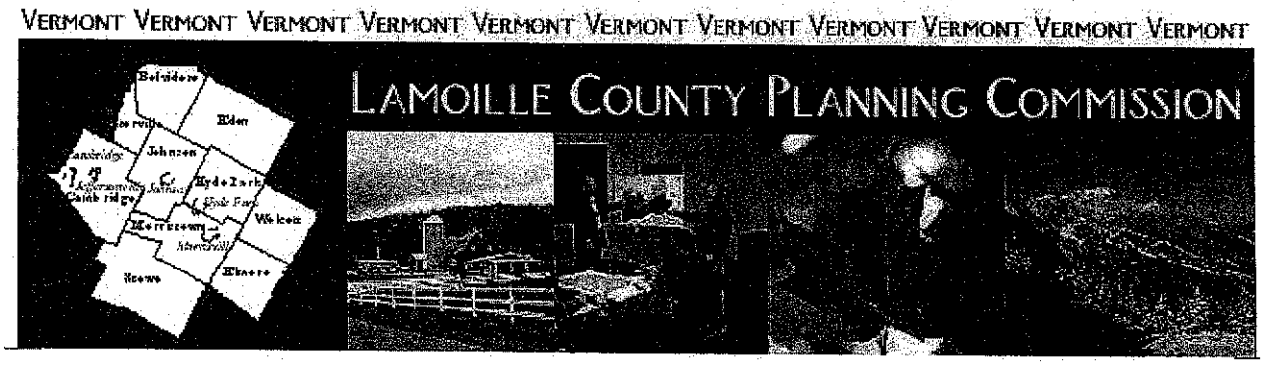
4 April 2016

Pumpkin Harbor Road Flooding at Bartlett Hill

Development update, Draft

University of Vermont civil and environmental engineering student team working in partnership with Lamoille County Planning Commission



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The University of Vermont
COLLEGE OF ENGINEERING
& MATHEMATICAL SCIENCES

Issue:

Residents of Bartlett Hill are inaccessible to emergency vehicles during flooding of Pumpkin Harbor Road and the Wrong Way Bridge.

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Extending Bartlett Hill Road to connect with Mudgett Farm Road, providing access to Pollander Rd. There are two options:

1. Bartlett Hill Extension ~14% grade (figure 1) (Lowest grade possible for this hill), too steep to meet engineering standards. ----------*page 4*
2. Bartlett Hill Extension varying grade, maximum 18% (Grade that results in minimal excavation), too steep to meet engineering standards. ----------*page 6*

Other possible alternatives (Currently unexplored in this scope)

3. Raise Pumpkin Harbor Road above the flood level of Lamoille river----------*page 9*
    - Rough plans developed by Jim Smith, cost estimate for fill and moving telephone poles reported at approximately $500,000
    - Requires obtaining special permitting for working in floodplain/wetlands
4. Right of way through properties separating Bartlett Hill Road from North Cambridge Road (figure 8) ----------*page 10*
    - Requires landowner permission
5. Do Nothing----------*page 11*
    - Contingency plan required in the case of access needed during flooding (ie. all-terrain vehicle, airlift, etc)
    - Future action may be required if flooding worsens

