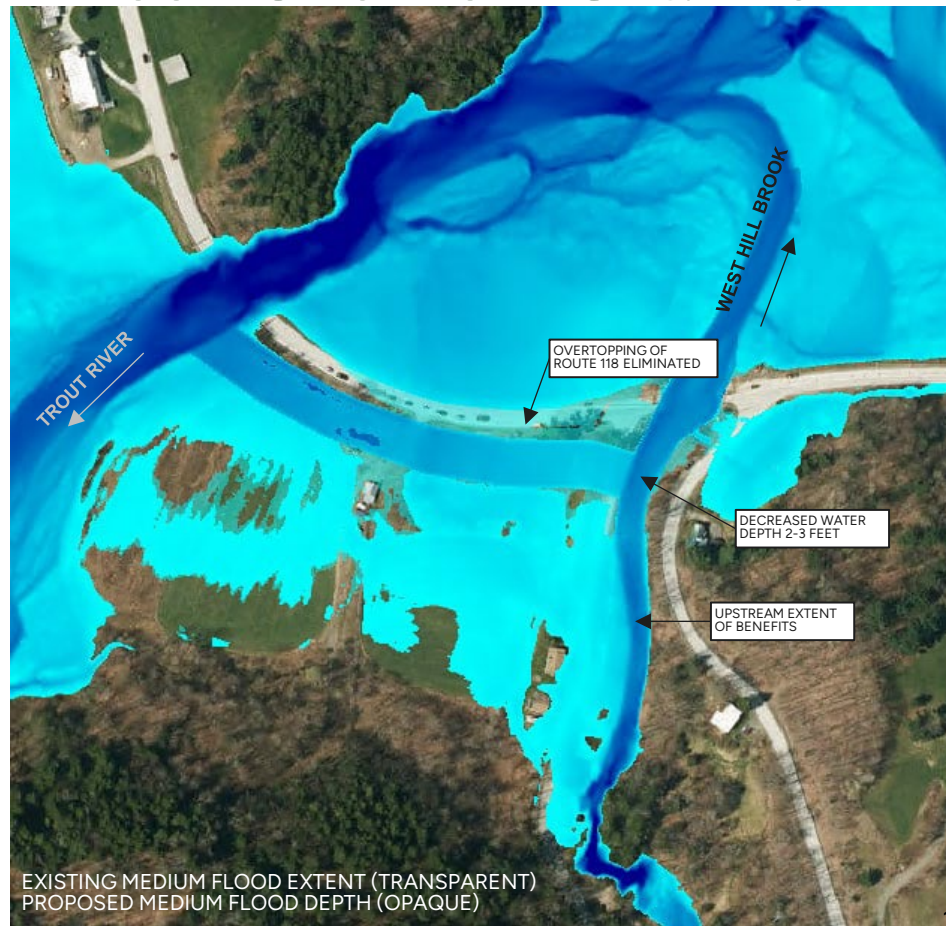
- Create overflow channel to keep floodwaters off Route 118
- Would include new structure on West Hill Road to cross overflow channel and driveway





# Alternative 3 – West Hill Brook Overflow Channel

- Reduced water depth for ~400 feet upstream of bridge
- Extent of floodwaters reduced around Route 118
- Effects do not extend farther upstream to location of homes





# Alternative 3 – West Hill Brook Floodplain Restoration

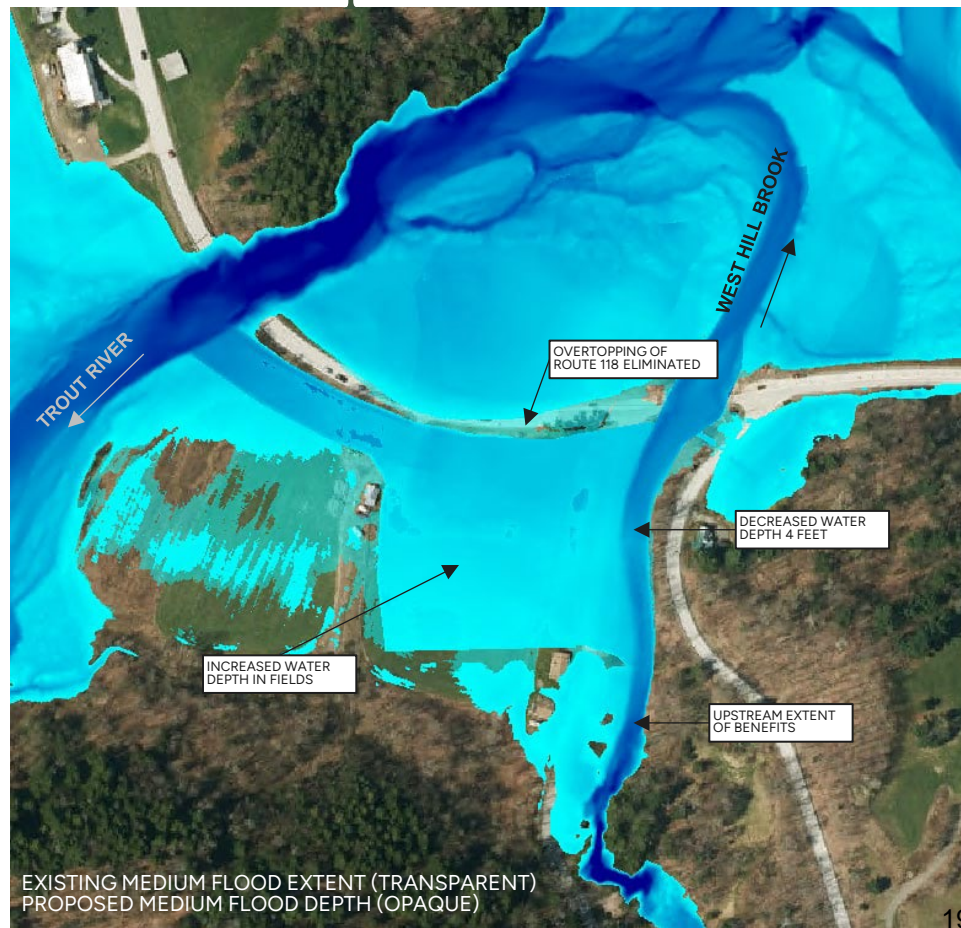
- Realign lower West Hill Road away from West Hill Brook
- Floodplain restoration – provide space for floodwater, sediment, and debris
- Would include new structure on West Hill Road to cross overflow channel





# Alternative 3 – West Hill Brook Floodplain Restoration

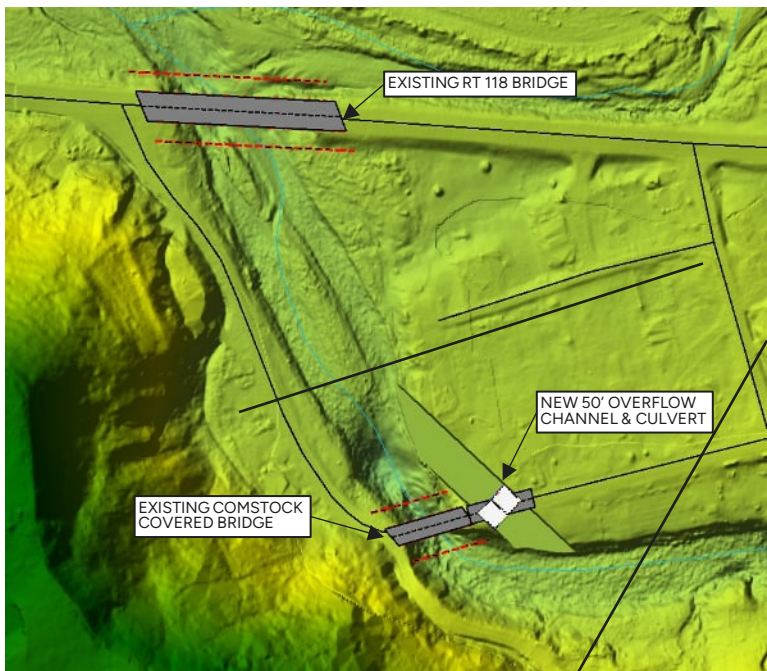
- Reduced water depth for ~550 feet upstream of bridge
- Extent of floodwaters reduced around Route 118
- Effects diminish near location of homes



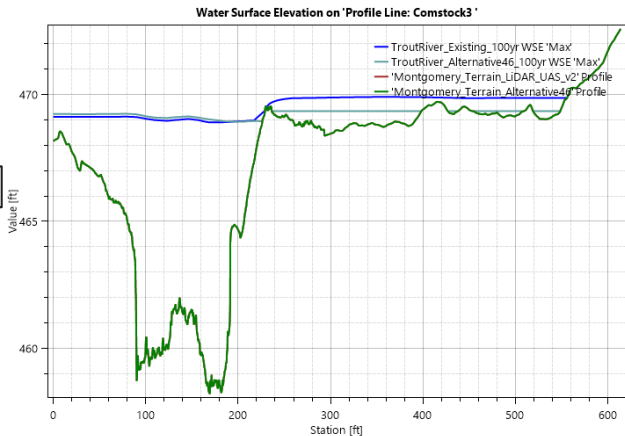
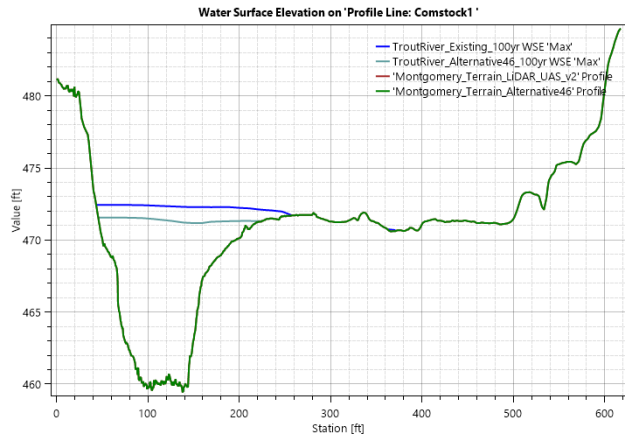


# Alternative 4 – Comstock Covered Bridge

- Model results show reduction in extent of water around homes and 0.5 to 1 foot reduction in water depths



FIX THIS LINE



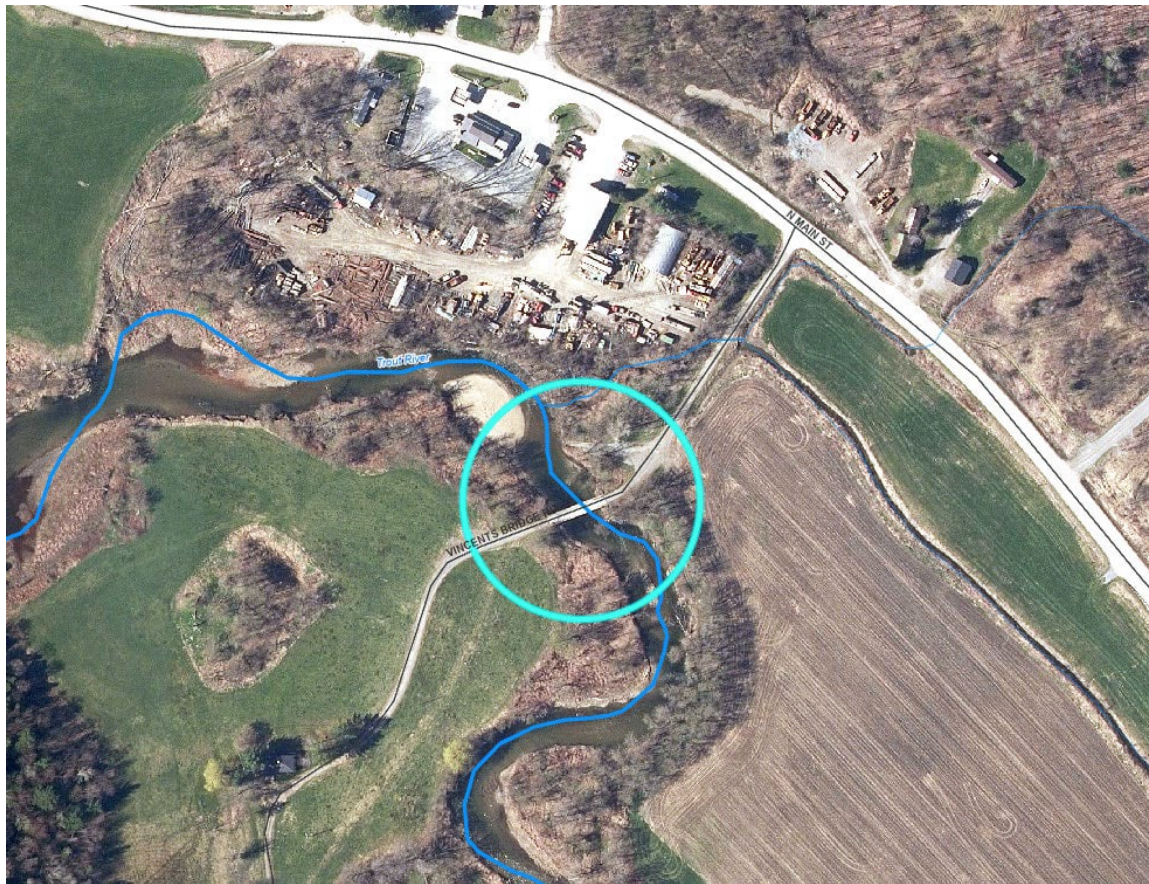
# Alternative 4 – Comstock Covered Bridge





# Alternative 5 – Vincent's Bridge

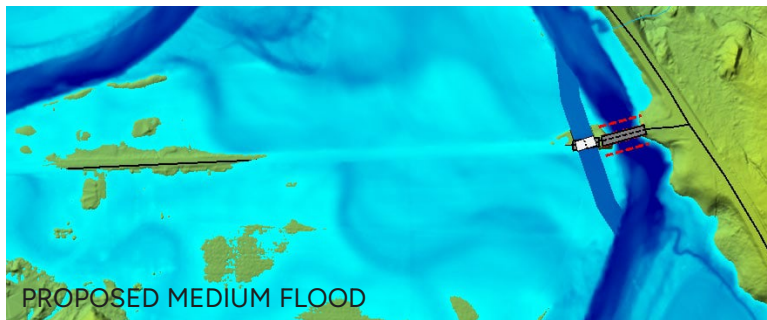
- Determined based on field reconnaissance and modeling not to be a major issue
- No recommended action





# Alternative 6 – Longley Covered Bridge

- Unable to contain floodwaters
- No substantial reduction in extent of road overtopping, but water depth reduced by 0.5 feet
- May still be beneficial for small floods





