Town of Reading Road Erosion Inventory 2016

Completed by Southern Windsor County Regional Planning Commission and the Town of Reading

Fieldwork completed June/ July 2016
Report last revised December 12, 2016

Funded by Vermont Better Backroads Program, Vermont Transportation Planning Initiative (TPI) and Town of Reading

SWCRPC
SOUTHERN WINDSOR COUNTY
REGIONAL PLANNING COMMISSION

TABLE OF CONTENTS

ABOUT THIS INVENTORY AND REPORT

Reading is a small town of 666 residents (2010 US Census) in Windsor County, Vermont, generally located between the Green Mountains to the west and the Connecticut River Valley to the east. The three person road crew maintains 39 miles of town roads (class 2 and 3), 9 bridges, and 626 culverts. The town has a mixture of flat river valleys alongside very steep hills. The town also has a variety of materials under the roads which affect how they function, including ledge, clay and glacial till.

The town has had several major flooding events recently which affected many roadways in town, particularly Tropical Storm Irene in August 2011. Other historical storms with major road impacts include 1973, 1996, 2009, and fall 2011. Town highways have been impacted by a variety of flood events, such as inundation, fluvial erosion, ice jams, beaver dam failure and landslides. Efforts are made to mitigate for all these events where possible. The road inventory identifies places which are particularly prone to these issues.

The road erosion inventory fieldwork was primarily completed in August 2016. This road erosion inventory and report was completed in conjunction with two other inventories:

- Road condition inventory – fieldwork completed June and July 2016
- Bridge and culvert inventory – fieldwork completed June and July 2016

All the fieldwork needed for the inventories were completed by Chris Yurek (SWCRPC Eco Americorp), Glen Towne (Town Road Foreman) and Mark Bithrow (Town Road Crew). Input was also provided by Bob Allen (Town Selectboard Chair) and Katharine Otto (SWCRPC Planner).

The inventories and report were funded by the Vermont Better Backroads Program, Vermont Transportation Planning Initiative (TPI) and Town of Reading.

This report focuses on the major road erosion sites that were identified in these inventories. For further information about other sites:

- 2016 Town of Reading Road Inventory – Available from Town Garage, Town office and Southern Windsor County Regional Planning Commission. See Appendices A and B for summary maps
- 2016 Town of Reading Bridge and Culvert Inventory – Available online at www.vtculverts.org. Also available from Town Garage, Town office and Southern Windsor County Regional Planning Commission. See Appendix C for summary map.

ACT 64 (VERMONT CLEAN WATER ACT) AND THE MUNICIPAL ROADS GENERAL PERMIT

As of July 8, 2016 we have the following guidance regarding Act 64 of 2015[1]:

> Act 64, the Vermont Clean Water Act, requires the Vermont Department of Environmental Conservation (DEC) (part of the Agency of Natural Resources) to develop a draft Municipal Roads General Permit (MRGP) to address road-related runoff impacting waterways. Towns will begin applying for coverage under the permit in summer of 2018 (proposed). As part of the development of the MRGP, new municipal road practice standards will be developed.

In 2016, DEC issued preliminary guidance which, at this point, is voluntary and likely to change. Aspects of this preliminary guidance has been incorporated into this inventory and report. A map of the potentially

[1] Municipal Road Inventory and Evaluation Interim Guidance. 2016 Field Season. Last Updated July 7, 2016. Emailed by Jim Ryan, July 7, 2016

hydrologically connected road segments is included in Appendix D. Some inventory questions from the guidance have been included into the field inventories, but not all. The assessment of roadways also was not done with 100 meter segments. Instead every mile of roadway had a road condition inventory which included flagging potential sites for the road erosion inventory. Then these potential sites were revisited and inventoried.

Future updates of this erosion inventory will likely need to fully comply with guidance provided by ANR. For more information about the Municipal Roads General Permit see http://dec.vermont.gov/watershed/stormwater/permit-information-applications-fees/municipal-roads-program

SUMMARY OF MAJOR ROAD EROSION SITES

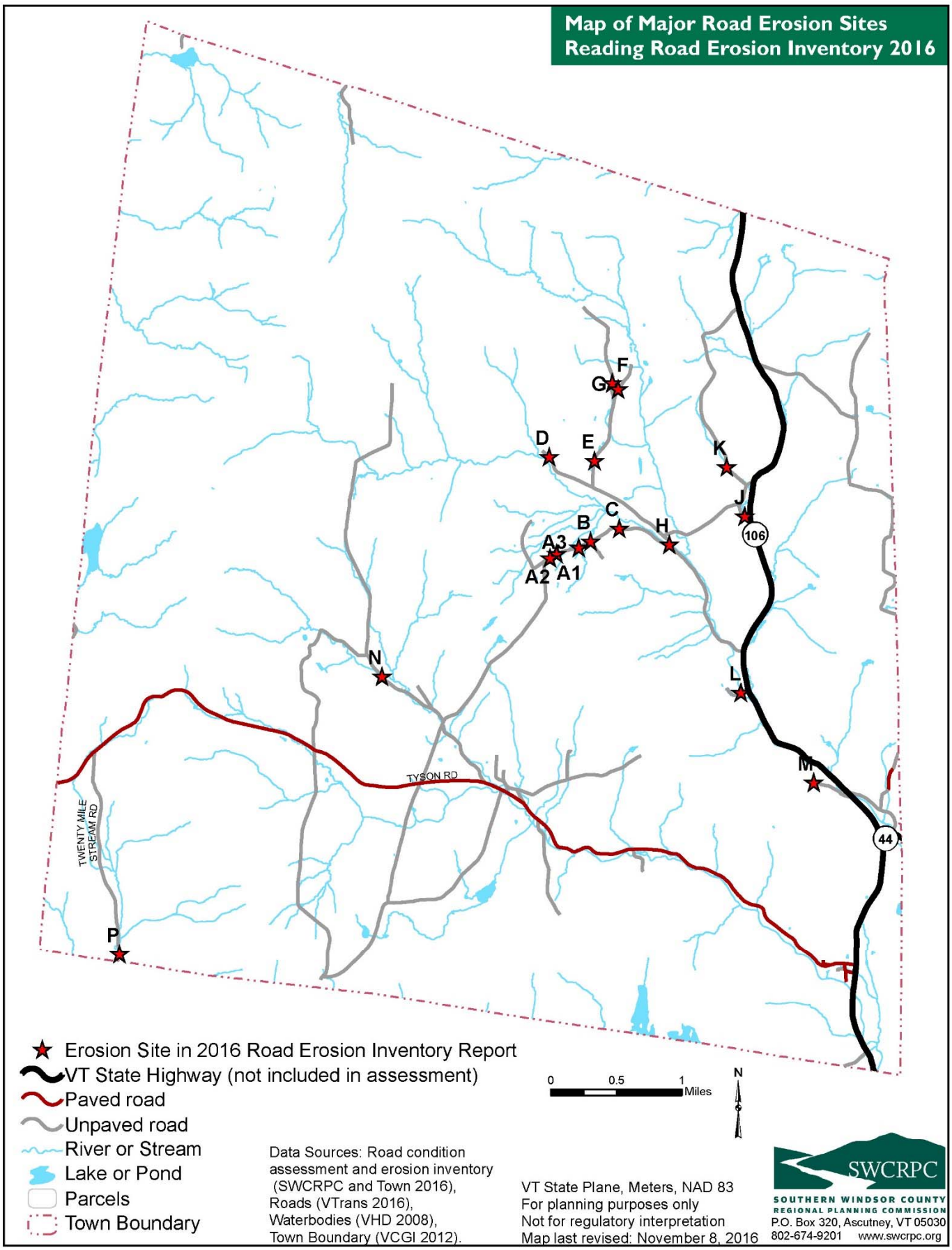
The process for choosing the "major erosion sites" included:

1. Town Road Inventory - Assessing conditions of all roadways in town through fieldwork (see Appendix C summary map)
2. Compare the draft Road Inventory to the following data
    a. ANR's Hydrologically Connected Road Segments data released in 2016[2] (see Appendix D for summary map)
    b. ANR's Road Erosion Risk Ranking data released in 2014[3] (see Appendix E for summary map)
    c. Town Bridge and Culvert Inventory (see Appendix C for summary map).
3. Visit any sites where one of the following was identified:
    a. High or medium erosion issue was identified in Town Road Inventory; or
    b. A town roadway or structure related project identified in the 2015 Mill Brook River Corridor Plan[4].
    c. Any additional sites flagged during Step 2
4. Write up summary for any major erosion sites identified through the fieldwork. Note: Not all sites identified in stage 3 were considered major. "Non-major" sites include those where relatively simple grading and ditching could make significant strides in addressing the issues.
5. Revise the road inventory as needed following the additional fieldwork to reflect some of the comments about future work needed to address roadway needs of non-major erosion sites.