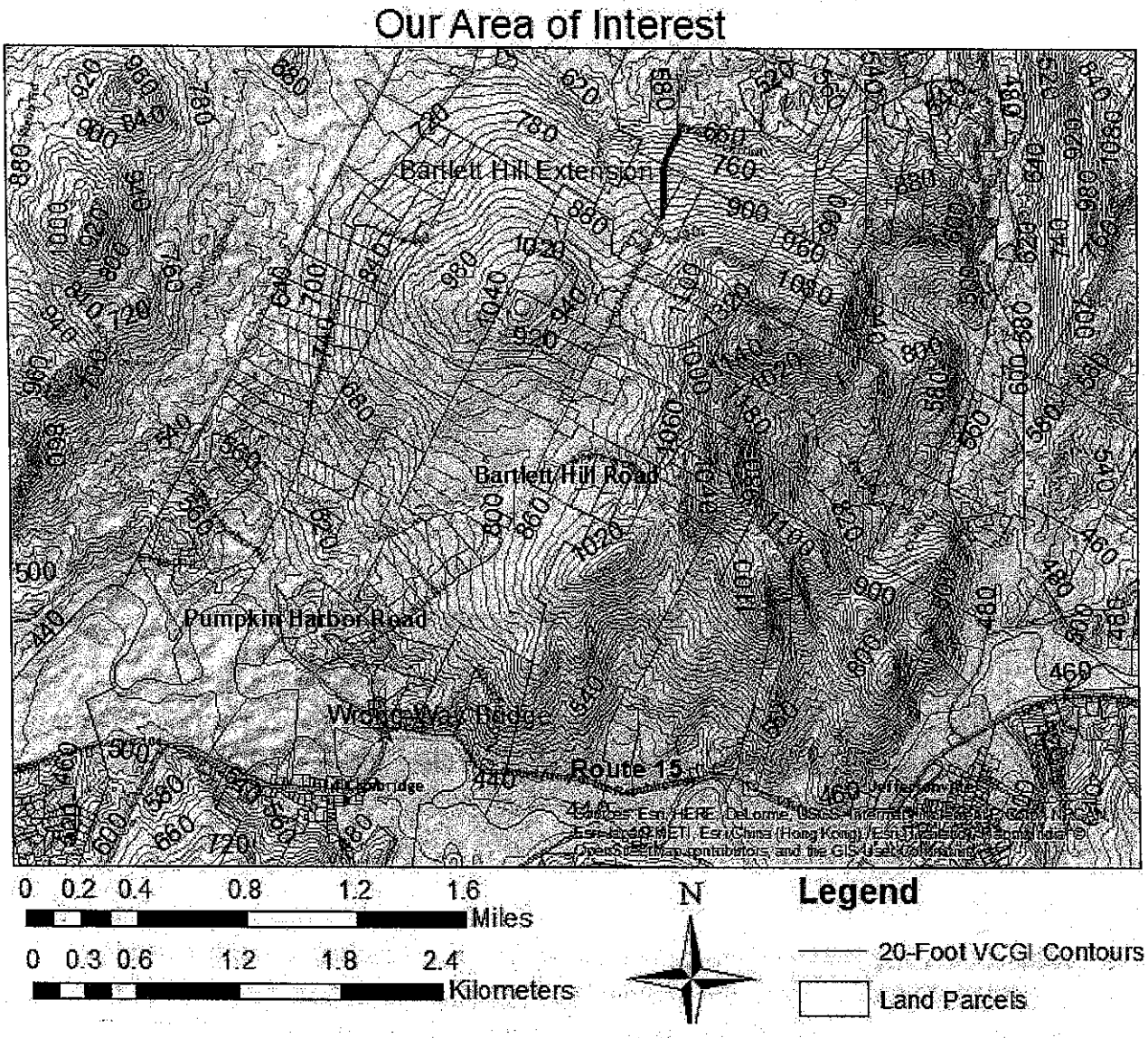

Figure 1: Locator map showing Cambridge and Jeffersonville. Proposed road extending Bartlett Hill Road is outlined in bold, note the steep terrain of the proposed road segment.