# Alternative 6 – Longley Covered Bridge

- Roadway paving and reinforcement recommended
- Reduce damages from overtopping

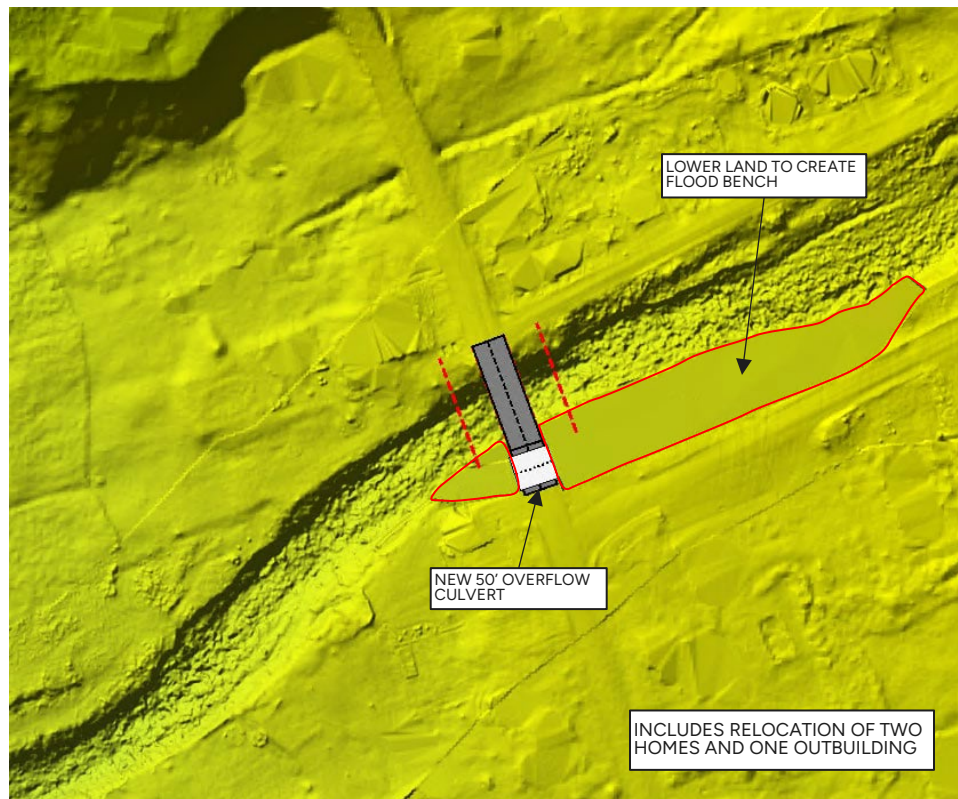


Halloween 2019 – from Town



# Alternative 7 – Fuller Covered Bridge

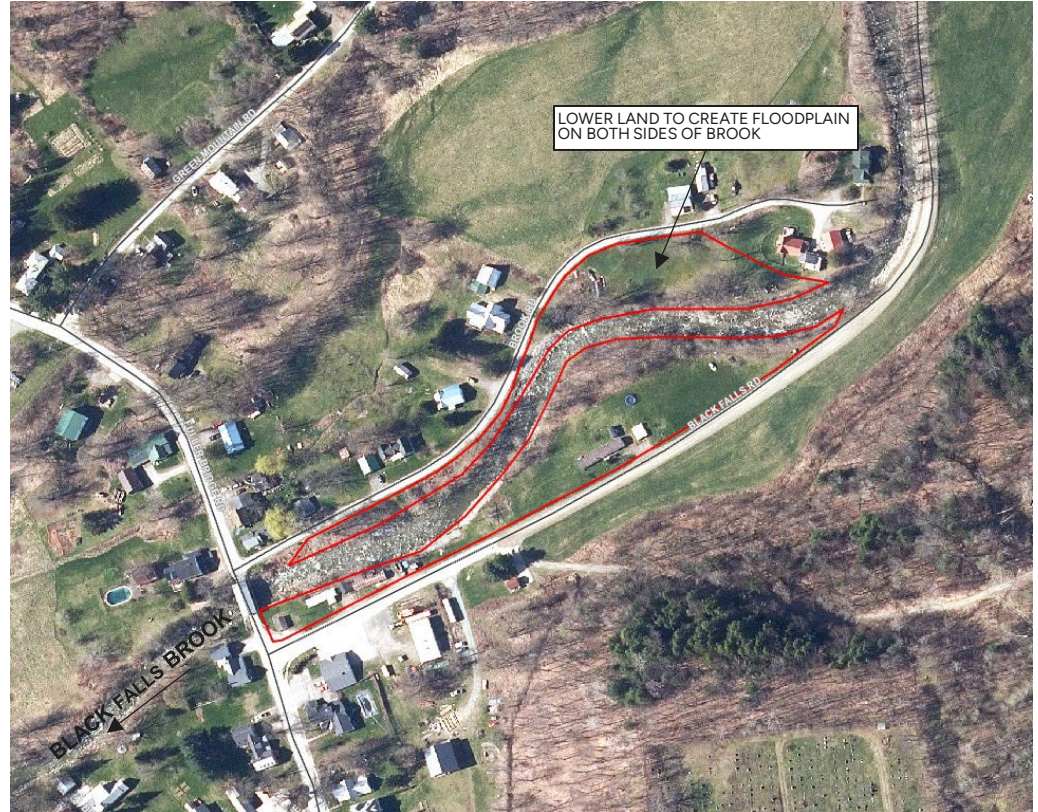
- Overflow culvert with flood bench creation
- Prevents water from flooding out of channel on south side of brook at bridge
- Not effective at reducing overall extent of floodwaters in Village when implemented without other alternatives



# Alternative 8 – Village Floodplain Restoration



- Limited benefit without replacement or modification of Fuller Covered Bridge



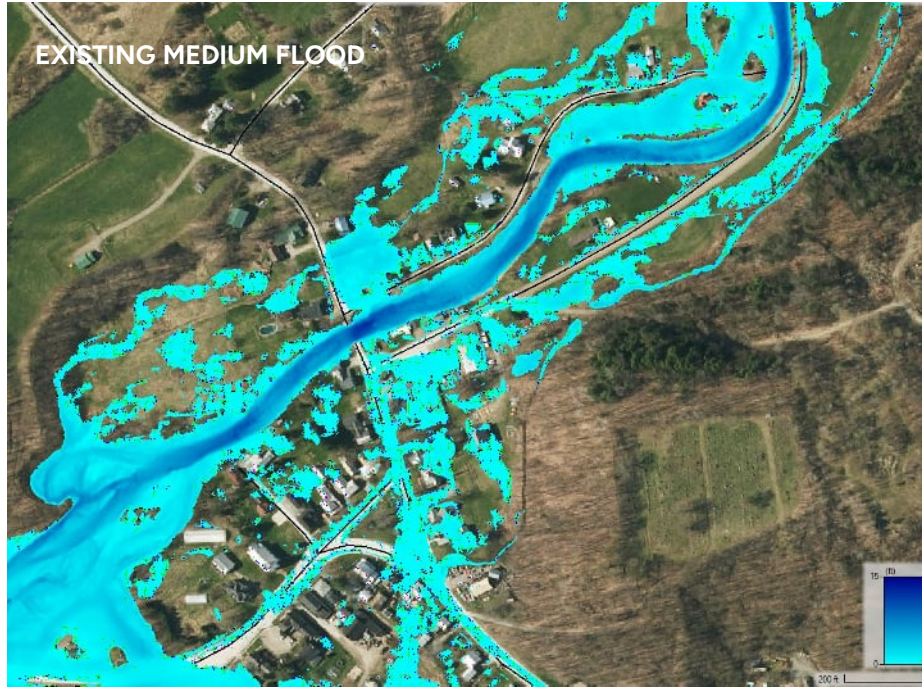
# Alternative 9 – Upper Black Falls Floodplain Restoration



- Prevents water from exiting channel and flowing along road into Village
- Substantial reduction in extent of floodwaters in Village



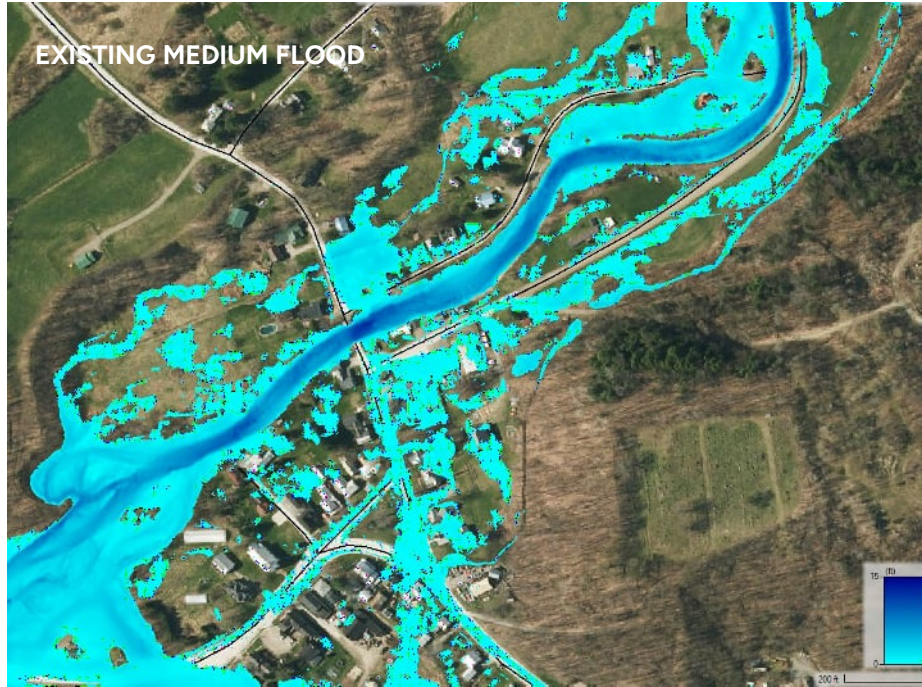
# Alternative 9 – Upper Black Falls Floodplain Restoration





# Alternatives 7 & 9

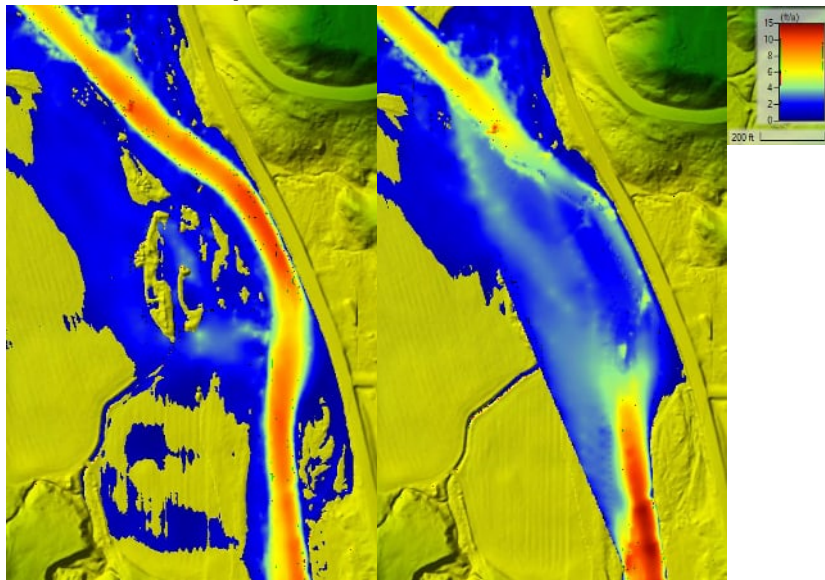
- Combination of upper floodplain creation and Fuller Covered Bridge overflow culvert





# Alternative 10

- Trout River at Route 118 embankment across from the Rec Center
- Floodplain lowering
- 8-11 ft/s existing, 3-5 ft/s proposed (small flood)





# Alternative 11

- Natural constriction below Village
- Remove deposition filling channel around bedrock





# Alternative 11

- No reduction in extent of flooding
- Effects carry 1,300 feet upstream but do not reach Center homes and businesses





# Alternative 12

- Slight reduction in extent of flooding with 0.5-2 feet reduction in flood depths around some homes



# Alternative 13 – South Branch Floodplain Restoration

- Upper cluster of floodplains modeled separately from lowest
- No reduction in flood depths or extent of floodwaters observed in Center from upper floodplains



# Alternative 13 – South Branch Floodplain Restoration



- Localized reduction in flood depth and extent with lowest floodplain





# Alternative 14

- Determined based on field reconnaissance and modeling not to be a major issue
- No recommended action





# Alternative 15 – Increase Conveyance in Center

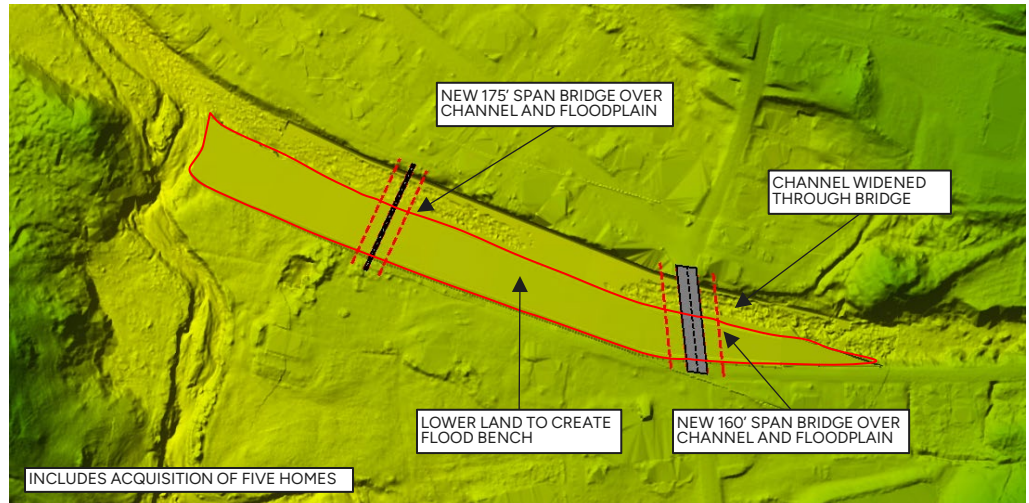
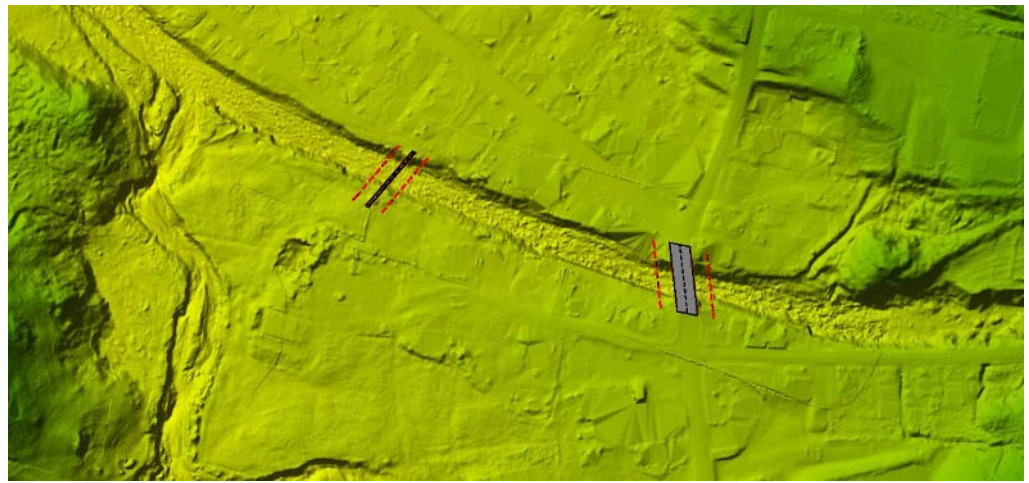
- River confined by walls and buildings
- Change in slope from steep upstream channel



1997 Flash Flood –  
from Town

# Alternative 15

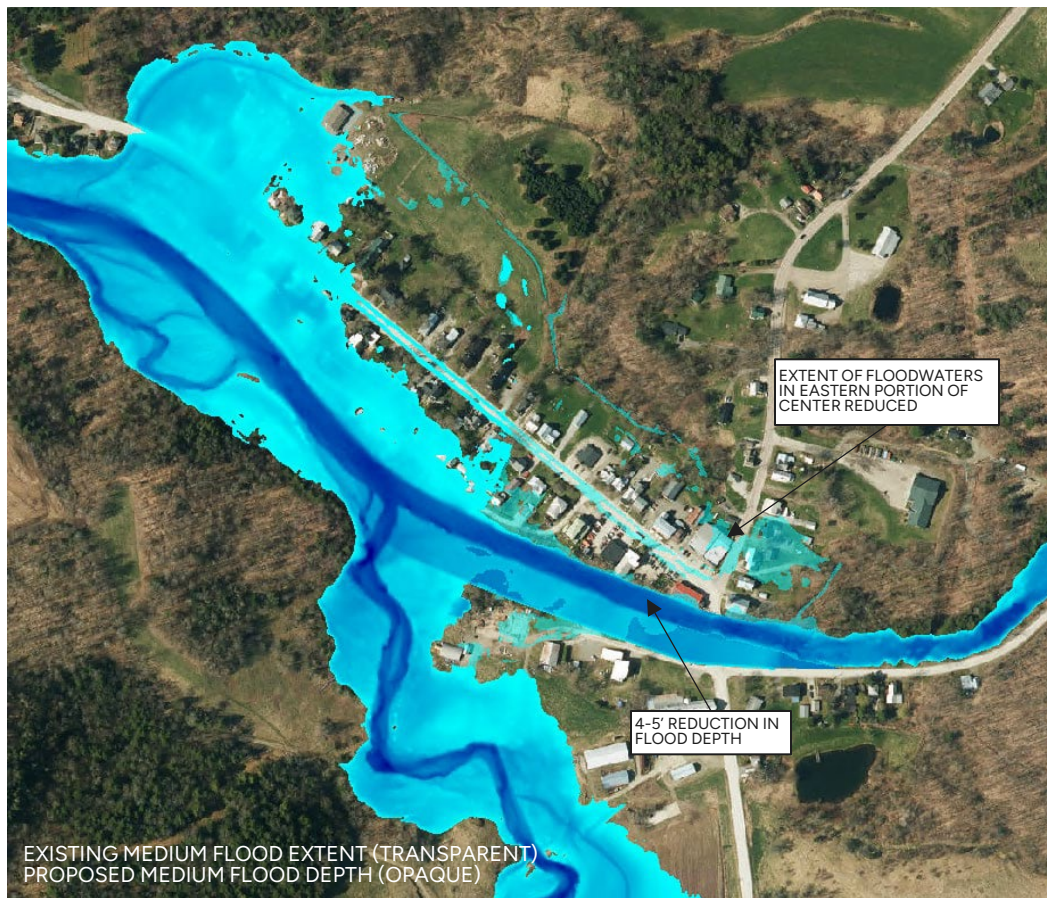
- South Main Street Bridge upsized from 60' to 160'
- Snowmobile bridge upsized from 100' to 175'
- Flood bench created along south side of Trout River