[2] In 2016 ANR released preliminary data about "Hydrologically connected road segments" as related to the Act 64 (Vermont Clean Water Act) Municipal Roads General Permit. http://dec.vermont.gov/watershed/stormwater/permit-information-applications-fees/municipal-roads-program and http://gis.vtanr.opendata.arcgis.com/datasets/ca438cfa73ef47b7b044b9b22045fc9b_164

[3] In 2014 Stone Environmental developed a Road Erosion Risk Ranking protocol and data for unpaved town and private roads in Vermont. In 2016 ANR slightly revised this ranking to include paved roads and remove private roads. For more information see http://anrmaps.vermont.gov/websites/vgisdata/layers_anr/metadata/TransRoad_EROSIONRISK.txt and http://gis.vtanr.opendata.arcgis.com/datasets/ca438cfa73ef47b7b044b9b22045fc9b_164

[4] River Corridor Plan for Mill Brook in Windsor, West Windsor and Reading, Vermont. May 29, 2015. Prepared by Fitzgerald Environmental Associates for SWCRPC http://swcrpc.org/wp-content/uploads/2015/06/2015-05-29_SWCRPC_Mill_RCP-compressed2.pdf


Map of Major Road Erosion Sites
Reading Road Erosion Inventory 2016
F
G
D
E
K
J
C
B
H
A3
A2
A1
106
N
L
M
TYSON RD
TWENTY MILE STREAM RD
44
P
Erosion Site in 2016 Road Erosion Inventory Report
VT State Highway (not included in assessment)
Paved road
Unpaved road
River or Stream
Lake or Pond
Parcels
Town Boundary
0
0.5
1
Miles
N
Data Sources: Road condition assessment and erosion inventory (SWCRPC and Town 2016), Roads (VTrans 2016), Waterbodies (VHD 2008), Town Boundary (VCGI 2012).
VT State Plane, Meters, NAD 83
For planning purposes only
Not for regulatory interpretation
Map last revised: November 8, 2016
SWCRPC
SOUTHERN WINDSOR COUNTY REGIONAL PLANNING COMMISSION
P.O. Box 320, Ascutney, VT 05030
802-674-9201 www.swcrpc.org

Site ID	Project Name/ Location	Quick Description	Priority	Estimated Total Cost	Other notes
A1	Town Hill Rd (Upper Section)	Ditches Phase 1	High	$39,837	Funding awarded 2016.
A2	Town Hill Rd (Upper Section)	Culverts	High	$45,955	Applied for Better Roads Funding in 2016, but not awarded. Project on hold to see how project A1 works.
A3	Town Hill Rd (Upper Section)	Ditches Phase 2	Medium	Unknown	Contractor estimate needed to determine cost
B	Town Hill Rd near Reading Center Rd	Stream Erosion near culvert	Low	$6,000	Given close proximity, it would be cost effective to do two sites together
C	Town Hill Rd (Lower Section)	Stream Erosion near culvert	Low	$4,000	
D	Kittridge Pasture Rd	Potential Mass Failure	Monitor only	Unknown	
E	Stone Chimney Rd	Stone Line Ditches	High	$8,500	Given close proximity, it would be cost effective to do three sites together
F	Stone Chimney Rd	Erosion	High	$6,500	
G	Newton Rd	Stone Line Ditches	High	$4,000	
H	Baileys Mills Rd	Undersized Large Culvert	Medium	$350,000	Needs scoping and engineering before proceeding
J	Whitmore Circle	Undersized Large Culvert	Low	Unknown	Needs hydraulics study and engineering before proceeding
K	Jenne Rd	Steep stream bank next to road	Low	Unknown	Short term solution via routine maintenance.
L	Agony Hill Rd	Undersized Large Culvert	Medium	$750,000	Needs scoping and engineering before proceeding
M	Hagan Hill	Erosion	Monitor only	Unknown	Solutions and costs to be determined if bank destabilizes
N	Brown Schoolhouse Rd	Undersized Large Culvert	High	Unknown	Needs engineering before costs can be determined.
P	Twentymile Stream Road	Vertical stream bank next to road	High	$15,000	Needs engineering before costs can be solidified.

Note: The following roads are not included in this inventory, despite having notable erosion issues:

- Weld Cemetery Road – This class 3 town highway was damaged during Tropical Storm Irene in 2011 but has not yet been restored, and may not be. Currently it is used as a horse trail.
- Archer Road – The erosion appears not to be due to issues related to roads or bridges.
- Tattle Street – This area could use stone lined ditches.

BUDGET FOR PROJECTS WITH ESTIMATED COSTS

There are three types of costs related to the projects in this report (which are included in the site descriptions where available):

- Construction – where good estimates for construction costs are known
- Maintenance – "Miscellaneous Erosion Control" – for stone lining ditches in areas which are not identified with major erosion or water quality issues. These sites may have minor water quality or erosion issues identified – and these will be prioritized over all other road segments. This is a potential new town budget line item to be added in 2016.
- Scoping/ Engineering – for sites where construction costs are not known. It is assumed that construction costs for those sites will be added to the budget in future years once costs are better understood.

The town has only budgeted for "Construction" costs that are known. As funding becomes available they will be pursuing other high priority projects that have significant engineering costs and large construction costs (eg undersized large culverts – Sites H, J and L).

Estimated Budget Year	Site ID	Project Name/ Location	Quick Description	Estimated Total Cost	Potential Funding Sources	Town Cash or in-kind match	Grant Funds
2016 (Funding awarded)	A1	Town Hill Rd (Upper Section)	Ditches Phase 1	$39,837	Better Roads	$19,837	$20,000
2017	E	Stone Chimney Rd	Stone Line Ditches	$8,500	Better Roads	$3,800	$15,200
2017	F	Stone Chimney Rd	Erosion	$6,500			
2017	G	Newton Rd	Stone Line Ditches	$4,000			
2018	A3	Town Hill Rd (Upper Section)	Ditches Phase 2	Unknown	Better Roads		
2018	B	Town Hill Rd near Reading Center Rd	Stream Erosion near culvert	$6,000	Better Roads	$2,000	$8,000
2018	C	Town Hill Rd (Lower Section)	Stream Erosion near culvert	$4,000			
2019	P	Twentymile Stream Road	Vertical stream bank next to road	$15,000	Better Roads	$3,000	$12,000
Project on hold	A2	Town Hill Rd (Upper Section)	Culverts	$45,955	Better Roads	$10,875	$35,080

For more information about potential funding sources, see appendix G – Funding matrix.