Alternative 1: Bartlett Hill Extension with 14.4% Grade

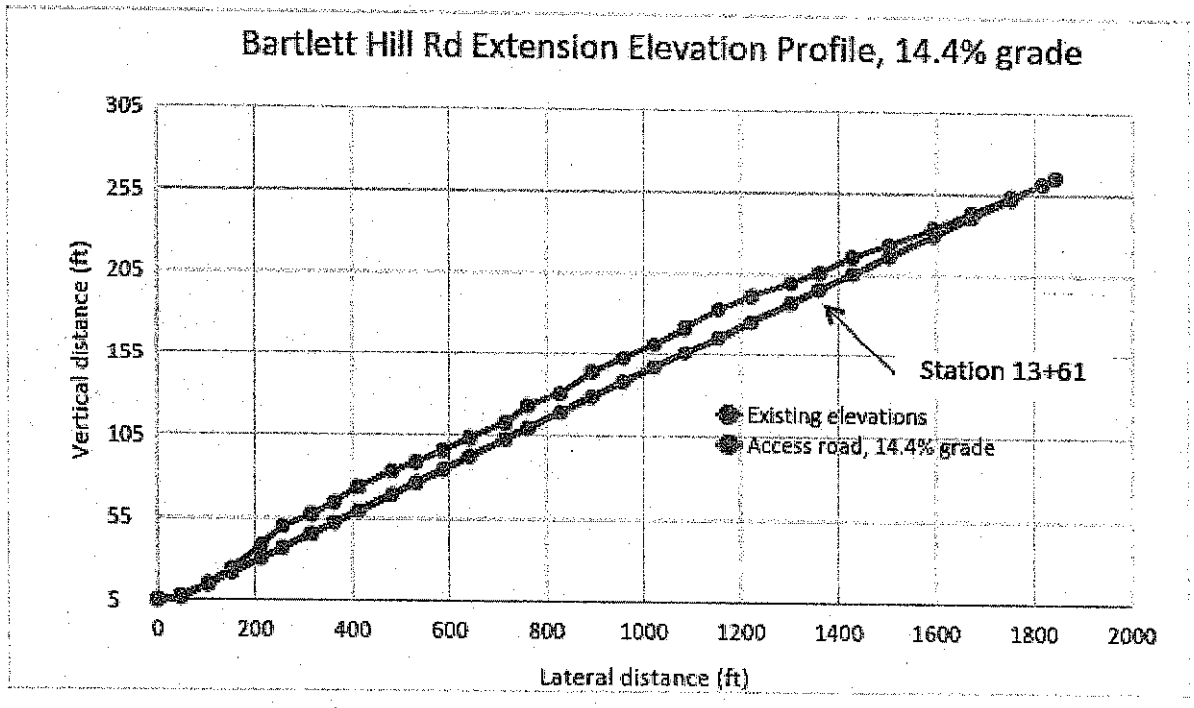

Figure 2: Elevation profile of the existing roadbed compared to the proposed seasonal access road with a varying grade of 14.4%, each point shows the elevation of existing roadbed and proposed roadbed (middle of road), and is associated with a cross section. Cross section examples below.

Key components:

- High initial cost due to amount of material required to be excavated and exported.
- Sustained grade of 14.4% does not meet local or VTrans regulations for class 3 road. Possible construction as class 4 road but use is limited by steep grade.
- Impassible for periods of the year when ice or mud is present, firetruck must seek alternate route during mud season.
- High maintenance cost due to steep grade.
- Runoff water quality concerns: bank stabilization, riprap, and waterbars used in design but erosion will be an issue due to steep grade.
- Waterbars: Installed approximately every 200 feet to control erosion, waterbars divert water off of the surface of the road in areas where crown of road is insufficient to divert water alone due to steep grade. Waterbars here are intended to correspond with a break in the embankment sending water from the culvert into the adjacent stream.

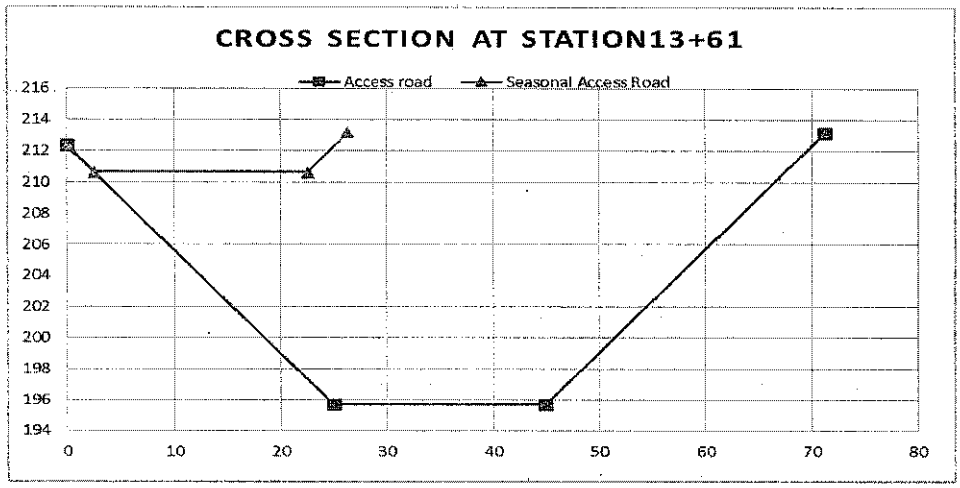

Figure 3: Cross section of existing gully and road with 14.4% grade showing the large volume of fill that must be excavated to achieve an embankment slope of 1.5 : 1.