# Alternative 15

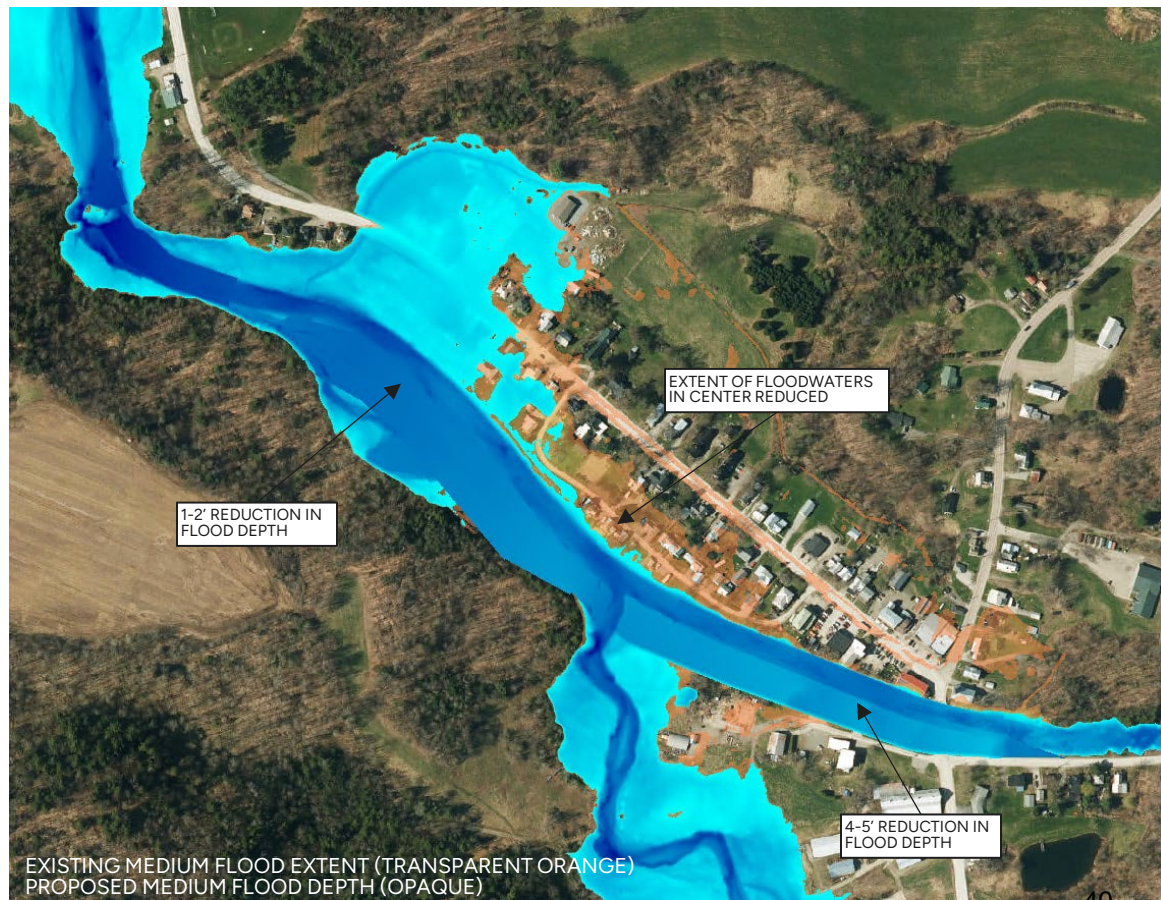
- Reduction in flood depths 4-5 feet for 1000' from upstream of South Main Street to just above South Branch



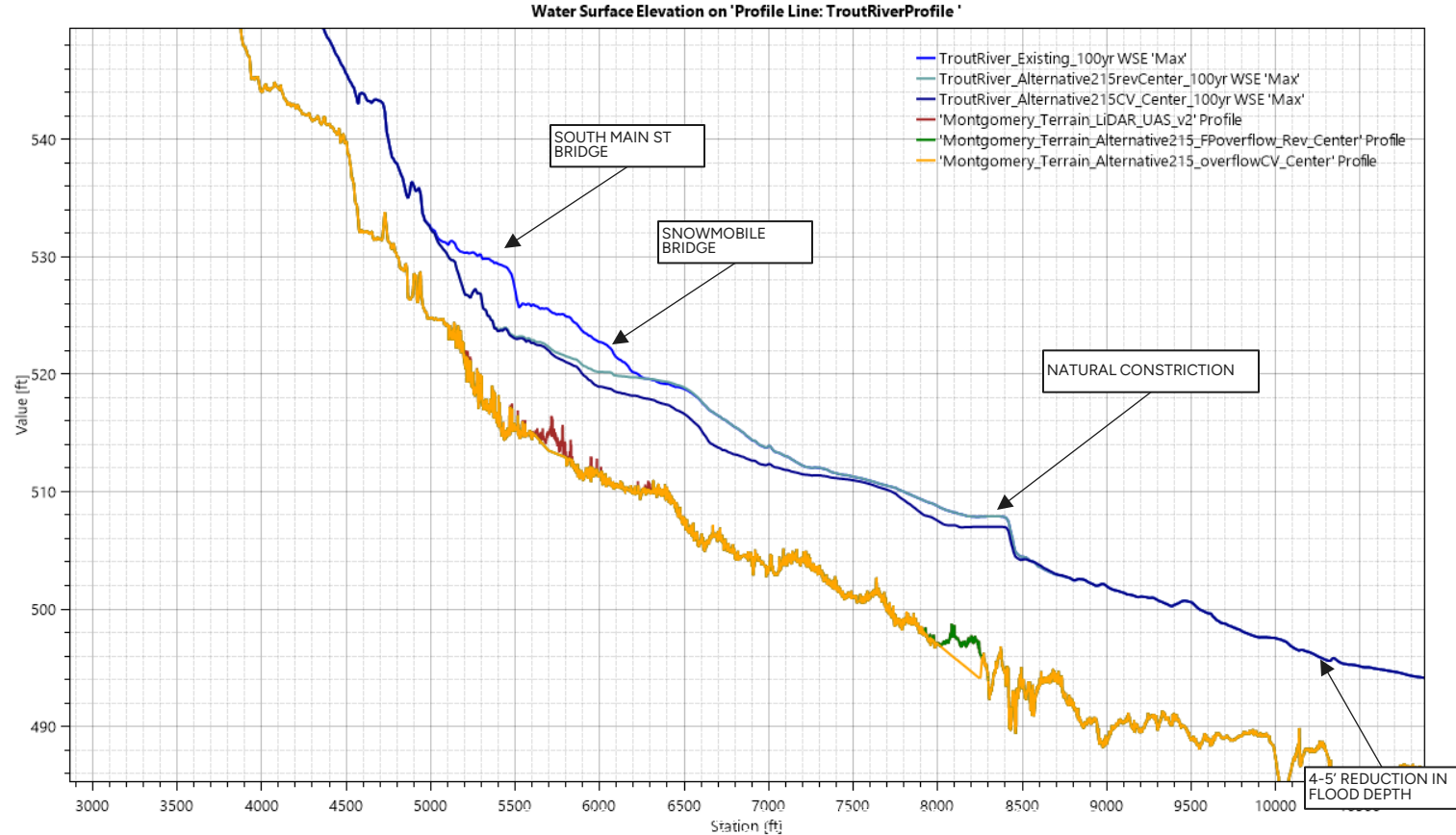


# Alternatives 11, 12, & 15

- Increase capacity through Center with floodplain reconnection, bridge replacement, and sediment management at natural constriction
- Reduction in flood depths through entire Center
- 4-5 feet for 1000' from upstream of South Main Street to just above South Branch



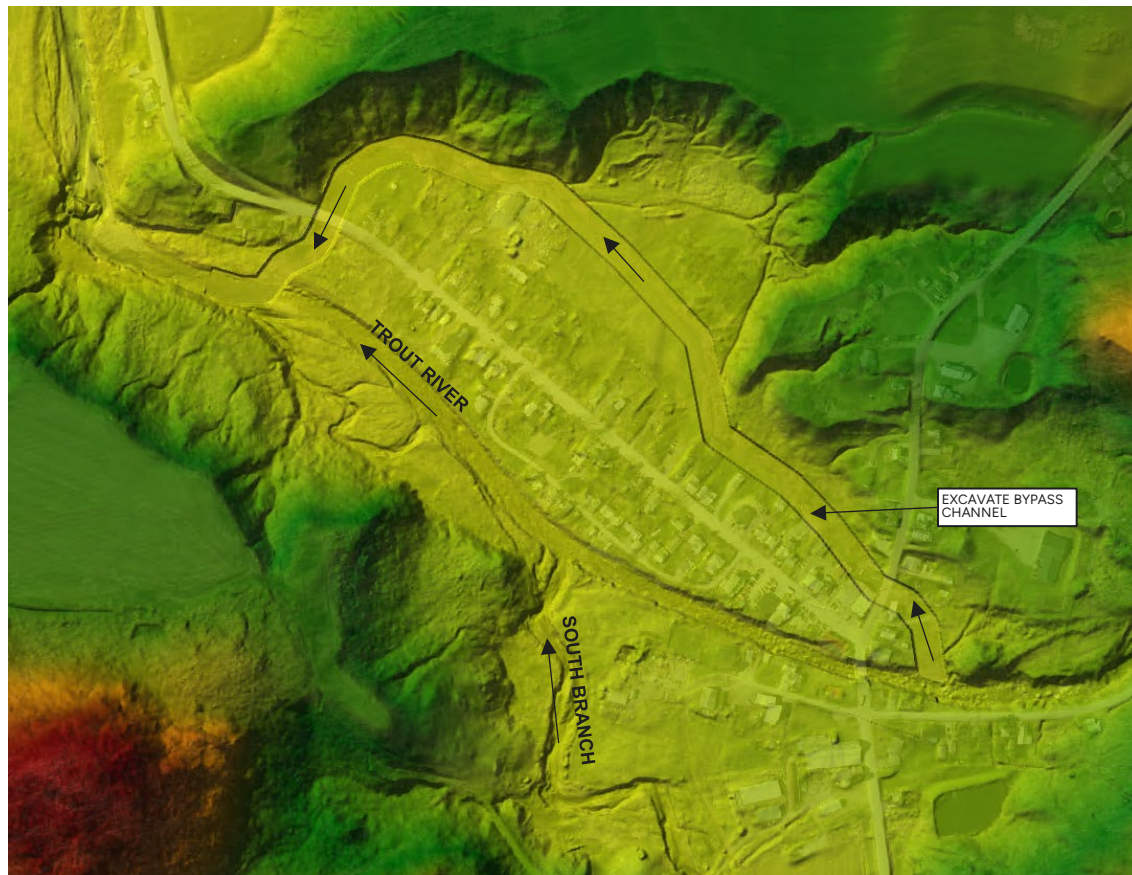
# Alternatives 11, 12, & 15





# Alternative 16 – Center Flood Bypass Channel

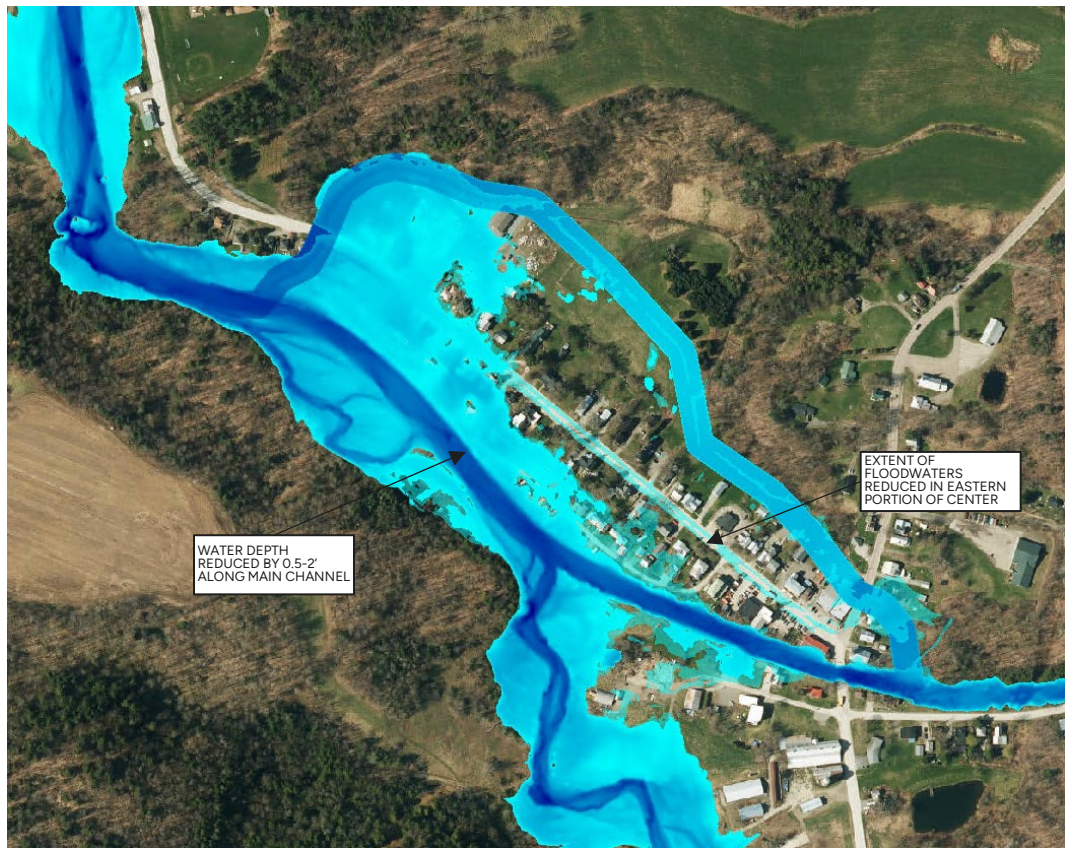
- Create bypass channel for floodwaters around Center
- Would include two bridges over channel and acquisition of 1-2 homes





# Alternative 16 – Center Flood Bypass Channel

- Depth of water along Trout River main channel reduced by 0.5-2' through entire extent of Center
- Extent of floodwaters reduced



# Other Types of Flood Mitigation Projects



ID	Location	Description
Future Work	All river adjacent areas	Buffer with woody vegetation & Protect River Corridor
Future Work	All upstream areas	Reduce sediment from road runoff
Future Work	Upstream areas	Increase flood storage with floodplain connection, wetland restoration.
Future Work	Upstream areas	Stormwater Mitigation
Individual Action	Individual Properties - Not Specified	Floodproofing of buildings / filling basements / raising utilities / elevating buildings
Individual Action	Individual Properties - Not Specified	Buyouts of properties

# Flood Mitigation Project Selection



ID	Location	Description
1	Black Falls Brook Confluence with Trout River	Floodplain / Wetland Restoration at 251 Fuller Bridge Road
2	Route 118 at West Hill Brook	Bridge Alternatives / Sediment Management
3	West Hill Road at West Hill Brook	Floodplain Reconnection or Overflow Channel at Gardens
4	Comstock Bridge at Trout River	Overflow Capacity
5	Vincent's Bridge Road at Trout River	Bridge Replacement or Reinforced Overflow
6	Longley Bridge Road at Trout River	Overflow Capacity / Reinforced Overflow
7	Fuller Bridge at Black Falls Brook	Overflow Capacity / Regain Channel Capacity
8	Black Falls Road at Black Falls Brook	Regain Floodplain Access
9	Black Falls Road at Black Falls Brook	Move Road and Restore Floodplain
10	Trout River near Rec Center	Regain Floodplain Access at constriction
11	Trout River below Center	Remove gravel deposits around boulder / valley constriction
12	Trout River in Center	Floodplain reconnection on Trout River
13	South Branch	Floodplain Reconnection at South Branch
14	Snowmobile Bridge at Trout River	Snowmobile Bridge Replacement
15	Trout River in Center	Bridge Replacement and Restore Floodplain
16	Trout River in Center	Flood Bypass Channel North of Main Street

We need your input.



# Flood Mitigation Project Selection

ID	Location	Description
1	Black Falls Brook Confluence with Trout River	Floodplain / Wetland Restoration at 251 Fuller Bridge Road
2	Route 118 at West Hill Brook	Bridge Alternatives / Sediment Management
3	West Hill Road at West Hill Brook	Floodplain Reconnection or Overflow Channel at Gardens
4	Comstock Bridge at Trout River	Overflow Capacity - Overflow Culvert
5	Vincent's Bridge Road at Trout River	Bridge Replacement or Reinforced Overflow
6	Longley Bridge Road at Trout River	Overflow Capacity / Reinforced Overflow
7	Fuller Bridge at Black Falls Brook	Overflow Capacity / Regain Channel Capacity
8	Black Falls Road at Black Falls Brook	Regain Floodplain Access
9	Black Falls Road at Black Falls Brook	Move Road and Restore Floodplain
10	Trout River near Rec Center	Regain Floodplain Access at constriction
11	Trout River below Center	Remove gravel deposits around boulder / valley constriction
12	Trout River in Center	Floodplain reconnection on Trout River
13	South Branch	Floodplain Reconnection at South Branch
14	Snowmobile Bridge at Trout River	Snowmobile Bridge Replacement
15	Trout River in Center	Bridge Replacement and Restore Floodplain
16	Trout River in Center	Flood Bypass Channel North of Main Street

We need your input.



Do you  
have any  
questions?