USEFUL CONTACTS AND INFO FOR PROJECTS

- VTrans District 4
  - Chris Bump – District Project Manager. Chris.bump@vermont.gov 802-296-5567
  - Mike Blakselee – District Tech. michael.blakslee@vermont.gov 802-291-4668
- ANR River Management Engineer – Scott Jensen. Scott.jensen@vermont.gov 802-490-6962
- Army Corp of Engineers - Unknown
- Project Dig Safe for identifying buried cable or utilities – 1-888-DIG-SAFE
- VTrans Hydraulics
  - Study Request – Go to http://apps.vtrans.vermont.gov/HydraulicsStudyRequest/HydraulicStudyRequest.aspx
  - Hydraulics Manual (due to be updated soon) - http://vtransengineering.vermont.gov/sites/aot_program_development/files/documents/environmental/EnviroHydraulicsManual1998.pdf
- Vermont Better Backroads Program
  - For technical assistance contact Alan May. Alan.may@vermont.gov 802-828-4585
  - Better Backroads Manual http://vtransengineering.vermont.gov/bureaus/mab/better-back-roads
- Vermont Local Roads Program
  - For technical assistance go to http://vermontlocalroads.org/assistance
  - Variety of trainings and resources at http://vermontlocalroads.org/
- Vermont Standards and Specifications for Erosion Prevention and Sediment Control 2006 - http://www.vtwaterquality.org/stormwater/htm/documents/sw_vt_standards_and_specifications_2006_updated_2_20_2008.pdf
- Town of Reading Road and Bridge Standards 2013 (using 2013 State model)
- Southern Windsor County Regional Planning Commission – Katharine Otto – Transportation Planner kotto@swcrpc.org 802-674-9201
- ANR Road Erosion Risk Map. Available online from http://anrmaps.vermont.gov/websites/anra5/ (Appendix D of this report)
- Funding Sources Matrix created by SWCRPC (Appendix E of this report)
- Watershed Sizes as Guidance in Stream Alteration Regulations (from http://www.watershedmanagement.vt.gov/rivers/htm/rv_management.htm) (Appendix F of this report)

ABBREVIATIONS

Act 64	Act 64 of 2015, the Vermont Clean Water Act
ANR	VT Agency of Natural Resources
DEC	VT Department of Environmental Conservation
HCRS	Hydrologically Connected Road Segments (first released in 2016)
MRGP	Muncipal Roads General Permit
TH	Town Highway
RERR	Road Erosion Risk Ranking (first released in 2014 and revised in 2016)
ROW	Right of Way
SWCRPC	Southern Windsor County Regional Planning Commission

EROSION SITE DESCRIPTIONS

SITE A – TOWN HILL ROAD (UPPER SECTION)

Road Name: Town Hill Road **TH Number:** 8 **TH Class:** 3
GPS coordinates: From: N 43.50114 W 72.58258 To: N 43.50187 W 72.57923
Road Characteristics: unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: High

Status: Part of the project has received funding through the Better Roads Program to address some issues in 2016/2017. Additional funding will be needed for subsequent project phases.

Site Visits

- January 2016 – Alan May (Better Roads Program), Bob Allen (Town Selectboard Chair), Glen Towne (Town Road Foreman), Gordy Eastman (Town Selectboard), Katharine Otto (SWCRPC), and Chris Yurek (SWCRPC).
- August 2016 – Alan May (Better Roads Program), Bob Allen (Town Selectboard Chair), Glen Towne (Town Road Foreman), Katharine Otto (SWCRPC), and Chris Yurek (SWCRPC).

Description of problem

The roadway has several cross culverts feeding water into one ditch. The ditch cannot cope with the amount of water that flows in from the roadway and several streams (some are formally identified, others are not). The road ditch currently flows straight into several streams causing water quality issues. The ditch has been gullying, particularly since Tropical Storm Irene affected the area. This section was completely washed out in heavy rains in 2009 and 2011, and some portions in 2012 and 2014.

Proposed solutions

There are three proposed solutions:

- A1 – Ditches Phase 1 – This phase has Better Roads funding for construction.
- A2 – Culverts
- A3 – Ditches Phase 2

Site Photographs

Examples of how the road washes out after major storms. This road section was completely washed out in heavy rains in 2009 and 2011, and some portions in 2012 and 2014.
For more photographs see solutions A1 and A2

SITE A1 – TOWN HILL ROAD (UPPER SECTION) DITCHES PHASE 1

See "Site A – Town Hill Road" for description of issue.

GPS coordinates: N 43.50114 W 72.58258

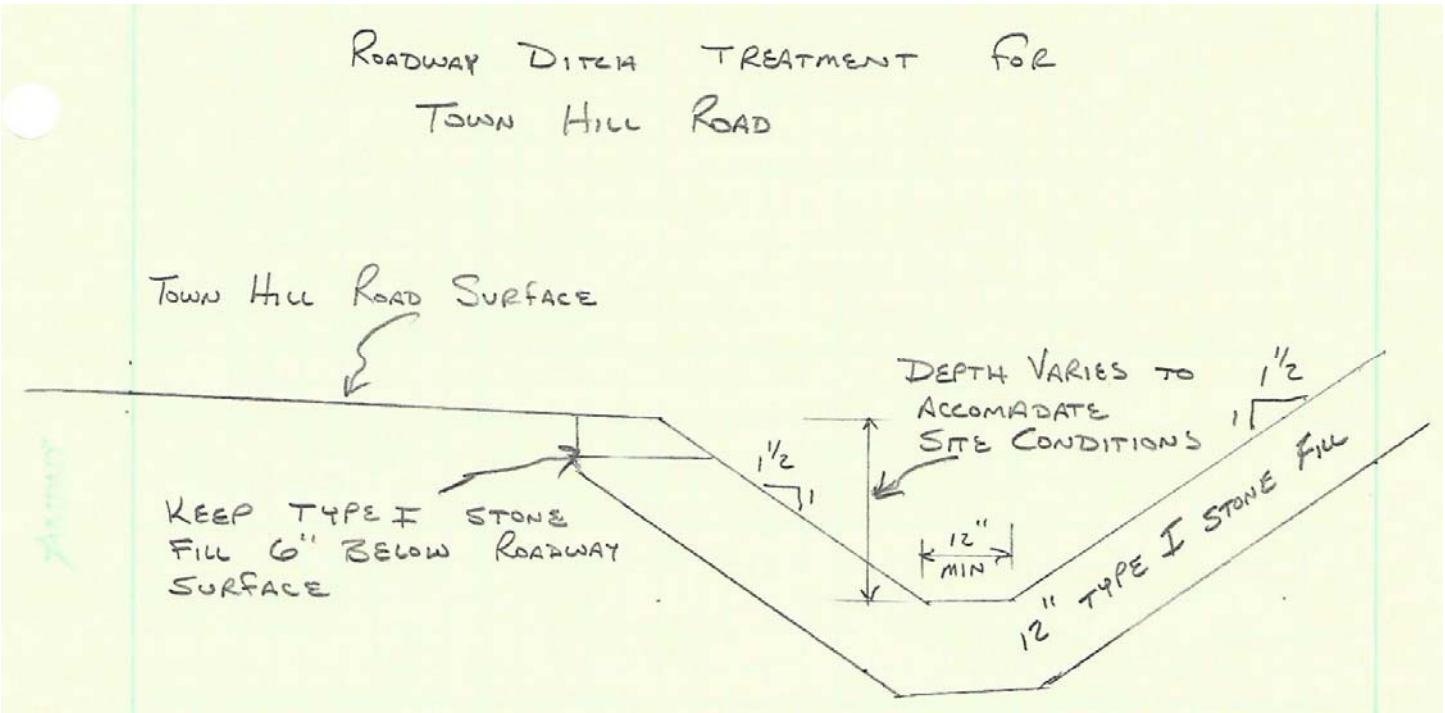
Proposed solution

Stone line approximately 1,100ft of ditch by reshaping the ditch and lining ditch with stone. This project can occur before, in conjunction with, or after the "Long Culvert" project (Site A2). The project will reduce road erosion by reshaping and lining an existing ditch with stone to collect water rather than water travelling along the roadway and/or eroding the road edges. The project will improve water quality as more water will travel through forest and vegetation before reaching a stream, rather than travelling along the road surface directly to the stream at the bottom of the hill.