Table 1: Construction cost of option 1. Note: Maintenance costs are not included. Estimated costs are from VTrans 2 year average price listings. Note: bedrock is likely to be encountered for the majority of the excavation and would cost $81 per CY, increasing unit excavation costs eightfold.

Bartlett Hill Extension Construction, 14.4% Grade				
Item description	Measurement	Quantity	Unit price	Total price
Tree removal, thinning and trimming	$/acre	1.7	$7600	$12,90
Common excavation*	$/CY	107,145	$10.71	$1,147,500
Aggregate surface, coarse	$/CY	2046.6	$32.87	$67,300
Relaying of existing culvert	$/ft	20	$43.25	$865
Processed Gravel Sub-base	$/CY	889	$38.41	$34,200
Coarse Graded Crushed Gravel	$/CY	222	$32.87	$7,300
Culverts	To be sized			TBD
Re-laying Pipe Culvert	$/LF		$51.00	TBD
Ditch Rip-Rap	$/CY	445	$42.70	$19,000
*Not including cost of blasting bedrock, which will most likely be necessary ($13.30/LF)			**Total**	**~$1.3 Million**

Alternative 2: Bartlett Hill Extension with <18% Grade

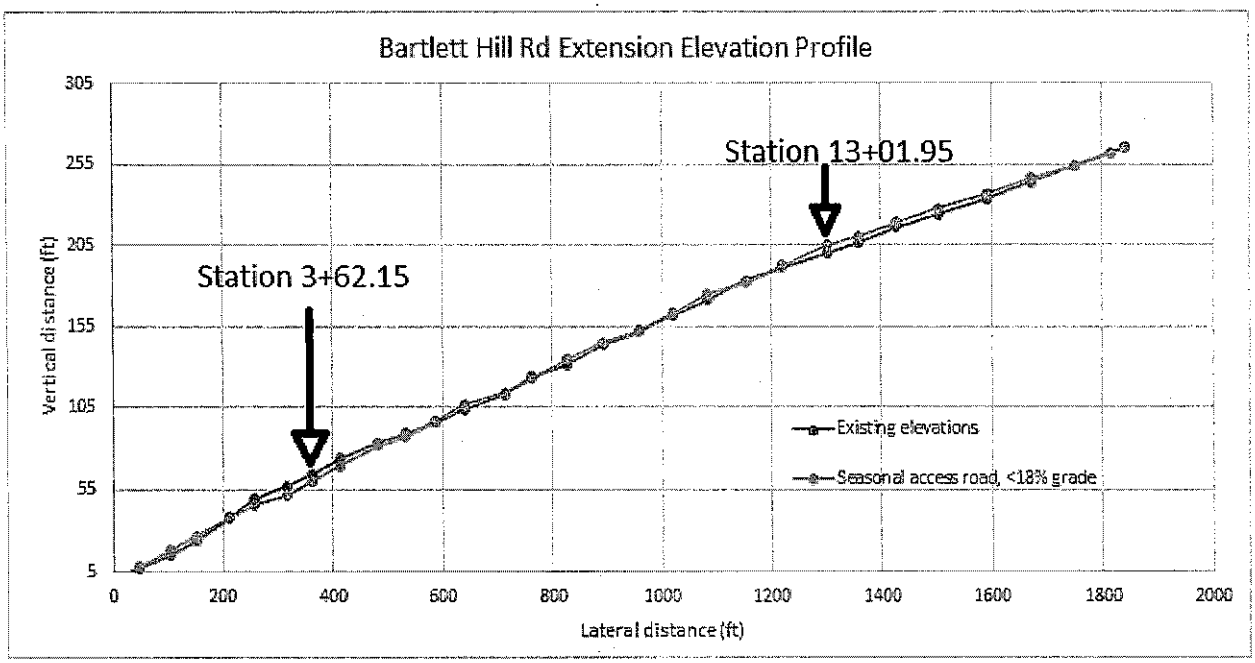

Figure 4: Elevation profile of the existing roadbed compared to the proposed seasonal access road with a varying grade of up to 18%, each point shows the elevation of existing roadbed and proposed roadbed (middle of road), and is associated with a cross section. Cross section examples below.