# **Appendix G    Public Presentation – Concept Design**

## **Montgomery Flood Hazard Mitigation Study**

**Franklin County Natural Resources Conservation District**

SLR Project No.: 146.13528.00001

December 27, 2024



# Montgomery, Vermont Flood Hazard Modeling & Project Identification

Jessica Louisos, PE, MS – Water Resource Engineer

Alex Marcucci, CFM – Water Resource Scientist

Lauren Weston – District Manager, Franklin County NRCDC

December 12, 2024



# Flood Hazard Modeling & Project Identification

## Understand Flood Issues and Patterns

- Aerial survey
- Bridge surveys
- Hydraulic models

## Identify Possible Mitigation Projects

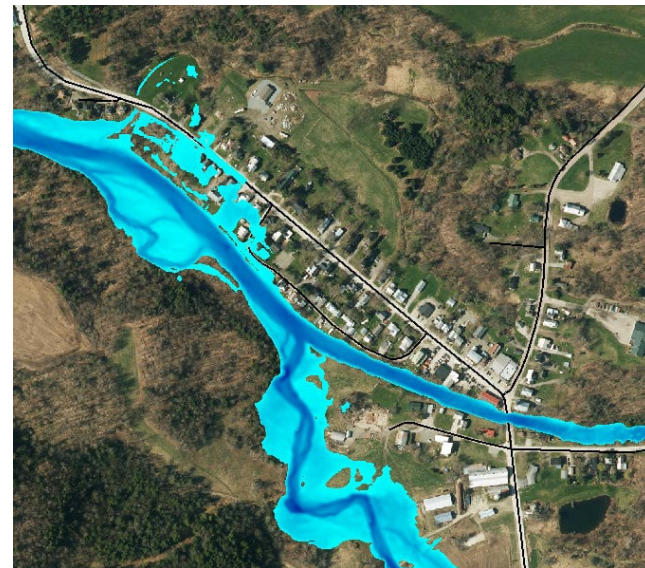
- Visit sites
- Collect ideas from residents

## Test Identified Alternatives

- Model possible projects in hydraulic model
- Consider constraints and project goals

## Concept Design

- Develop the top 5 projects to start the design process



DISCUSS  
TODAY

# Flood Mitigation Project – Selected Alternatives



ID	Location	Description
1	Black Falls Brook Confluence with Trout River	Floodplain / Wetland Restoration at 251 Fuller Bridge Road
2	Route 118 at West Hill Brook	Sediment Management
7	Fuller Bridge at Black Falls Brook	Overflow Capacity / Regain Channel Capacity
9	Black Falls Road at Black Falls Brook	Move Road and Restore Floodplain
11	Trout River below Center	Remove gravel deposits around boulder / valley constriction
12	Trout River in Center	Floodplain reconnection on Trout River
15	Trout River in Center	Bridge Replacement and Restore Floodplain

The next slides will walk through each alternative and results



# Alternative 1 – Floodplain & Wetland Restoration

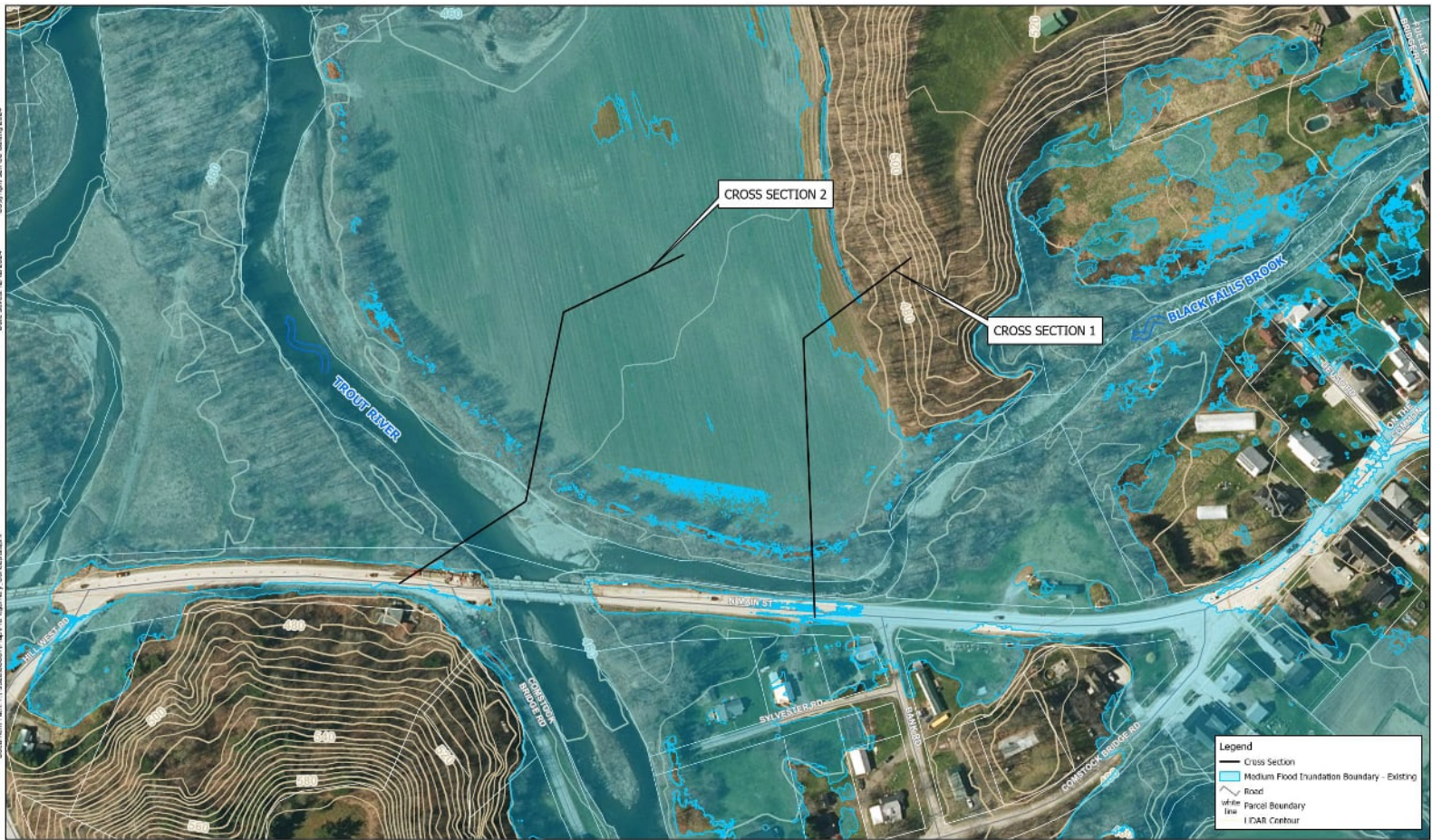
- Floodplain and Wetland Restoration at 251 Fuller Bridge Road
- Small footprint moved to concept design



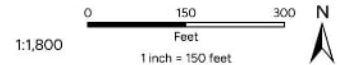


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**ALTERNATIVE 1 - EXISTING CONDITIONS**  
 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



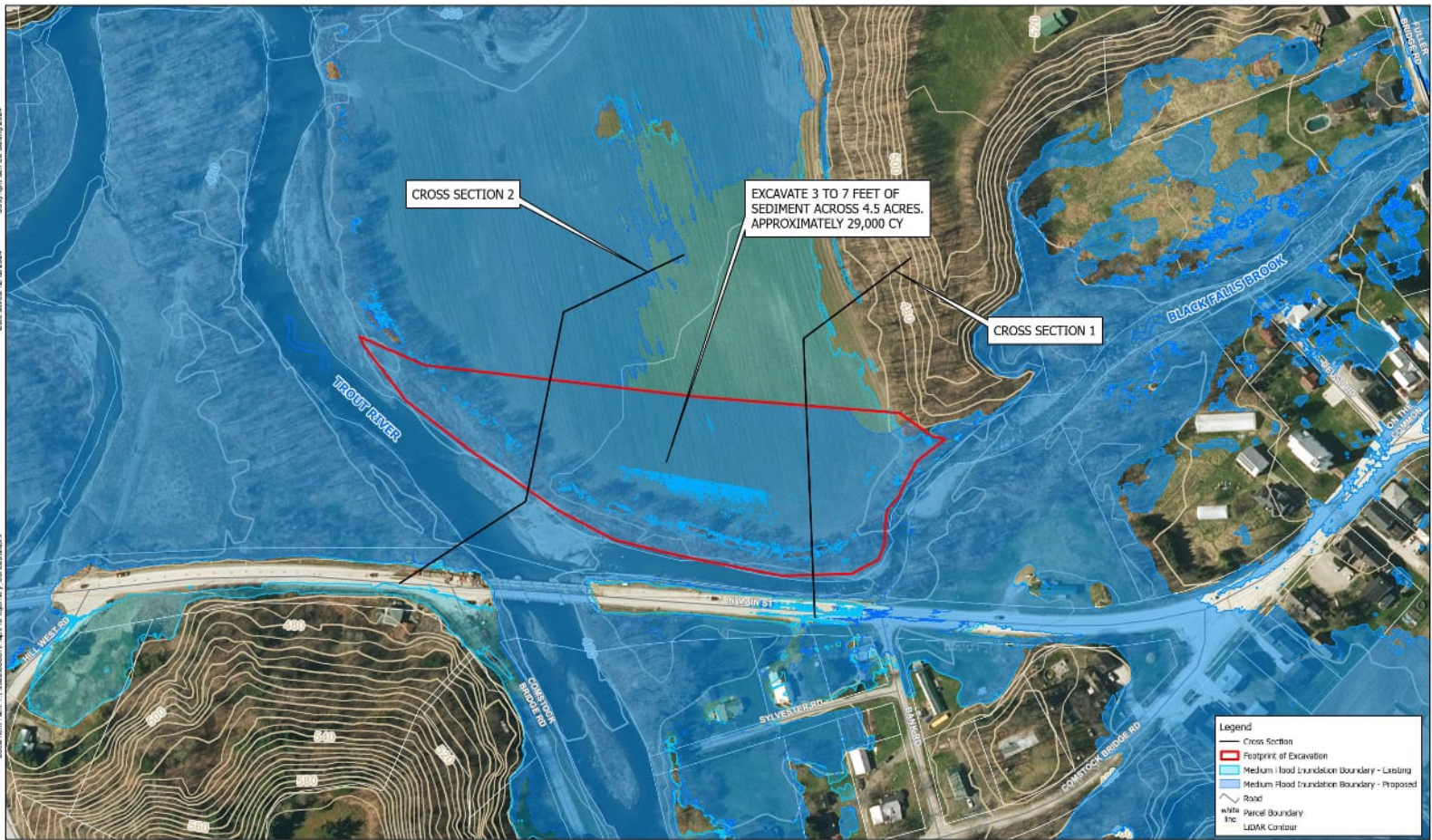
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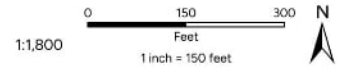
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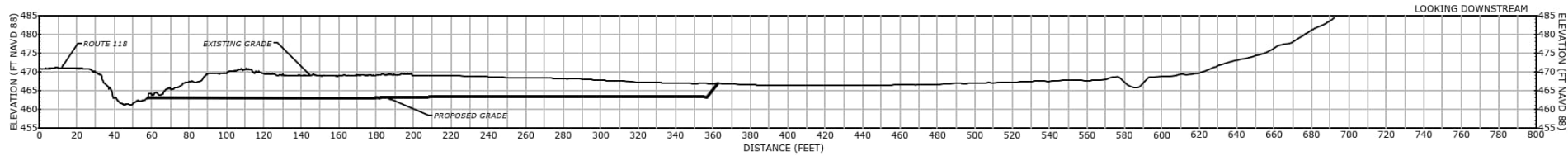


**ALTERNATIVE 1 - PROPOSED CONDITIONS**  
 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT

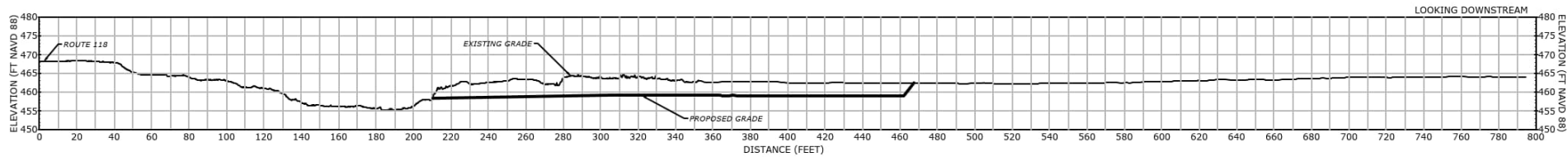


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# Alternative 1 – Floodplain & Wetland Restoration



ALTERNATIVE 1 CROSS SECTION 1  
SCALE: H: 1"=60', V: 1"=30'

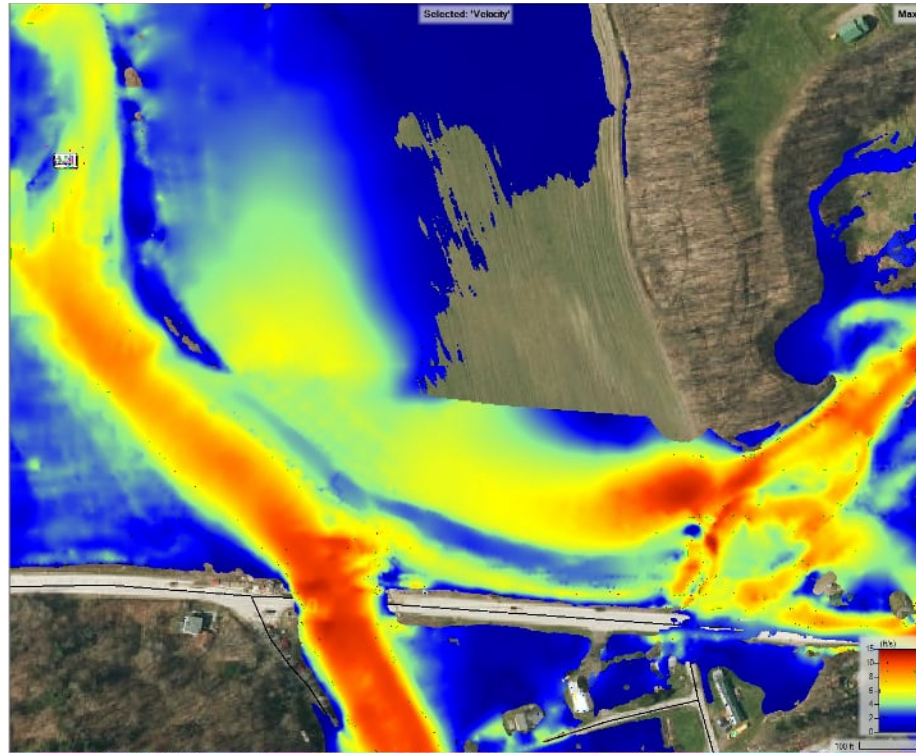
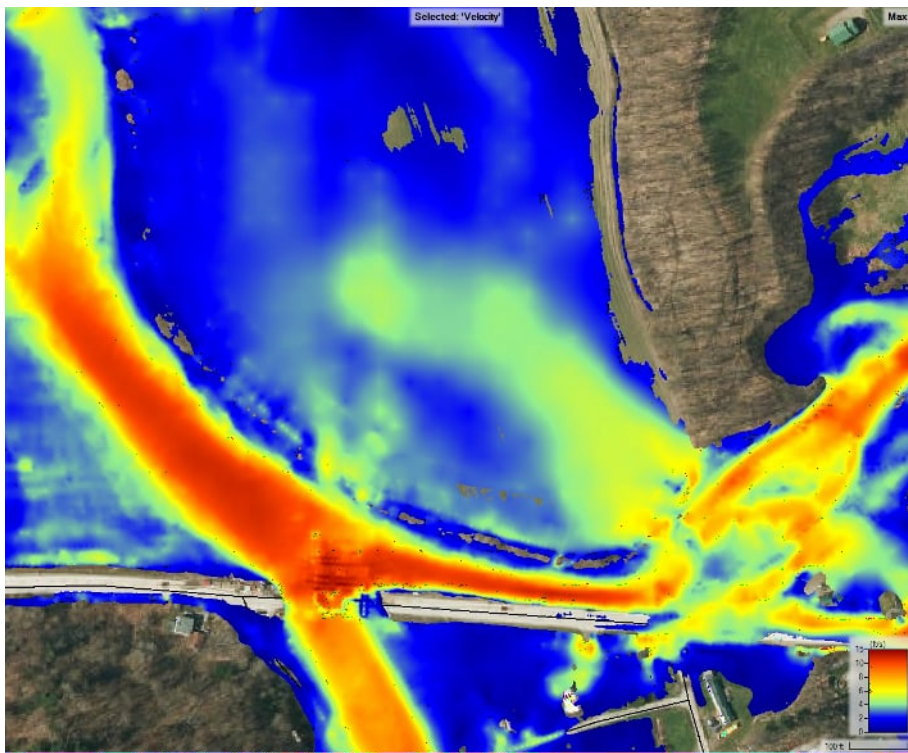


ALTERNATIVE 1 CROSS SECTION 2  
SCALE: H: 1"=60', V: 1"=30'