There is no outlet treatment needed at the end of the stone lined roadway ditch because this water will exit into a well vegetated area for about 150' before it enters into the water course. Therefore no excavation or stone fill is needed. There should be some temporary silt fence installed at the construction limits to prevent any construction runoff. When the new ditch is completed and stabilized, any sediment at the silt fence will be removed and the silt fence will be removed and the area mulched.

Check dams will be installed along the new ditch to slow down the speed of the water. These would be installed as appropriate, but likely one or two above the culvert half way up, and then another 3 or 4 before the turn out.

A coffer dam will be installed on the turn out just at the edge of the ROW so that a sediment pond can be created. This pond would allow water to slow down more, and allow sediment to filter out. During high water events water should be able to travel over the top of the check dam into the turn out, and Solution A3 would also allow for excess water to travel via a culvert.



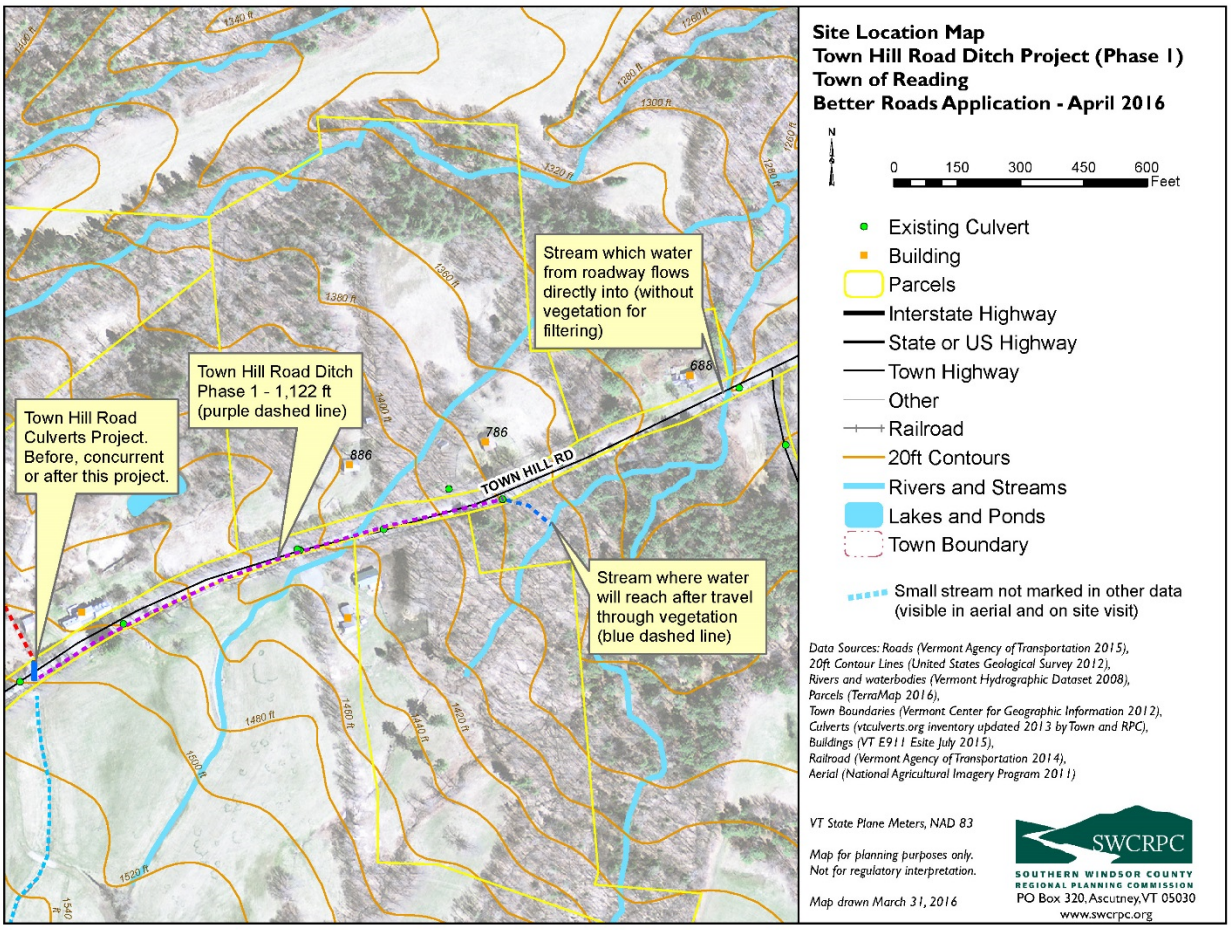
Permits
Alan May visited the site in January 2016 and determined the project does not include road/ river conflicts that require documentation with a River Management Engineer.

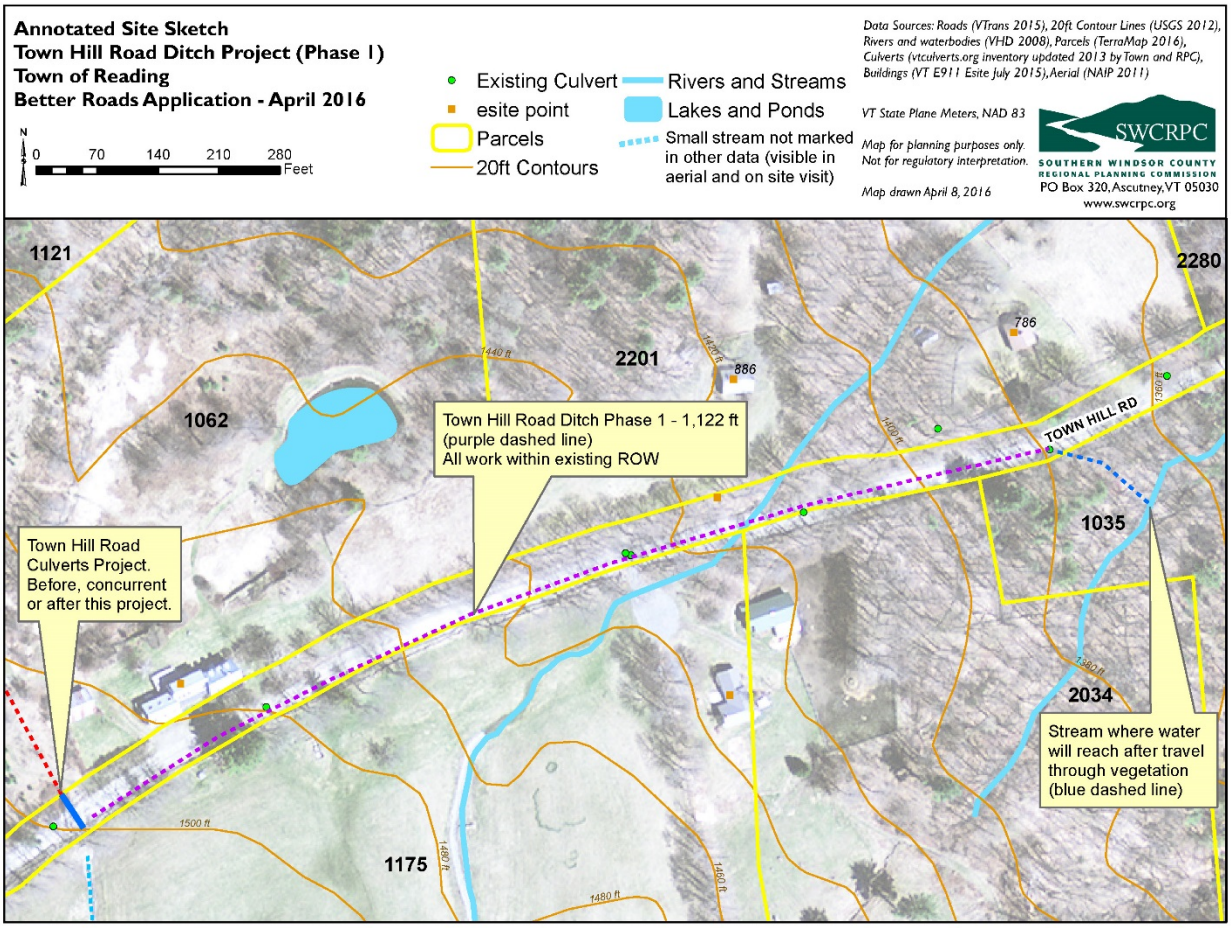
ROW
This solution would be fully within the Town ROW

Cost Estimate
This cost estimate was provided by a contractor in early 2016.