Key components:

- Lower initial cost by minimizing net import/export of fill
- Maximum grade of 18% does not meet local or VTrans regulations for class 3 road. Possible construction as class 4 road but use is limited by steep grade.
- Impassible for periods of the year when ice or mud is present, firetruck must seek alternate route during mud season.
- Extremely high maintenance cost due to steep grade.
- Runoff water quality concerns: bank stabilization, riprap, and waterbars used in design but erosion is inevitable due to steep grade.
- Waterbars: Approximately every 200 feet is a "step" to control erosion. Waterbars divert water off of the surface of the road in areas where crown of road is insufficient to divert water alone due to steep grade. Waterbars here are intended to correspond with a break in the embankment sending water from the culvert into the adjacent stream.

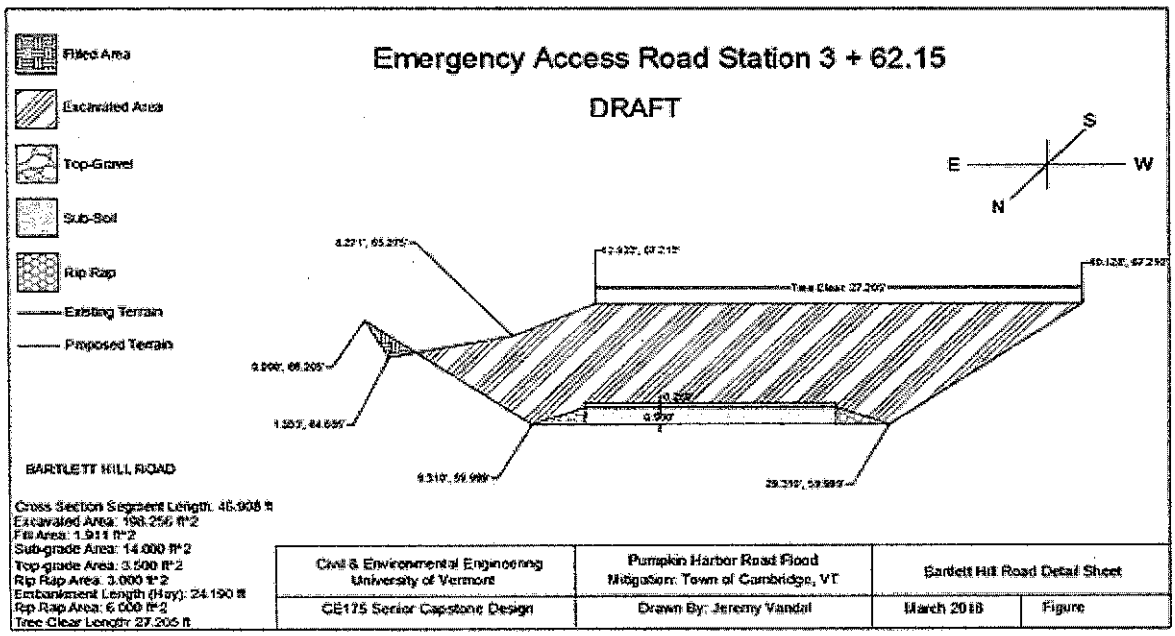

Figure 5: Cross section of existing terrain compared to proposed road with ~18% grade showing a large volume of excavation required. See details for road design below.