# Alternative 1 – Floodplain & Wetland Restoration

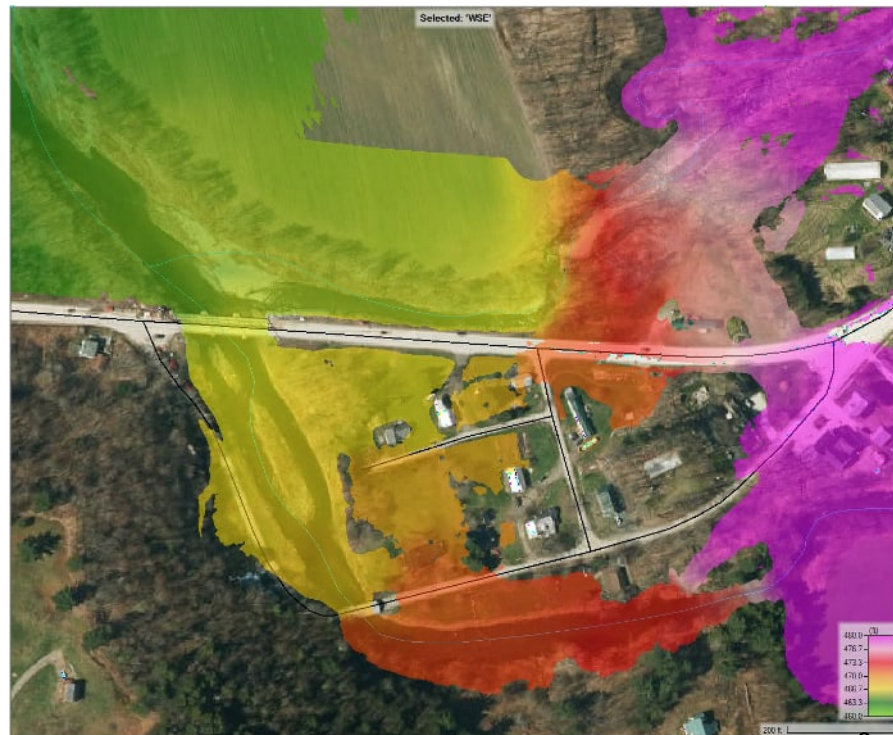
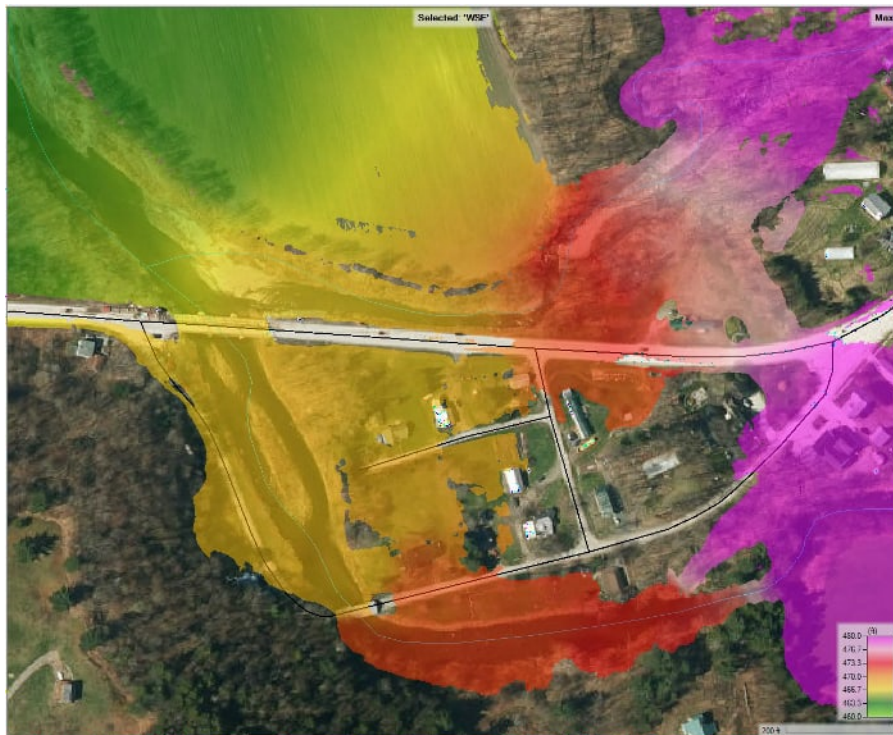
- Reduction of in-channel velocities from 10-13 ft/s to 4-6 ft/s along highway





# Alternative 1 – Floodplain & Wetland Restoration

- Reduction of depths: 1.4' DS Rt 118, 2' at Rt 118 bridge opening, 1.5' Sylvester Rd.





# Alt 1 - Floodplain Restoration Benefits

- Ecosystem benefits of floodplain restoration
- 4.5 acres of floodplain valued by FEMA
- Assumes 25% Open Space and 75% Riparian Restoration
- Reduces velocity on highway

BCR = 2.42 = eligible for FEMA grant review process

- Cost based on low level design
- Cost \$1,100,000
- Fill site important for cost
- Includes design and permitting

FEMA BCA Calculator - [https://bcaofficeaddin-prod.azurewebsites.net/projects?cpmlID=d0d73fa3-b326-4c2c-a05c-d3bf9aecf311&\\_host\\_info=ExcelSWin32516.01Sen-US\\$telemetry\\$isDialog\\$50](https://bcaofficeaddin-prod.azurewebsites.net/projects?cpmlID=d0d73fa3-b326-4c2c-a05c-d3bf9aecf311&_host_info=ExcelSWin32516.01Sen-US$telemetry$isDialog$50)

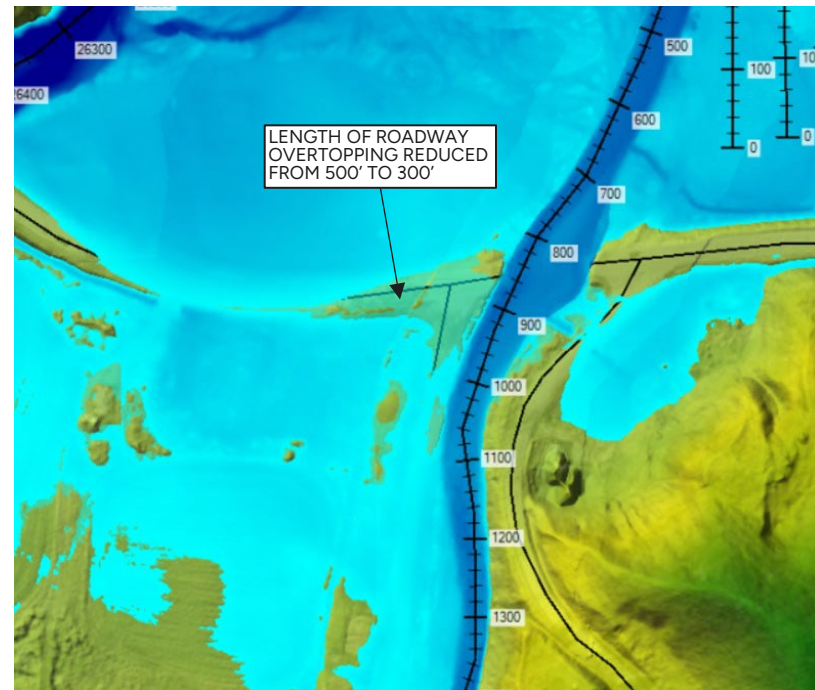
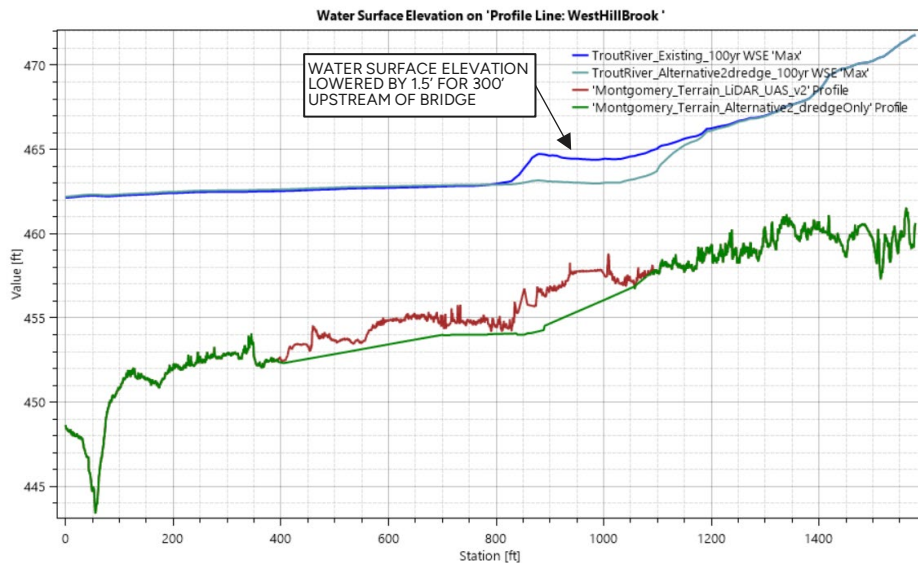
The screenshot shows the FEMA Benefit-Cost Calculator interface. It includes the FEMA logo and the text 'Benefit-Cost Calculator V.6.0 (Build 20241018.1218 | Release Notes)'. Below this is a navigation bar with options: '+ Add Project', '← Import Projects', '→ Export Projects', 'Batch Processing', and 'Delete Projects'. The main table has columns for 'Select', 'Project Title', 'County, State', 'Benefits (B)', 'Costs (C)', and 'BCR (B/C)'. A single project is listed: 'Floodplain at Town parcel' in Franklin, VT, with Benefits of \$2,660,702 and Costs of \$1,100,000, resulting in a BCR of 2.42. A summary table at the bottom shows 'TOTAL (SELECTED)' with Benefits of \$2,660,702, Costs of \$1,100,000, and a BCR of 2.42.

Select	Project Title	County, State	Benefits (B)	Costs (C)	BCR (B/C)
<input checked="" type="checkbox"/>	Floodplain at Town parcel	Franklin, VT	\$ 2,660,702	\$ 1,100,000	2.42
TOTAL (SELECTED)			\$ 2,660,702	\$ 1,100,000	2.42
TOTAL			\$ 2,660,702	\$ 1,100,000	2.42

# Alternative 2 – Sediment Management at West Hill Brook Bridge



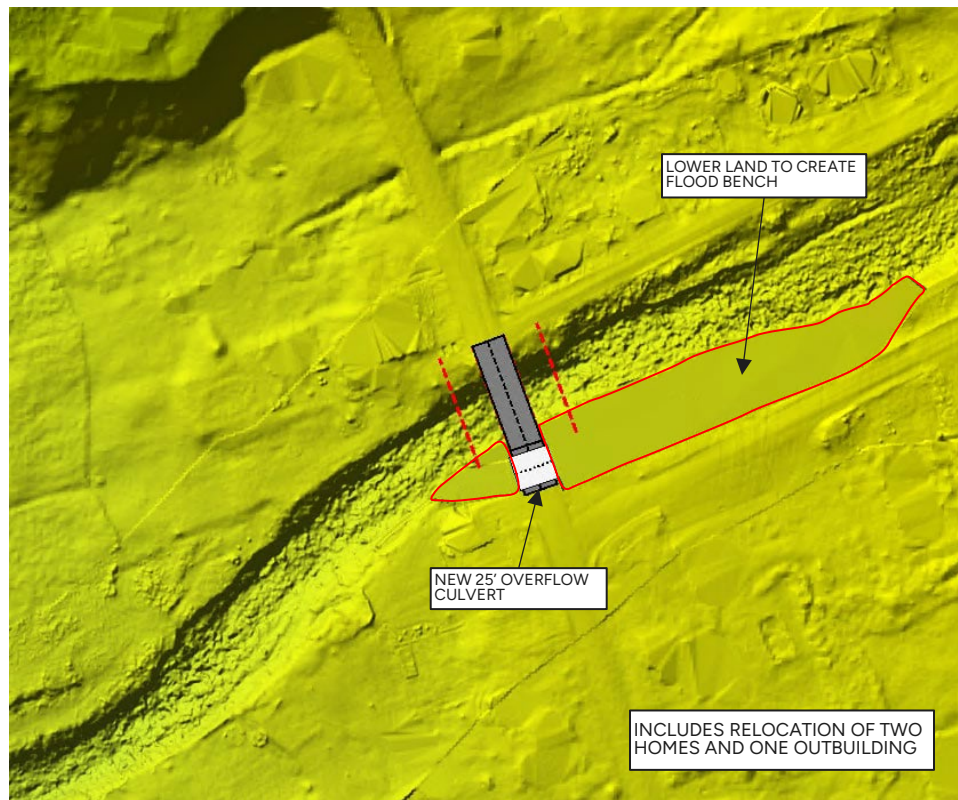
- Modeled removal of accumulated sediment under Route 118 Bridge
- Clear flow impacts localized but reduces potential for clogging with debris





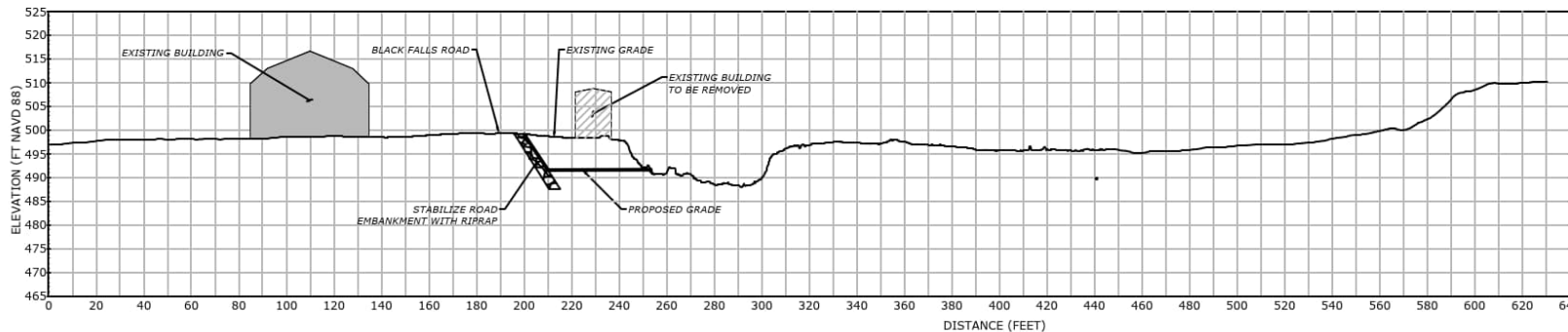
# Alternative 7 – Fuller Covered Bridge

- Overflow culvert with flood bench creation
- Prevents water from flooding out of channel on south side of brook at bridge
- Alone, not effective at reducing overall extent of floodwaters in Village

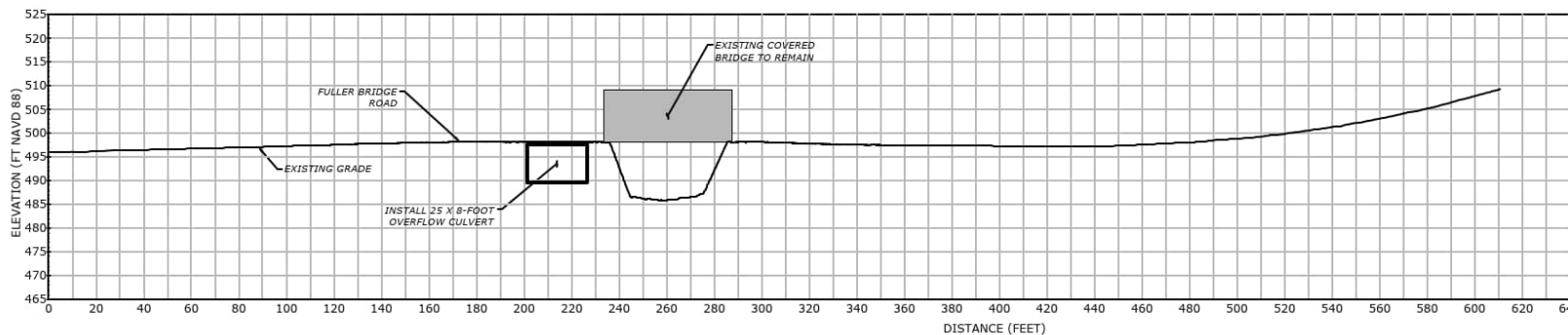




# Alternative 7 – Fuller Covered Bridge



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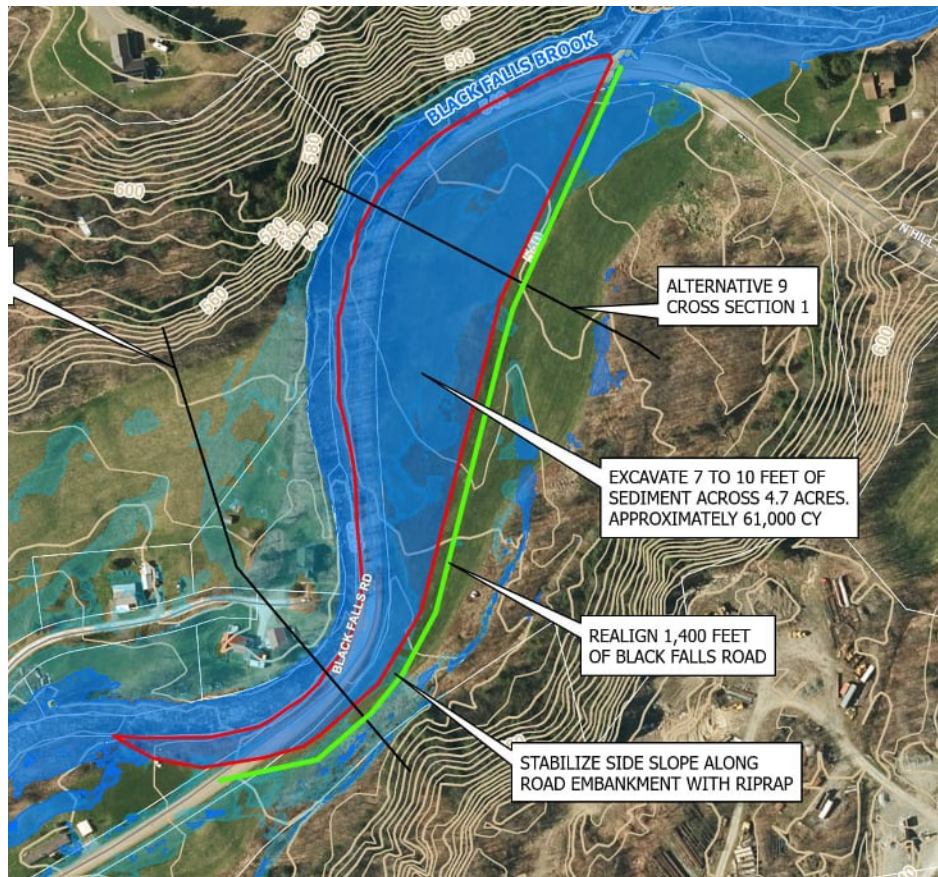