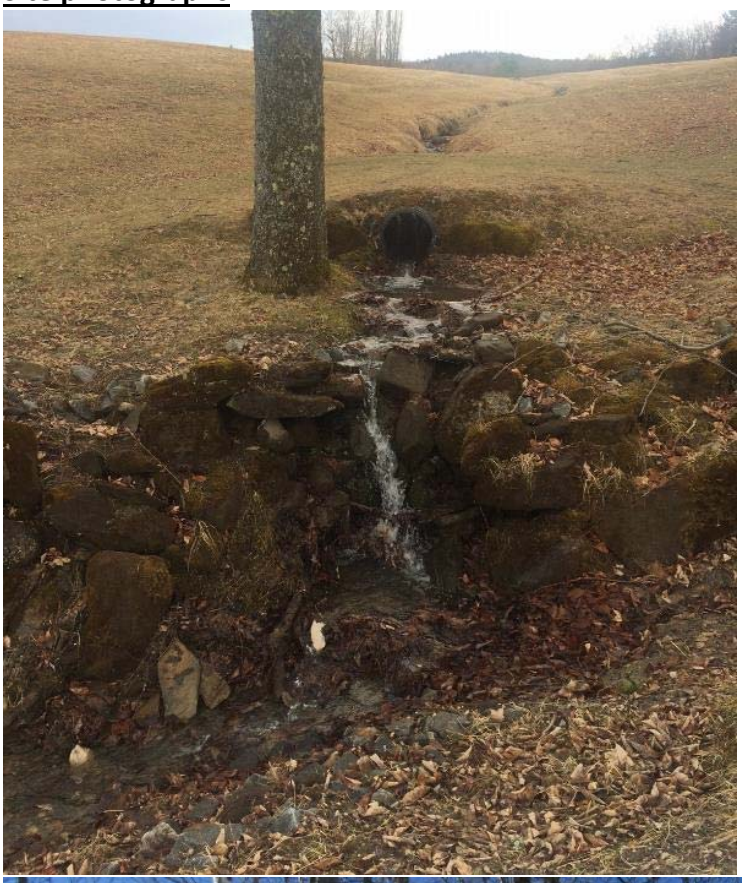
Labor	**Rate**	**# Hours**	**Total (Rate x Hours)**
Contractor Labor	$50.00	35	$1,750
Match - Town Labor	$34.00	91	$3,094
		Labor Total	**$4,844**
Equipment	**Rate**	**# Hours**	**Total (Rate x Hours)**
Contractor Rubber Tired Excavator	$165.00	50	$8,250
Contractor Dump Truck	$90.00	70	$6,300
Contractor Compaction Equipment	$75.00	6	$450
Match - Town Grader	$91.00	16	$1,456
Match - Town Loader	$51.77	8	$414
Match - Town Dump Truck	$43.70	32	$1,398
Match - Town Dump Truck	$35.00	35	$1,225
		Equipment Total	**$19,494**
Materials	**Rate**	**Amount**	**Total (Rate x Amount)**
Silt fence	$100.00	3	$300
Gravel	$15.00	160	$2,400
Rip-rap	$22.00	450	$9,900
Seed and mulch			$400
Match - Town Gravel	$11.50	100	$1,150
		Materials Total	**$14,150**
Miscellaneous	**Rate**	**Amount**	**Total (Rate x Amount)**
Unknown costs for installation of coffer dam			Unknown
		Miscellaneous Total	**Unknown**
		PROJECT TOTAL	**$38,488**
		Total Grant Funds Requested (Maximum award)	**$20,000**
		In-Kind Match	**$7,588**
		Remaining balance after in-kind match - Cash Match	**$12,250**

Maps


Site Location Map
Town Hill Road Ditch Project (Phase 1)
Town of Reading
Better Roads Application - April 2016
0 150 300 450 600 Feet
Existing Culvert
Building
Parcels
Interstate Highway
State or US Highway
Town Highway
Other
Railroad
20ft Contours
Rivers and Streams
Lakes and Ponds
Town Boundary
Small stream not marked in other data (visible in aerial and on site visit)
Stream which water from roadway flows directly into (without vegetation for filtering)
Town Hill Road Ditch Phase 1 - 1,122 ft (purple dashed line)
Town Hill Road Culverts Project. Before, concurrent or after this project.
Stream where water will reach after travel through vegetation (blue dashed line)
TOWN HILL RD
Data Sources: Roads (Vermont Agency of Transportation 2015), 20ft Contour Lines (United States Geological Survey 2012), Rivers and waterbodies (Vermont Hydrographic Dataset 2008), Parcels (TerraMap 2016), Town Boundaries (Vermont Center for Geographic Information 2012), Culverts (vtculverts.org inventory updated 2013 by Town and RPC), Buildings (VT E911 Esite July 2015), Railroad (Vermont Agency of Transportation 2014), Aerial (National Agricultural Imagery Program 2011)
VT State Plane Meters, NAD 83
Map for planning purposes only. Not for regulatory interpretation.
Map drawn March 31, 2016
SWCRPC
SOUTHERN WINDSOR COUNTY REGIONAL PLANNING COMMISSION
PO Box 320, Ascutney, VT 05030
www.swcrpc.org