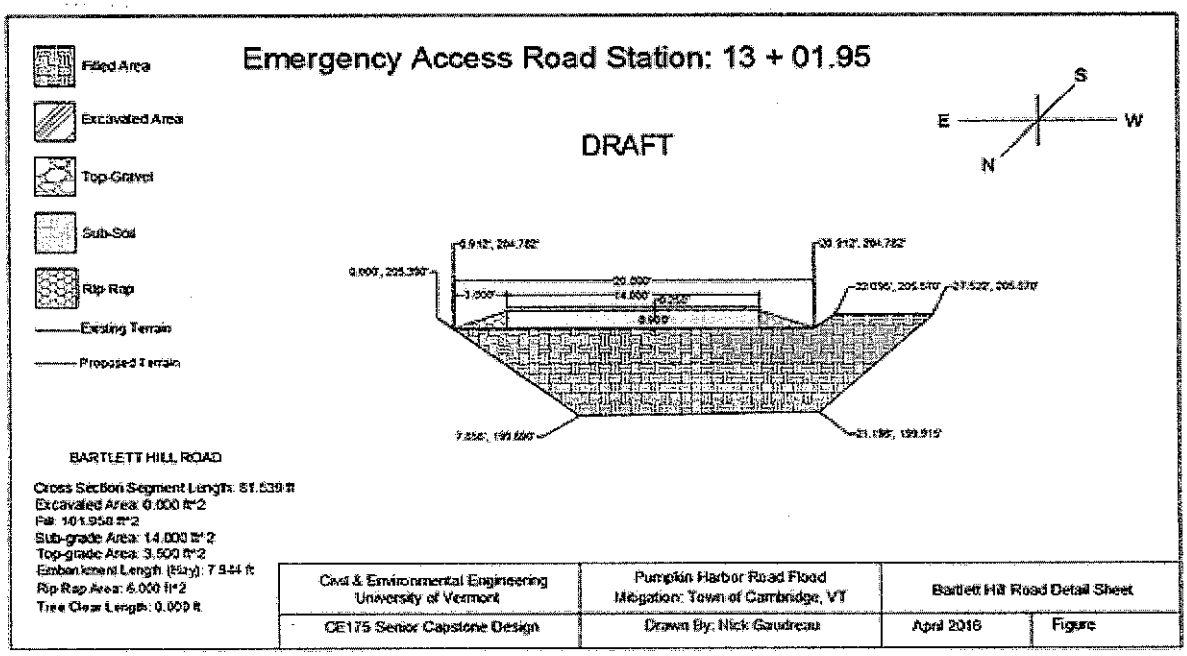

Figure 6: Cross section of existing terrain compared to proposed road with ~18% grade. This option minimizes the net import/export of fill, by excavating some areas (i.e. Station 3+62.15) and filling others (i.e. Station 13+01.95). Complete set of cross sections available. A 14 foot lane width and 3 foot culverts are designed with 12 inches of subgrade and 3 inches of road surface. Riprap is used in culverts and temporary erosion matting is used on embankments.

Table 2: Construction cost of option 2. Estimated costs per unit from VTrans 2 year average price listings. Note: maintenance costs are not included. Note bedrock is likely to be encountered for the half of the excavation and would cost $81 per CY, increasing unit excavation costs eightfold.

Bartlett Hill Extension Construction, ~18% Grade				
Item description	Measurement	Quantity	Unit price	Total price
Tree removal, thinning and trimming	$/ft^2	1802.7	$5.2	$9,400
Common excavation*	$/CY	3135.3	$10.71	$33,600
Fill	$/CY	1856.7	$9.37	$17,400
Relaying of existing culvert	$/ft	20	$43.25	$865
Processed Gravel Sub-base	$/CY	955.5	$32.87	$31,400
Coarse Graded Crushed Gravel	$/CY	238.9	$47.12	$11,300
Road Bed Geotextile	$/ft^2	2866.5	$1.63	$4,700
Culverts	To be sized			TBD
Re-laying Pipe Culvert	$/LF		$51.00	TBD
Temporary Erosion Matting	$/CY	2651.6	$2.45	$6,500
Ditch Rip-Rap	$/CY	409.5	$42.70	17,500
*Not including cost of blasting bedrock, which may be necessary in some locations ($13.30/LF)			**Total**	**$133,000**

Permit	**Fees**	**Application Time Frame**
Stream Alteration	$225	3+ months
Moderate Risk General Construction (3-9020)	$360	N/A
Total	$585	

Alternative 3: Raise Pumpkin Harbor Road

This option is not explored in this scope. Preliminary cost estimate performed by Jim Smith of Smith Technical services.