ALTERNATIVE 7 CROSS SECTION 2  
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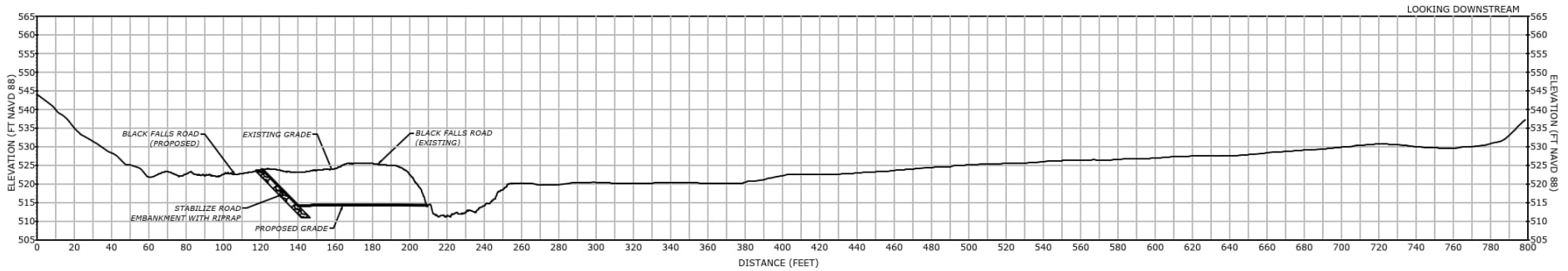
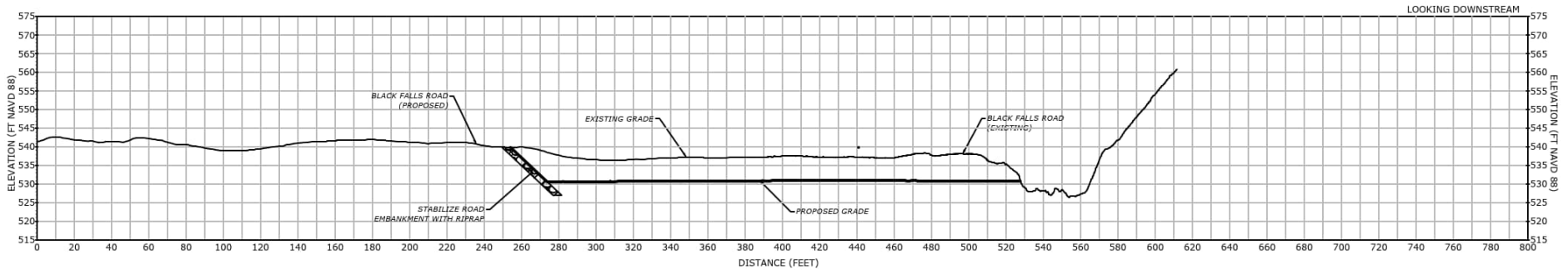


# Alternative 9 – Upper Black Falls Floodplain Restoration

- Prevents water from exiting channel and flowing along road into Village
- Substantial reduction in extent of floodwaters in Village
- Reduced footprint since initial alternatives analysis



# Alternative 9 – Upper Black Falls Floodplain Restoration

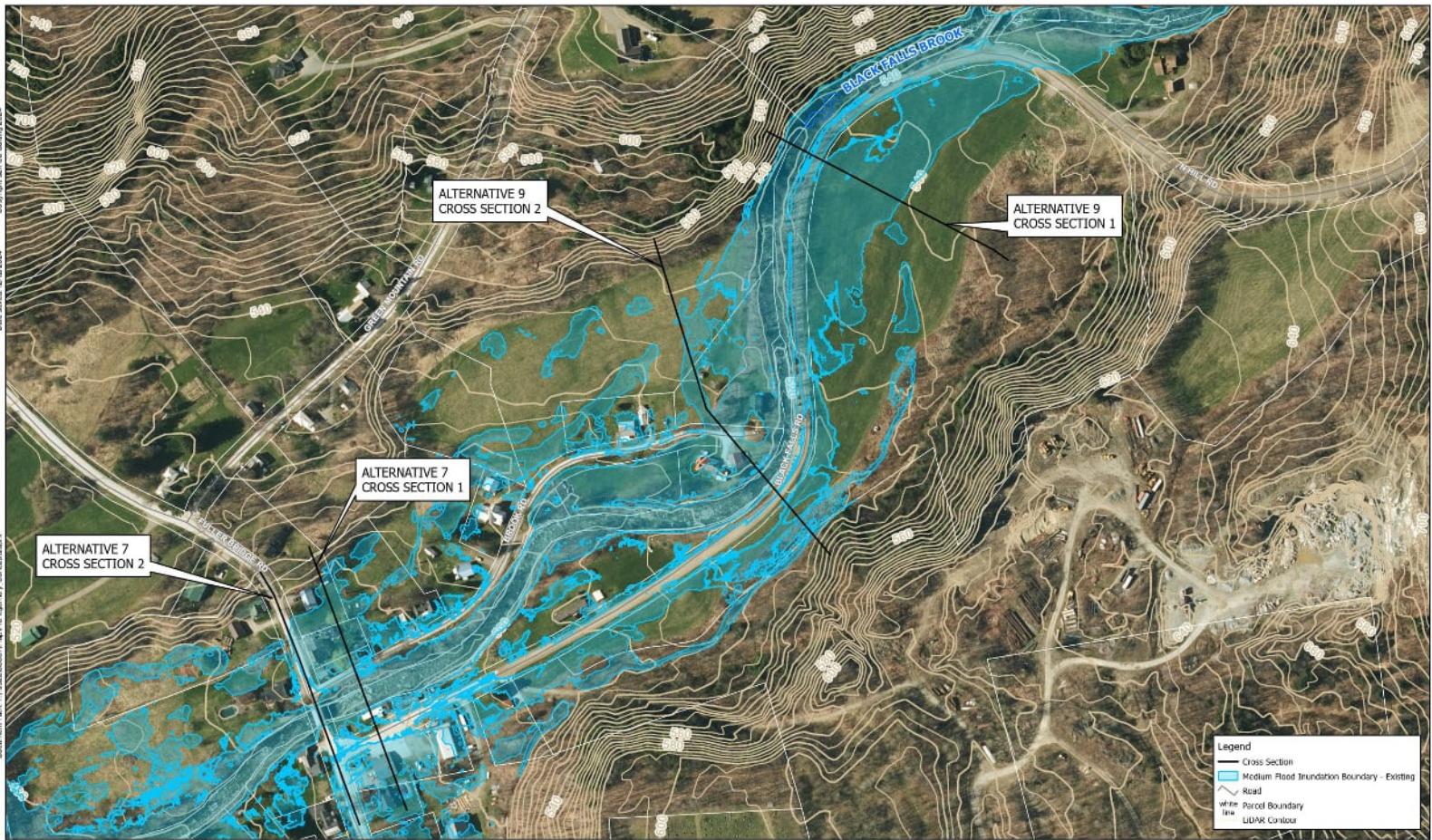




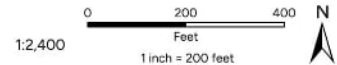
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**ALTERNATIVES 7 & 9 - EXISTING CONDITIONS**  
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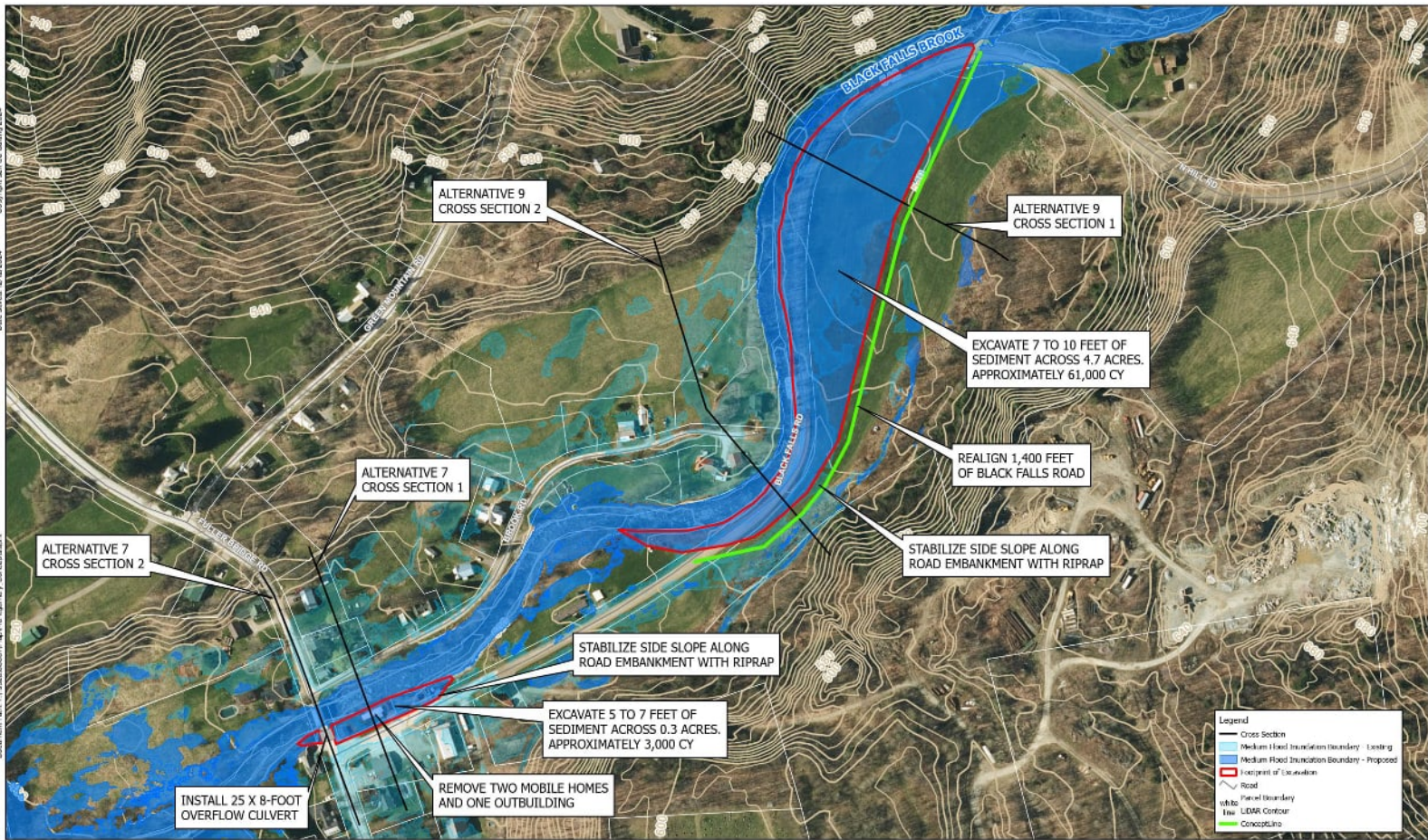


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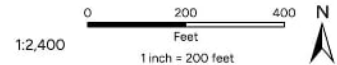


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**ALTERNATIVES 7 & 9 - PROPOSED CONDITIONS**  
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 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT



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# Alternatives 9



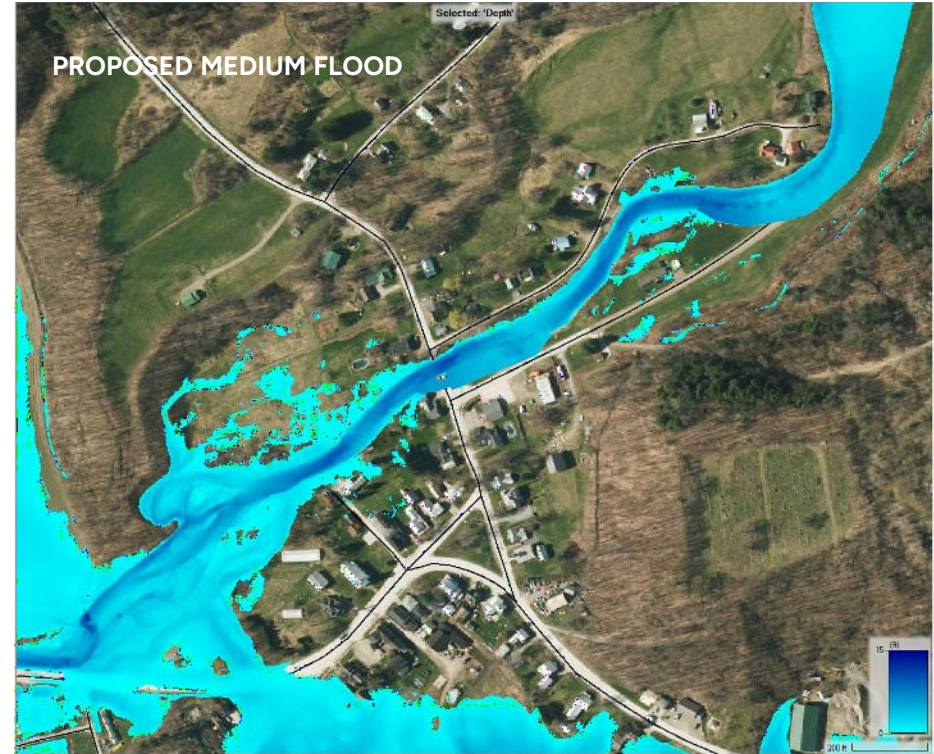
- Upper floodplain creation



# Alternatives 7 & 9



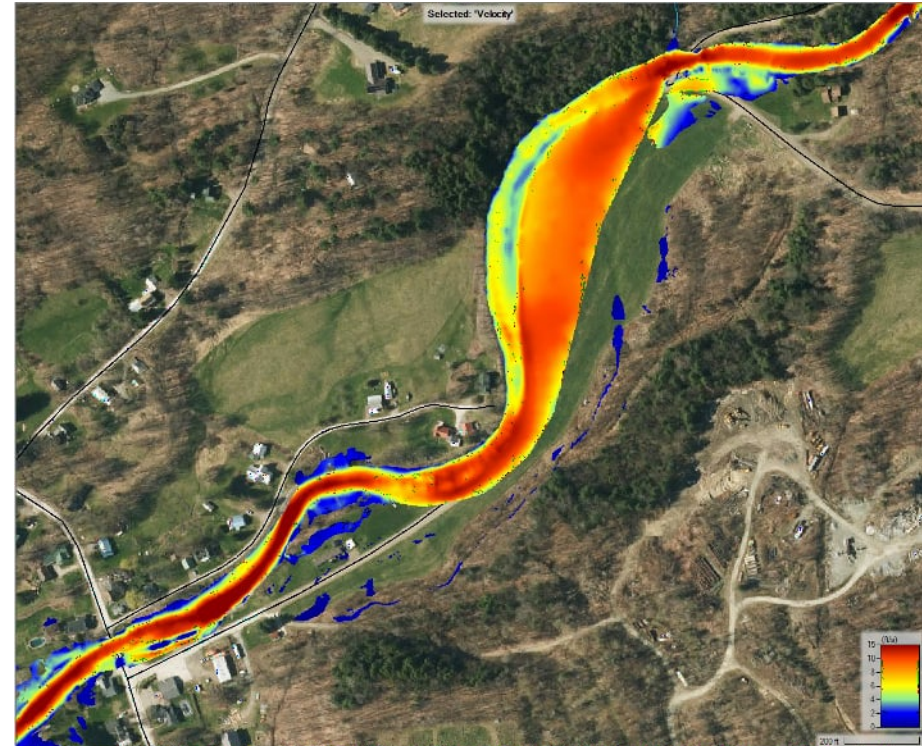
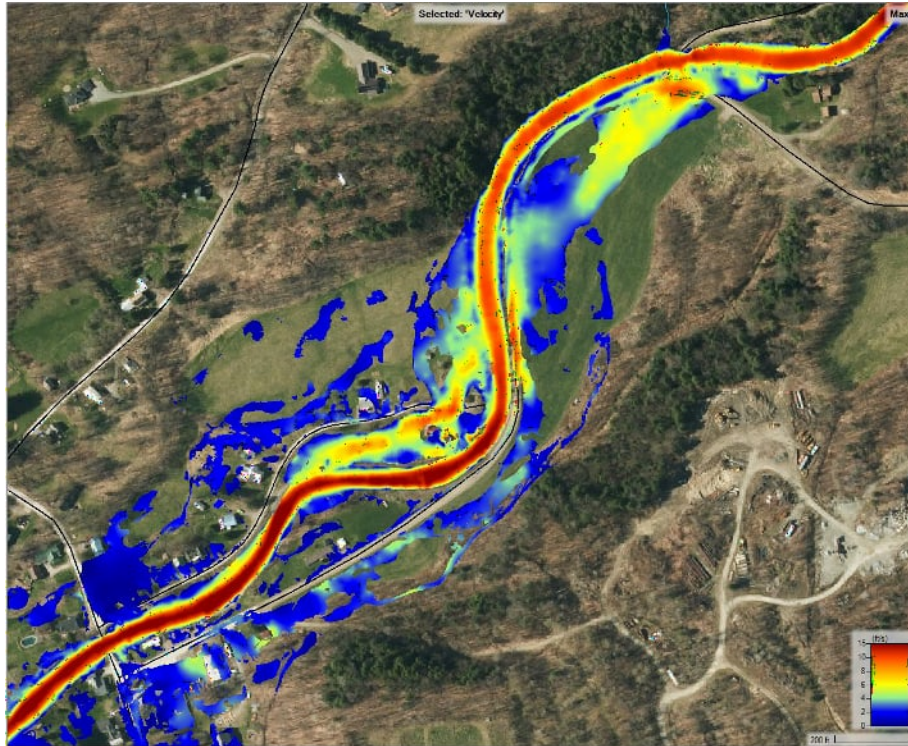
- Combination of upper floodplain creation and Fuller Covered Bridge overflow culvert