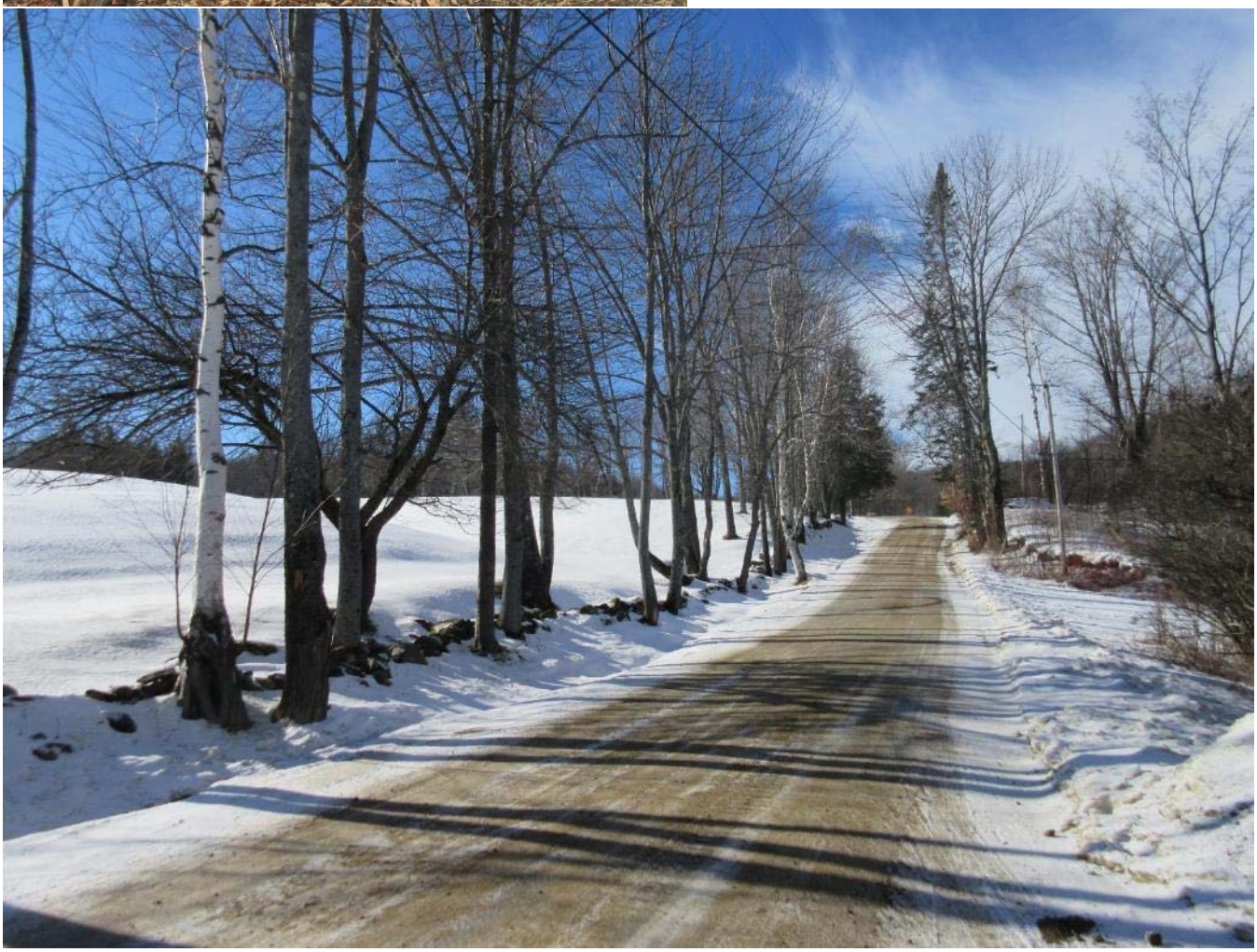

Annotated Site Sketch
Town Hill Road Ditch Project (Phase 1)
Town of Reading
Better Roads Application - April 2016
0 70 140 210 280 Feet
Existing Culvert
esite point
Parcels
20ft Contours
Rivers and Streams
Lakes and Ponds
Small stream not marked in other data (visible in aerial and on site visit)
Data Sources: Roads (VTrans 2015), 20ft Contour Lines (USGS 2012), Rivers and waterbodies (VHD 2008), Parcels (TerraMap 2016), Culverts (vtculverts.org inventory updated 2013 by Town and RPC), Buildings (VT E911 Esite July 2015), Aerial (NAIP 2011)
VT State Plane Meters, NAD 83
Map for planning purposes only. Not for regulatory interpretation.
Map drawn April 8, 2016
SWCRPC
SOUTHERN WINDSOR COUNTY REGIONAL PLANNING COMMISSION
PO Box 320, Ascutney, VT 05030
www.swcrpc.org
1121
2280
2201
1062
1035
2034
1175
Town Hill Road Ditch Phase 1 - 1,122 ft (purple dashed line)
All work within existing ROW
Town Hill Road Culverts Project. Before, concurrent or after this project.
Stream where water will reach after travel through vegetation (blue dashed line)
TOWN HILL RD

Site photographs



Top: Stream and culvert flowing into site. This water level is typical year round and increases dramatically in the smallest of rain storms.

Bottom: Roadway just above where the project will start



Top: Existing ditch where the ditch improvements would start. Photographer is standing at the site where the “Town Hill Road Culverts project” would start.

Bottom: Gullying on ditches further downhill from culvert site


Top left and right: Gullying begins along road

Bottom: Place where ditch turns out to the right into forest. In high water flow water also flows along roadway which turns to the left

Top Left: Red circle is where the turn out begins

Top Right: Turn out which heads into the woods

Bottom: Water from the road stopping in the woodlands

Top and Bottom: Examples of how the road washes out after major storms. This road section was completely washed out in heavy rains in 2009 and 2011, and some portions in 2012 and 2014.

SITE A2 – TOWN HILL ROAD (UPPER SECTION) CULVERTS

See “Site A – Town Hill Road” for description of issue.

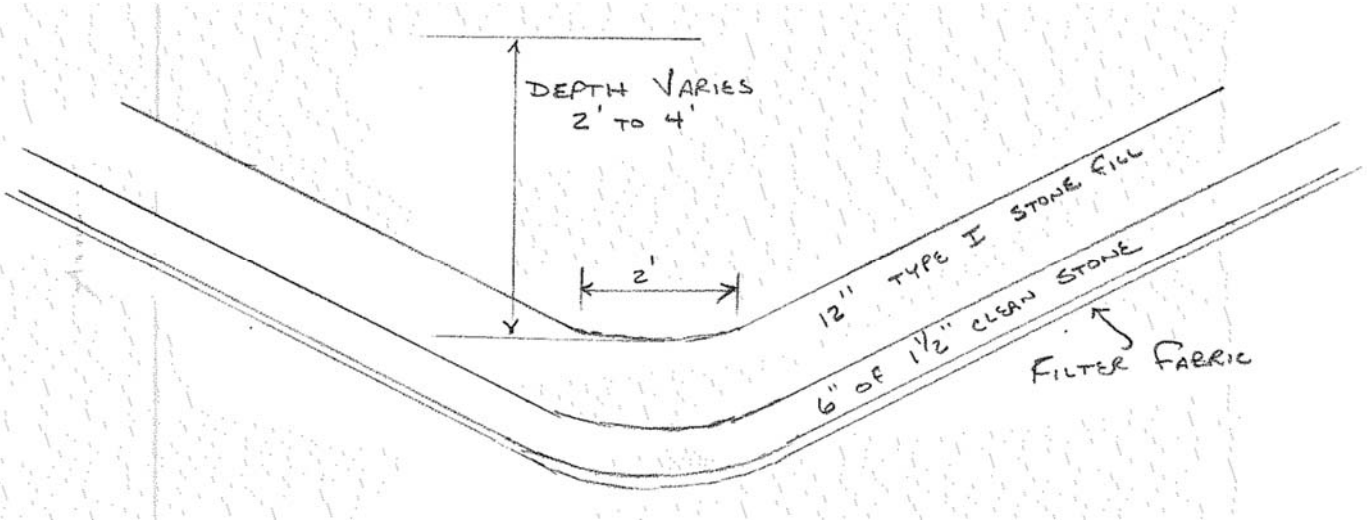
GPS coordinates: N 43.50072 W 72.58359

Status: This project is currently on hold for the foreseeable future. The landowner would not give consent at this time but did not “close the door”. The Town will wait to see how the upgraded ditch outlined in project A1 works before considering asking the landowner again.

Proposed solution

The town plans to install a new long culvert that extends from the ditch on the east side of the road, under the road and then under some private property so the water flows into adjacent forested land. The water flowing into the new culvert will be coming from the stream in the adjacent land, through an existing short culvert, then past a stone wall, and then enter the new town cross-culvert. This project can occur before, in conjunction with, or after the "Town Hill Road Ditch (Phase 1)" project.

The project will reduce road erosion further down Town Hill Road by reducing the amount of water which has to flow down the side of the road. The project will improve water quality as more water will travel through forest and vegetation before reaching a stream. Installing approximately 400ft of culvert will reduce erosion and water quality issues along approximately 1,100ft of road ditch.



Permits

Alan May visited the site in January 2016 and determined the project does not include road/ river conflicts that require documentation with a River Management Engineer.