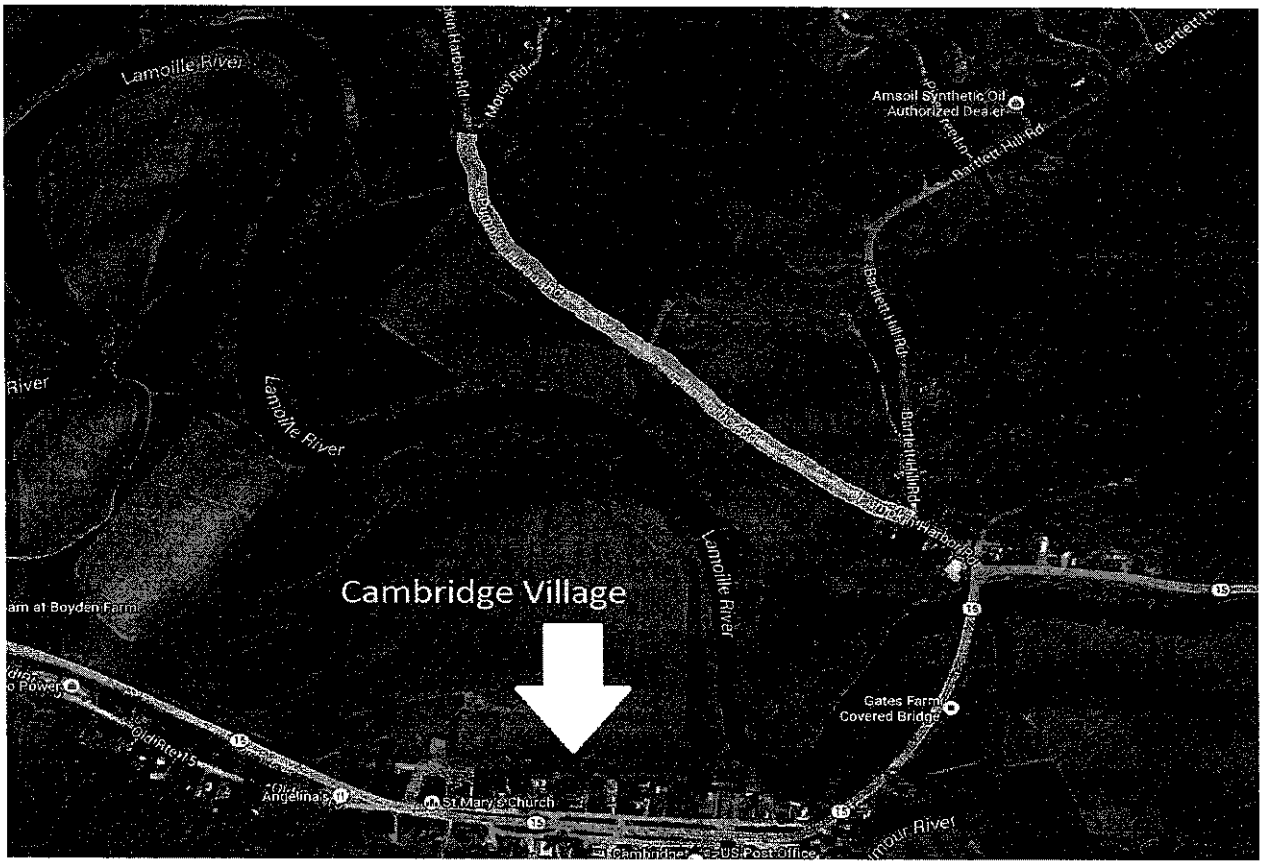

Figure 7: Location of alternative 3, area of construction is highlighted.

Key components:

- Raising Pumpin Harbor road out of the reach of Lamoille River
- Raising up to 4 feet above existing road grade, requiring widening of the footprint imposed on the Lamoille floodplain requiring strict permitting, phone pole relocation
- Raised roadway would act as a levee, and culverts must be capable of sustaining flow to prevent the roadway from acting as a dam
- Repaving of Pumpkin Harbor road is planned, project could be incorporated in repaving
- Target elevation has been approximated by observation, approximately the height of Pumpkin Harbor Road at the junction of Bartlett Hill Road
- Option would allow passage from Bartlett Hill Road away from Cambridge, North on Pumpkin Harbor Road
- It will take time to gain permits to perform work in floodplain
- Preliminary estimate of $500,000 by Smith Technical Services