# Alternatives 7 & 9

- Combination of upper floodplain creation and Fuller Covered Bridge overflow culvert





# Alt 7 & 9 - Floodplain Restoration Benefits

- Ecosystem benefits of floodplain restoration
- 5.0 acres of floodplain valued by FEMA
- Assumes 100% Riparian Restoration

## BCR ~ 1.0 = eligible for FEMA grant review process

FEMA BCA Calculator - <https://bcaofficeaddin-prod.azurewebsites.net/projects?cpmlID=287aa596-4dff-4d9f-a163-225c48>

- Cost based on low level design
- Cost \$1 - 1,500,000 culvert
- Cost \$2 – 3,000,000 for floodplain
- Fill site important for cost
- Includes design and permitting
- Benefits to buildings not included

**FEMA** Benefit-Cost Calculator  
V.6.0 (Build 20241018.1218 | Release Notes)

+ Add Project   ← Import Projects   → Export Projects   📄 Batch Processing   🗑 Delete Projects

Select	Project Title	County, State	Benefits (B)	Costs (C)	BCR (B/C)
<input checked="" type="checkbox"/>	Fuller Bridge and Upper Black Falls Brook	Franklin, VT	\$ 3,598,908	\$ 3,700,000	0.97
<b>TOTAL (SELECTED)</b>			<b>\$ 3,598,908</b>	<b>\$ 3,700,000</b>	<b>0.97</b>
<b>TOTAL</b>			<b>\$ 3,598,908</b>	<b>\$ 3,700,000</b>	<b>0.97</b>



# Alternative 11

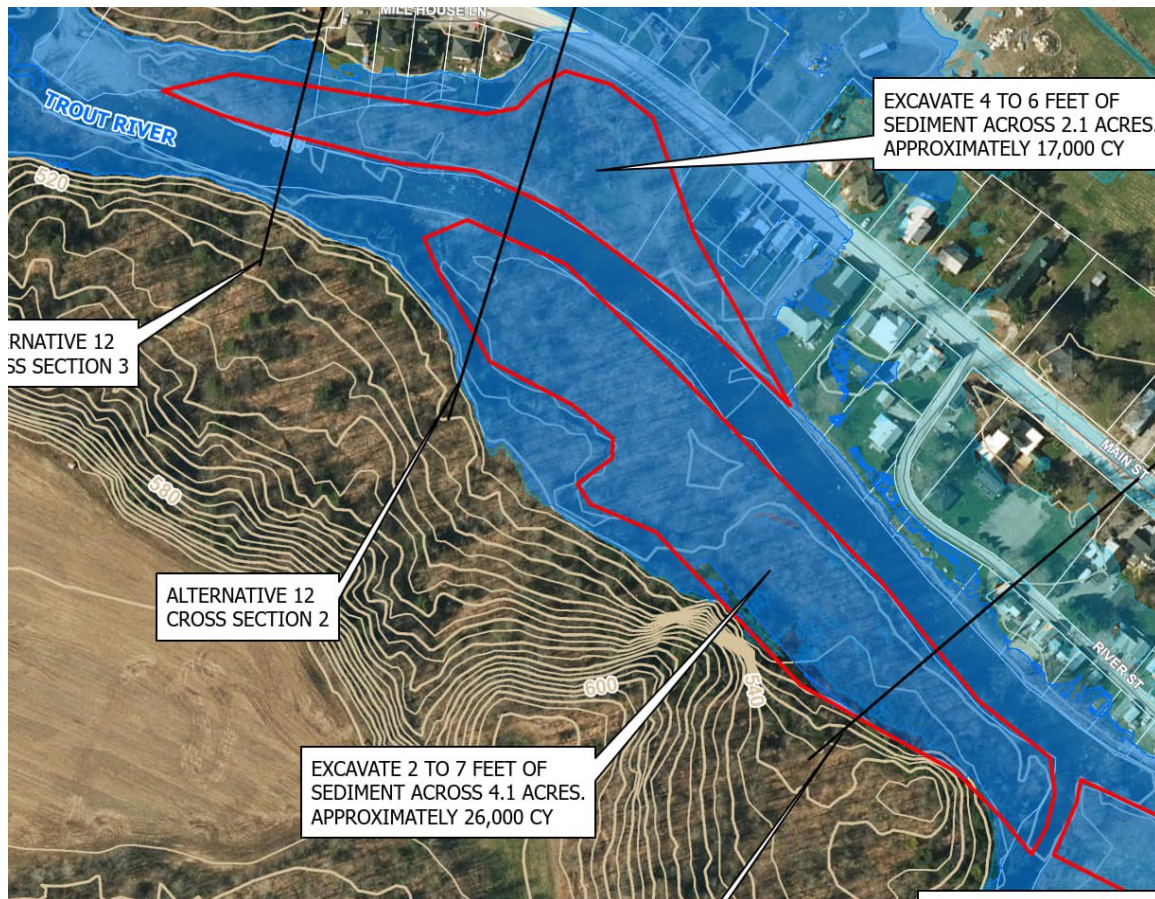
- No reduction in extent of flooding
- Effects carry 1,300 feet upstream but do not reach Center homes and businesses
- May not need to be done, as the upstream alternatives are very effective without it.





# Alternative 12

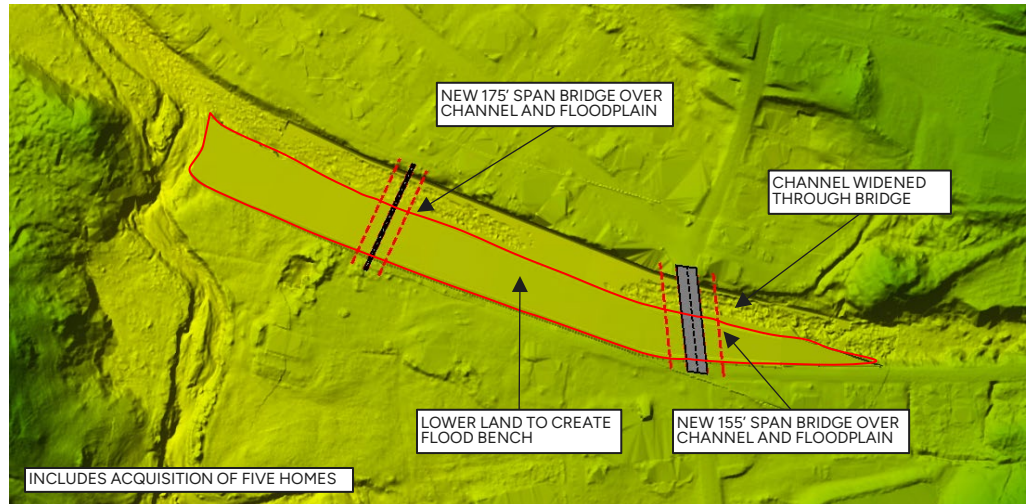
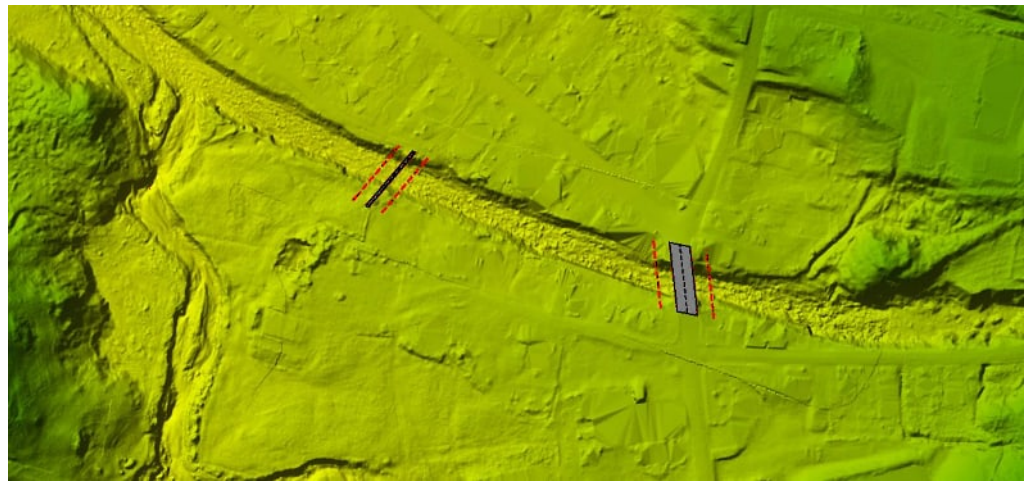
- Added northern floodplain since alternatives discussion
- Floodplain lowering benefits nearby homes the most





# Alternative 15

- South Main Street Bridge upsized from 60' to 155'
- Snowmobile bridge upsized from 100' to 175'
- Flood bench created along south side of Trout River

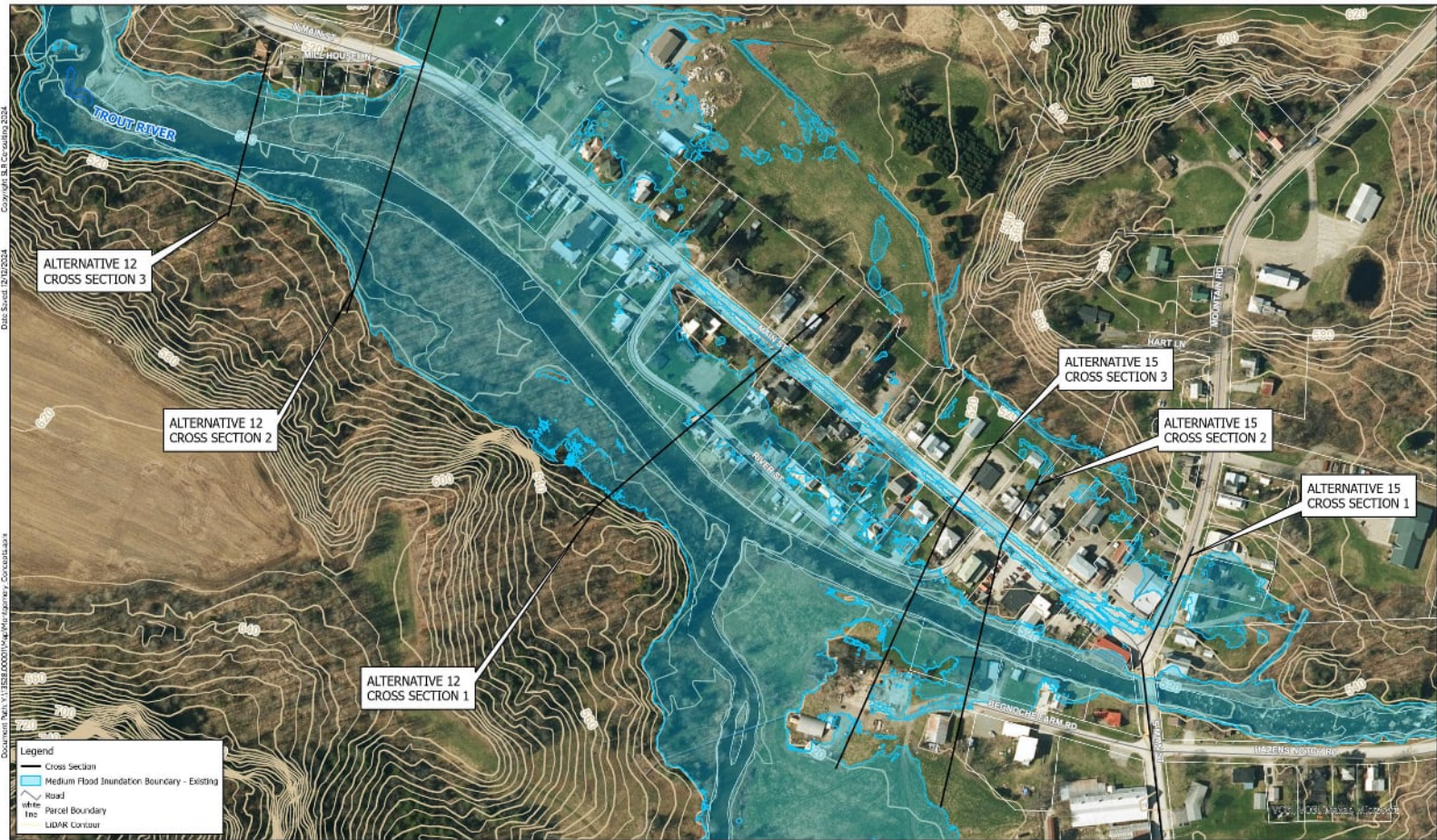






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**ALTERNATIVES 12 & 15 - EXISTING CONDITIONS**  
 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT

1:2,400

0 200 400 Feet  
1 inch = 200 feet

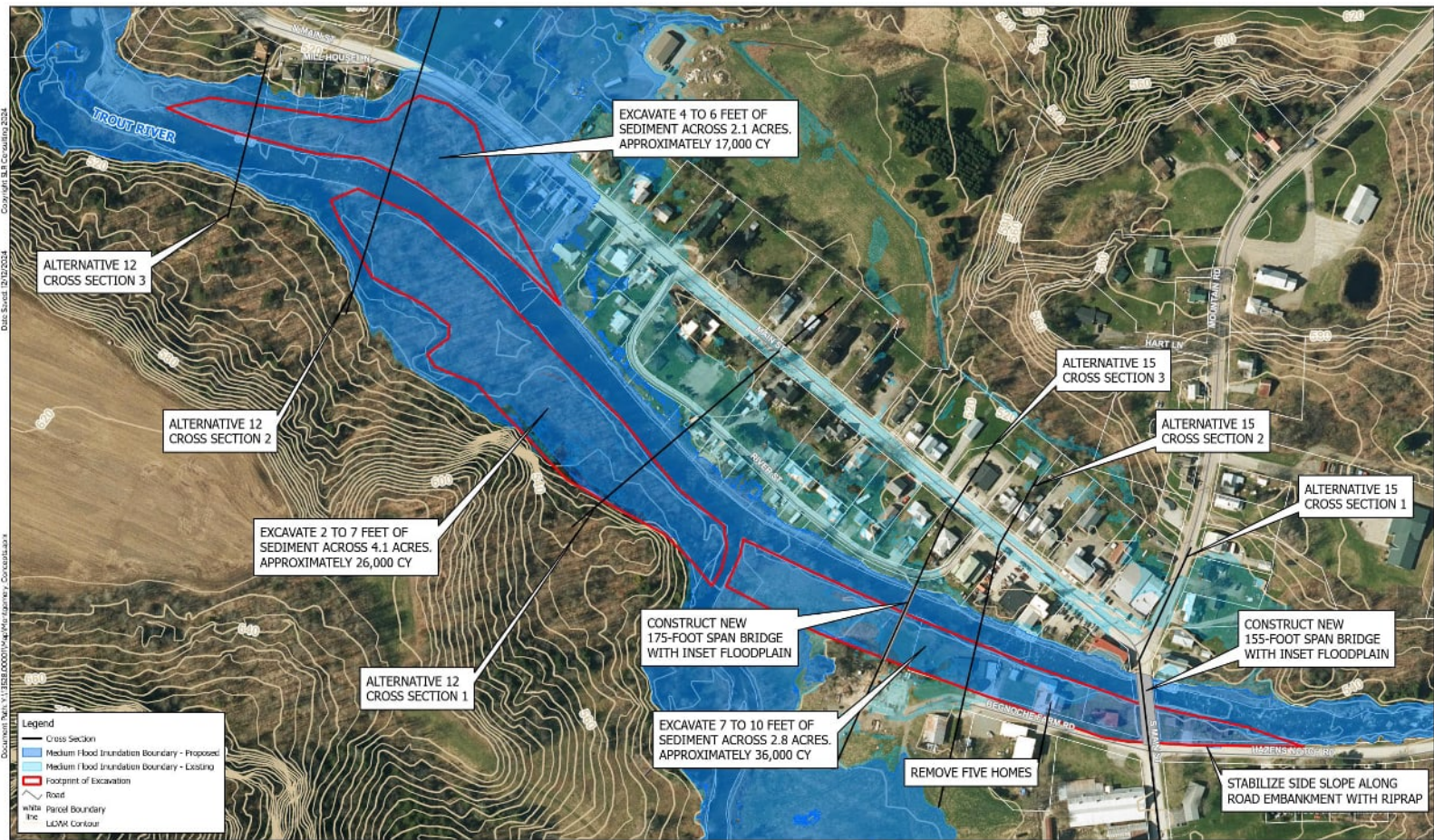
N

**SLR**  
 1 SOUTH MAIN STREET  
 SECOND FLOOR  
 WATERSBURY, VT 05676  
 802.882.8335

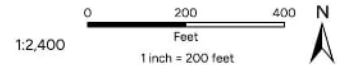


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Document Path: Y:\155810001\Montgomery\Map\Alternatives - Conceptual