ROW

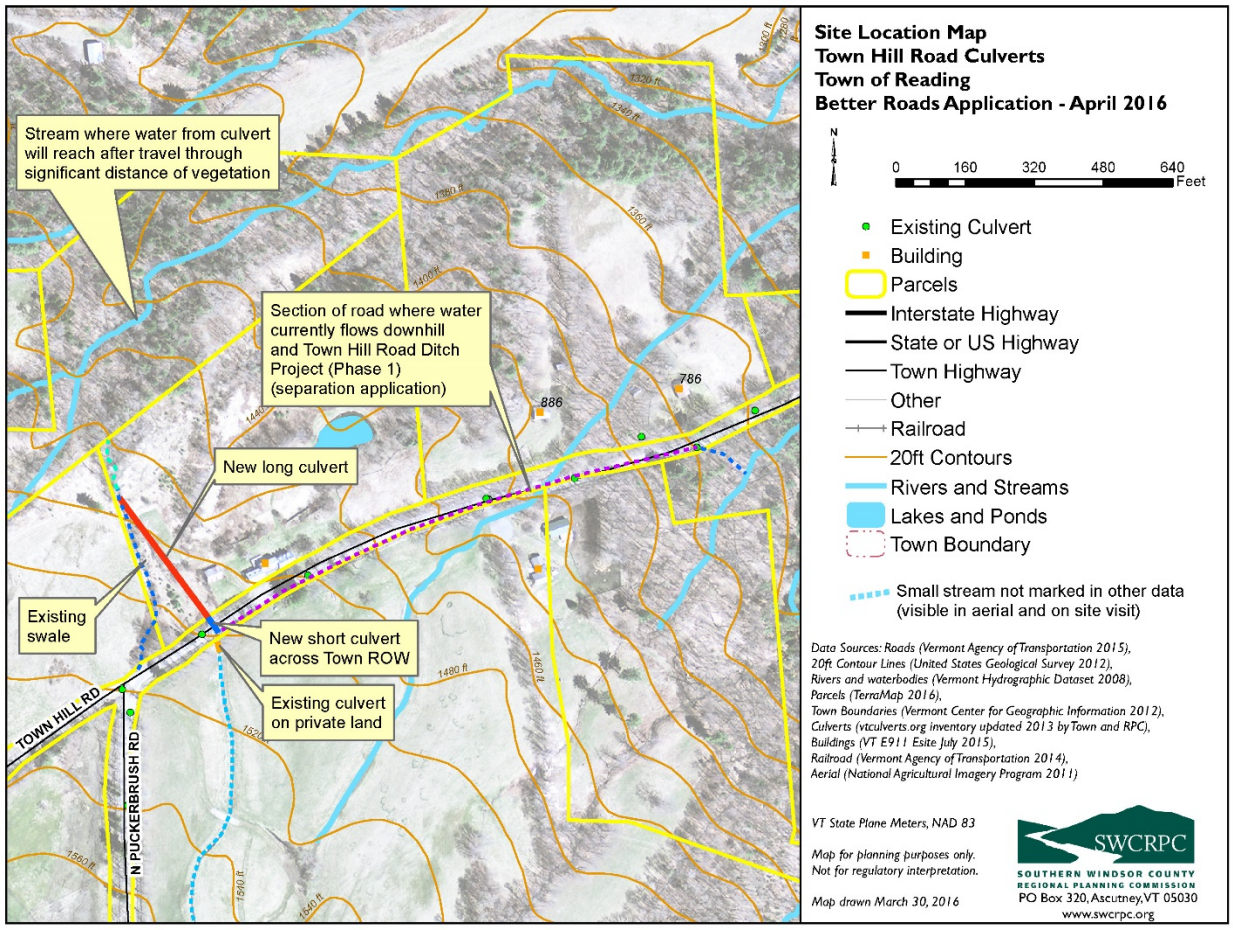
The short new culvert under the roadway would be in Town ROW. The long culvert would be under private property

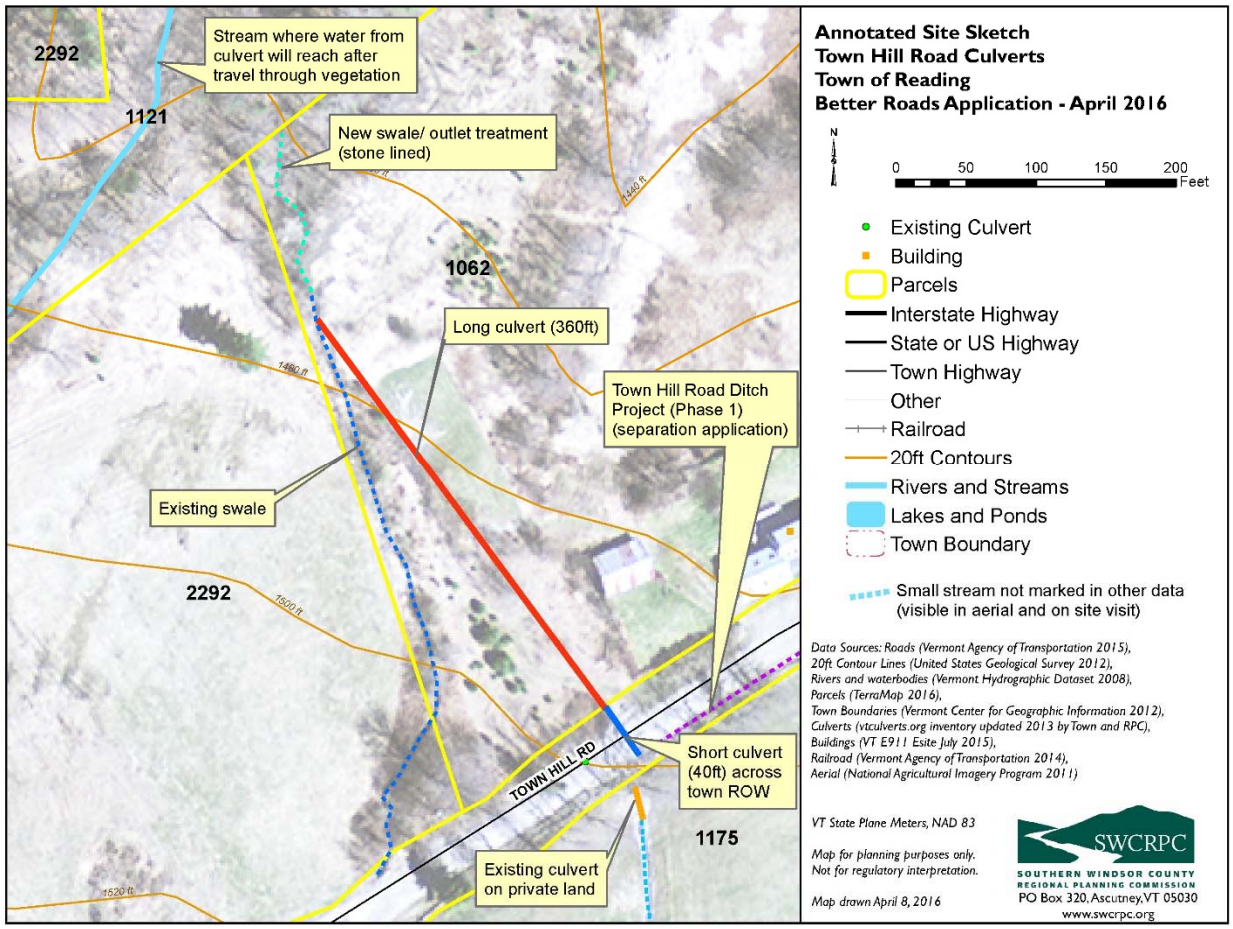
Cost Estimate

This cost estimate was provided by a contractor in early 2016.