Alternative 4: Connector road to North Cambridge Road

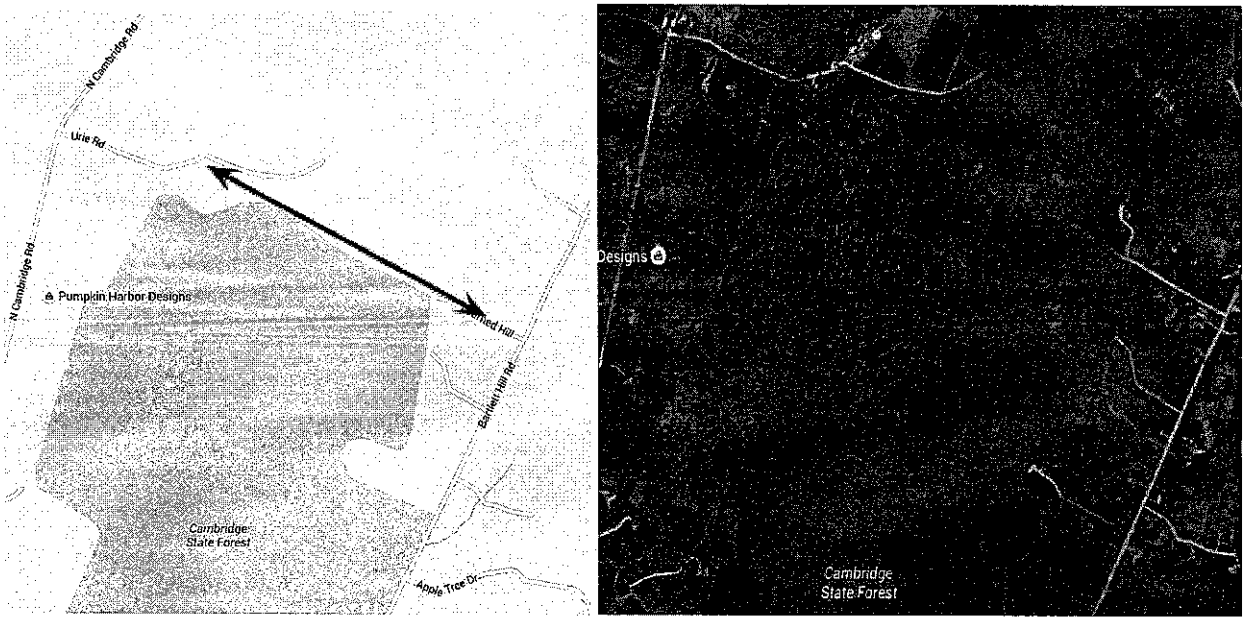

Figure 8: Possible connector road from North Cambridge Road to Bartlett Hill Road crossing private property, two fields over the length of approximately 2,000 feet.

Key components:

- Potentially lower construction cost
- Potentially low maintenance cost
- Requires gaining the right of way from the landowners

"Pert" road

Alternative 5: Do nothing

Key components:

- No construction cost
- Pumpkin Harbor Road will continue to flood, trapping residents of Bartlett Hill Road
- In the case of an emergency on Bartlett Hill Road during a flood that closes Route 15 and floods Pumpkin Harbor road, access must be gained. A contingency plan will be required and will cost money to execute regardless of the cost, this contingency plan may require maintenance of a all-terrain vehicle and maintenance of a trail
- There is a cost to the do nothing alternative

Summary:

- Most feasible option for budget: 18% grade access road connecting Bartlett Hill to Pollander Road
    - Grade is largest issue, must be safe/possible for fire truck/ambulance to drive on and plowable in the winter
    - Erosion/maintenance will be an issue because of steep grades
- 14% grade is too costly, grade may still be an issue
- Raising Pumpkin Harbor Road is too costly, working in wetlands and floodplains should be avoided if possible and would add length of time to gain permits
- Other possibilities:
    - Investigate cause of flooding and possible remediation, if flooding can be prevented or minimized Bartlett Hill issue as well as other flooding issues in the area will be solved
    - Connect Bartlett Hill to North Cambridge Road
        - No grade issues, no forest clearing, easy construction through flat fields
        - Private drives, private land, Cambridge State Forest

The intent of this report is to present the data collected, evaluations, analysis, design, and opinions of probable cost for the Pumpkin Harbor Road Flood Mitigation project. The work presented here was performed in a 15-week long project as part of the course, CE 175 Senior Capstone Design instructed by Professor John Lens, P.E.. Although we have exercised care while working on all components of this project, the reader should be aware that the work was performed within a short time period and with limited resources. This work was directed and reviewed by Professor Lens, other UVM faculty and external evaluators; however, it has not been formally reviewed by a Professional Engineer. The reader is advised that before using any part of this report, the work presented here must be independently evaluated by a qualified Professional Engineer licensed in Vermont.

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