**ALTERNATIVES 12 & 15 - PROPOSED CONDITIONS**  
 MONTGOMERY FLOOD HAZARD MITIGATION STUDY  
 FRANKLIN COUNTY NATURAL RESOURCES CONSERVATION DISTRICT

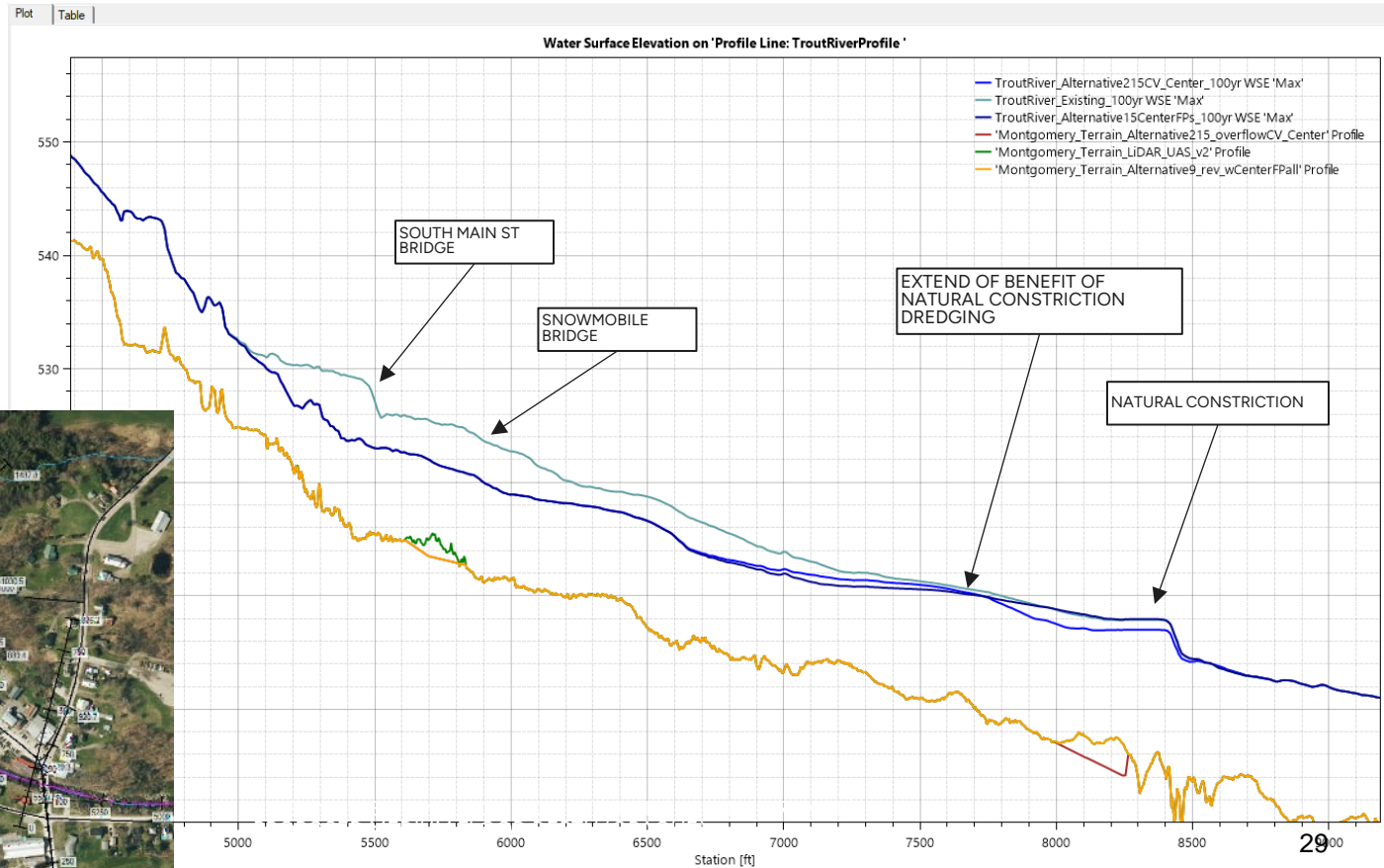


**SLR**  
 1 SOUTH MAIN STREET  
 SECOND FLOOR  
 WATERSURY, VT 05676  
 802.882.8335

# Alternatives 12 & 15 with and without 11



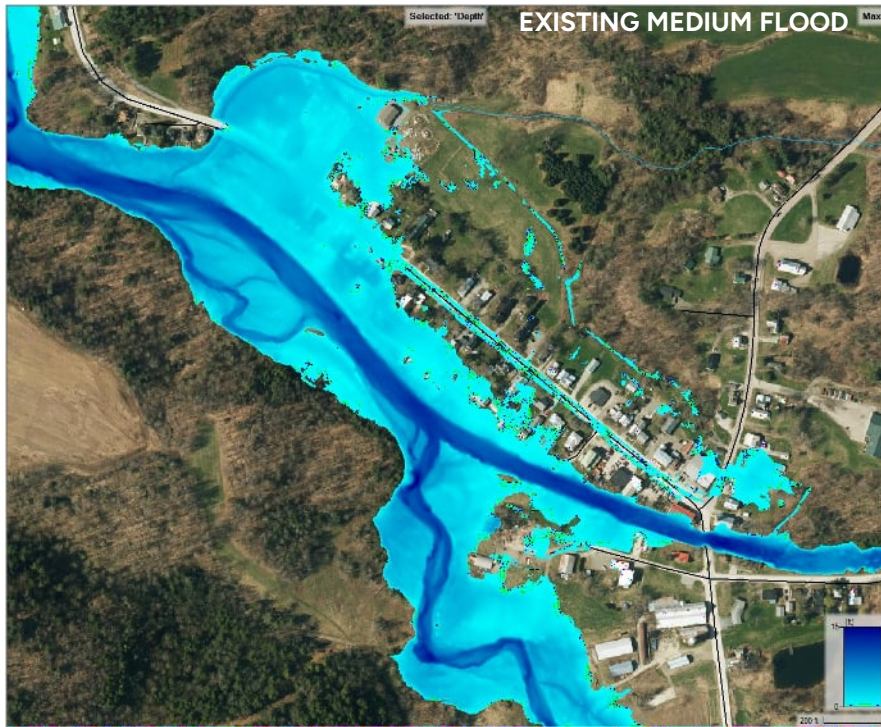
RASMapper Plot





# Alternative 12 & 15

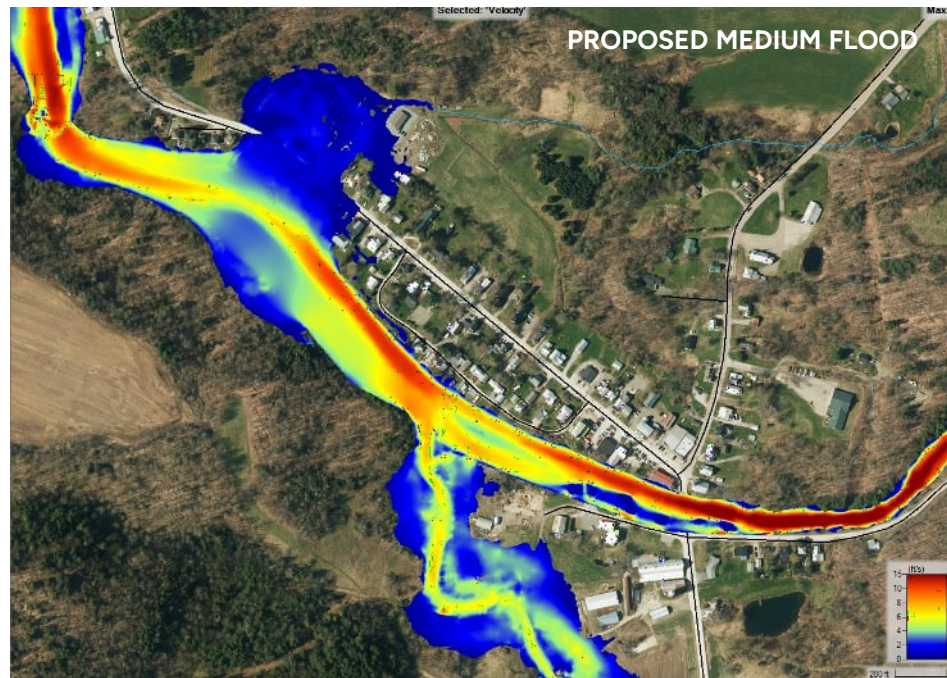
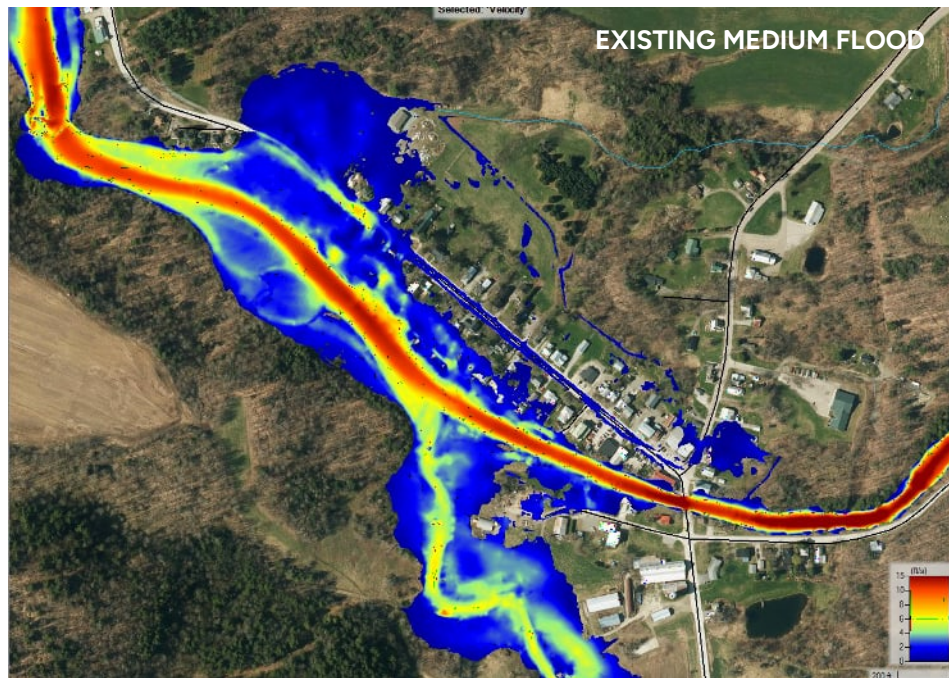
- Reduction in flood depths 1-2' downstream South Branch and 4-5 feet for 1,000' to upstream of South Main Street





# Alternative 12 & 15

- In-channel velocities reduced in vicinity of bridges and homes (17 to 14ft/s at S Main St Bridge, 10-12ft/s to 7-9ft/s along River Street)





# Alt 12 & 15 - Floodplain Restoration Benefits

- Ecosystem benefits of floodplain restoration
- 9.0 acres of floodplain valued by FEMA
- Assumes 100% Riparian Restoration

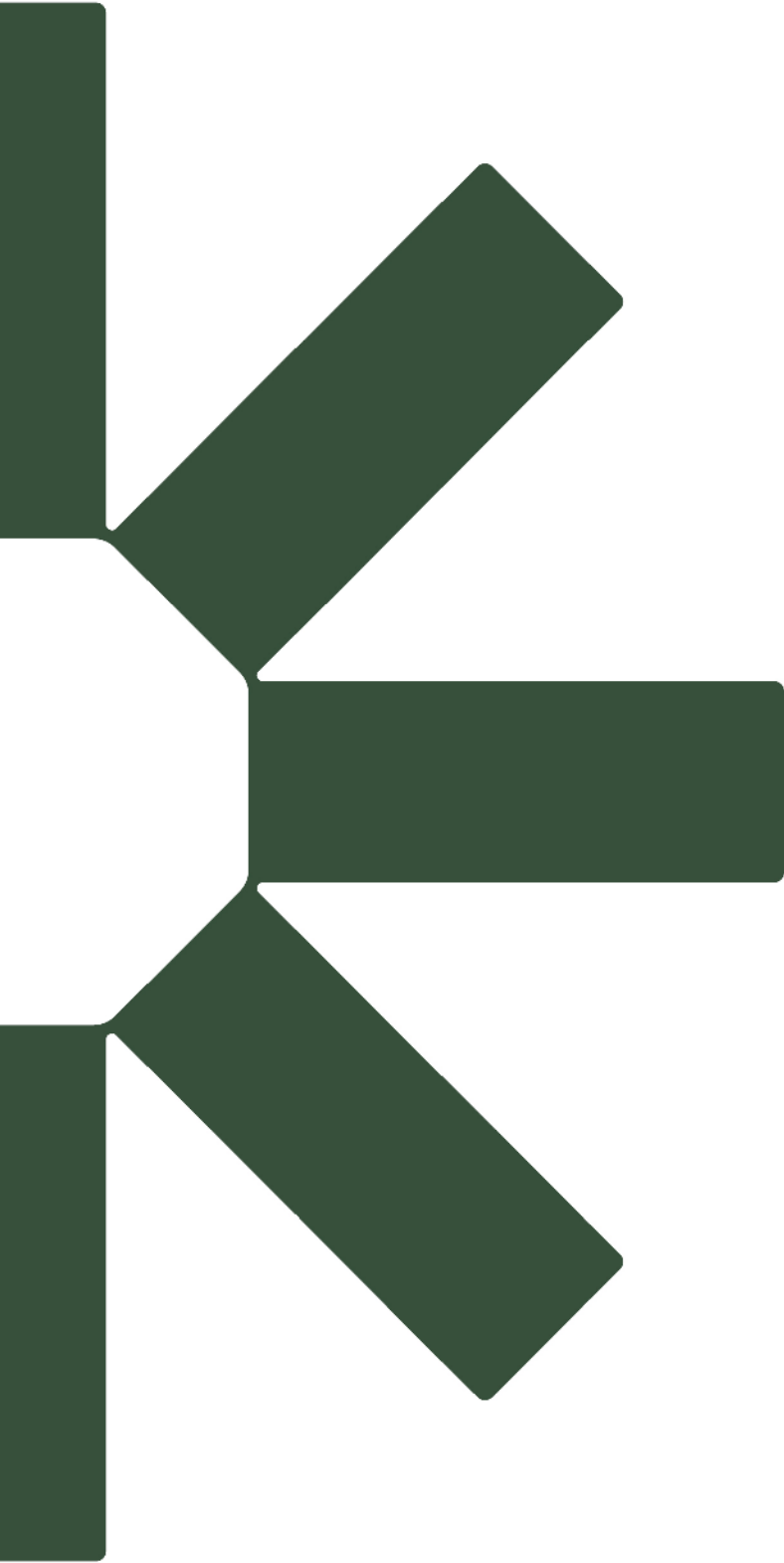
BCR > 1.1 = eligible for FEMA

- Cost based on low level design
- Cost ~\$1,500,000 Alt 12
- Cost \$6,000,000 - \$7,000,000 for Alt 15
- Fill site important for cost
- Includes design and permitting
- Benefits to buildings not included

Select	Map Marker	Mitigation Title	Property Type	Hazard	Discount Rate (%)	Benefits (B)	Costs (C)	BCR (B/C)
<input checked="" type="checkbox"/>	1	Floodplain and Stream Restoration @ Montgomery Center, Vermont		DFA - Riverine Flood	3.1	\$ 8,452,895	\$ 8,000,000	1.06
TOTAL (SELECTED)						\$ 8,452,895	\$ 8,000,000	1.06
TOTAL						\$ 8,452,895	\$ 8,000,000	1.06



Do you  
have any  
questions?



Making Sustainability Happen