Labor	**Rate**	**# Hours**	**Total (Rate x Hours)**
Contractor Labor	$50.00	250	$12,500
Match - Town Labor	$34.00	32	$1,088
		Labor Total	**$13,588**
Equipment	**Rate**	**# Hours**	**Total (Rate x Hours)**
Contractor Rubber Tired Excavator	$165.00	50	$8,250
Contractor Small bulldozer	$120.00	12	$1,440
Contractor Dump Truck	$90.00	40	$3,600
Contractor Compaction Equipment	$75.00	12	$900
Match - Town Grader	$91.00	4	$364
Match - Town Loader	$51.77	1	$52
Match - Town Dump Truck	$43.70	32	$1,398
		Equipment Total	**$16,004**
Materials	**Rate**	**Amount**	**Total (Rate x Amount)**
Concrete, rebar and forms for Culvert Header			$3,500
Gravel	$15.00	130	$1,950
Rip-rap	$22.00	70	$1,540
Seed and mulch			$400
Match - 24" HDPE culvert 400ft long (40ft for town ROW and 140ft for private property)	$19.53	400	$7,812
Match - Town Gravel	$11.50	14	$161
		Materials Total	**$15,363**
Miscellaneous	**Rate**	**Amount**	**Total (Rate x Amount)**
Fence post and wire reinstallation			$1,000
		Miscellaneous Total	**$1,000**
		PROJECT TOTAL	**$45,955**
		Grant funds requested	**$35,080**
		Minimum required match	**$9,191**
		Match	**$10,875**

Maps


Stream where water from culvert will reach after travel through significant distance of vegetation
Section of road where water currently flows downhill and Town Hill Road Ditch Project (Phase 1) (separation application)
New long culvert
Existing swale
New short culvert across Town ROW
Existing culvert on private land
TOWN HILL RD
N PUCKERBRUSH RD
886
786
Site Location Map
Town Hill Road Culverts
Town of Reading
Better Roads Application - April 2016
N
0 160 320 480 640
Feet
Existing Culvert
Building
Parcels
Interstate Highway
State or US Highway
Town Highway
Other
Railroad
20ft Contours
Rivers and Streams
Lakes and Ponds
Town Boundary
Small stream not marked in other data (visible in aerial and on site visit)
Data Sources: Roads (Vermont Agency of Transportation 2015), 20ft Contour Lines (United States Geological Survey 2012), Rivers and waterbodies (Vermont Hydrographic Dataset 2008), Parcels (TerraMap 2016), Town Boundaries (Vermont Center for Geographic Information 2012), Culverts (vtculverts.org inventory updated 2013 by Town and RPC), Buildings (VT E911 Esite July 2015), Railroad (Vermont Agency of Transportation 2014), Aerial (National Agricultural Imagery Program 2011)
VT State Plane Meters, NAD 83
Map for planning purposes only. Not for regulatory interpretation.
Map drawn March 30, 2016
SWCRPC
SOUTHERN WINDSOR COUNTY REGIONAL PLANNING COMMISSION
PO Box 320, Ascutney, VT 05030
www.swcrpc.org

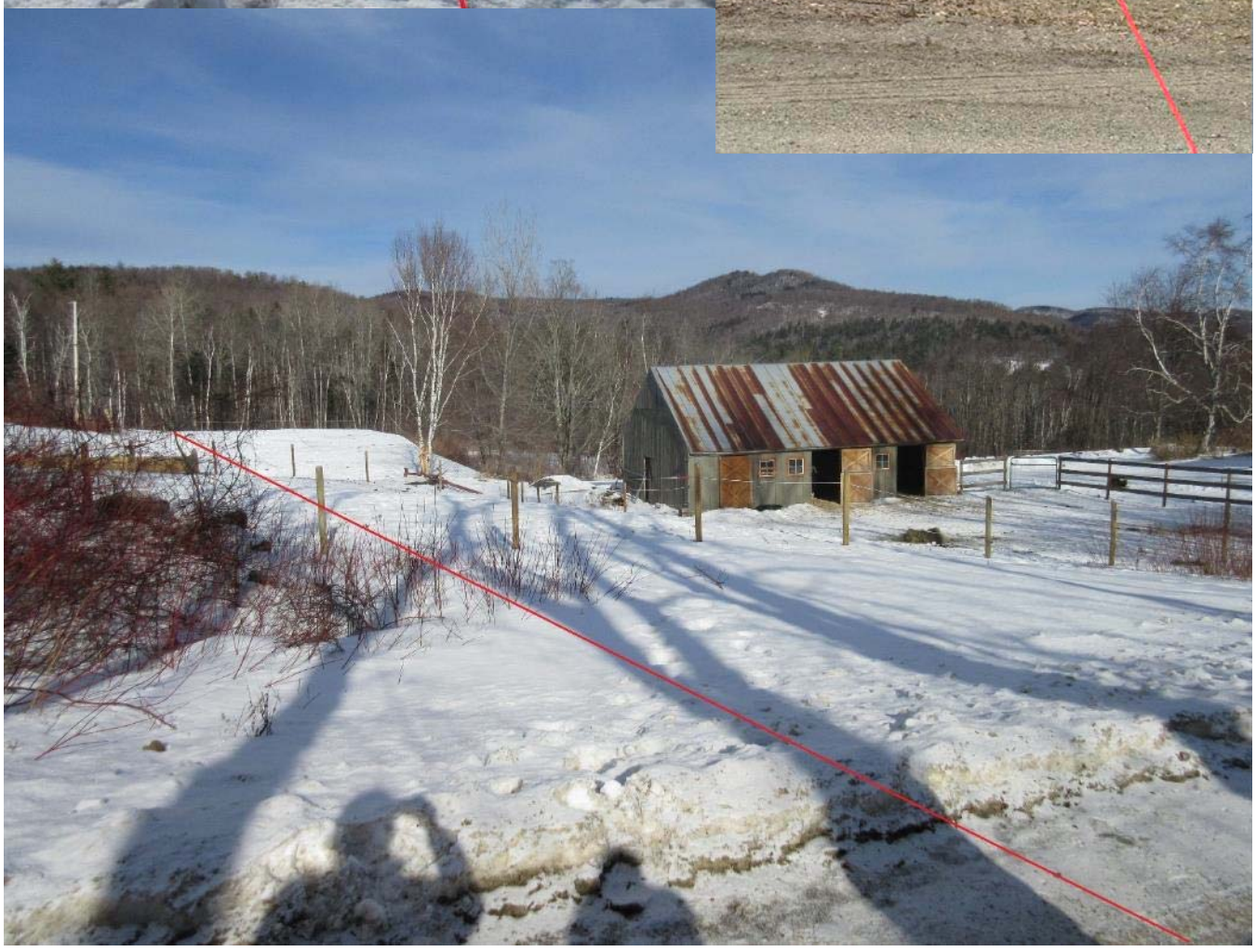

Stream where water from culvert will reach after travel through vegetation
New swale/ outlet treatment (stone lined)
Long culvert (360ft)
Town Hill Road Ditch Project (Phase 1) (separation application)
Existing swale
Short culvert (40ft) across town ROW
Existing culvert on private land
TOWN HILL RD
2292
1121
1062
2292
1175
Annotated Site Sketch
Town Hill Road Culverts
Town of Reading
Better Roads Application - April 2016
N
0 50 100 150 200
Feet
Existing Culvert
Building
Parcels
Interstate Highway
State or US Highway
Town Highway
Other
Railroad
20ft Contours
Rivers and Streams
Lakes and Ponds
Town Boundary
Small stream not marked in other data (visible in aerial and on site visit)
Data Sources: Roads (Vermont Agency of Transportation 2015), 20ft Contour Lines (United States Geological Survey 2012), Rivers and waterbodies (Vermont Hydrographic Dataset 2008), Parcels (TerraMap 2016), Town Boundaries (Vermont Center for Geographic Information 2012), Culverts (vtculverts.org inventory updated 2013 by Town and RPC), Buildings (VT E911 Esite July 2015), Railroad (Vermont Agency of Transportation 2014), Aerial (National Agricultural Imagery Program 2011)
VT State Plane Meters, NAD 83
Map for planning purposes only. Not for regulatory interpretation.
Map drawn April 8, 2016
SWCRPC
SOUTHERN WINDSOR COUNTY REGIONAL PLANNING COMMISSION
PO Box 320, Ascutney, VT 05030
www.swcrpc.org

Site Photographs

For more photos of the context see Site A1

Top: Red line shows approximate location of new ditch relative to roadway and details shown in photograph above

Middle and Bottom: Red line shows approximate location of long culvert over private property



Top: Looking from end of proposed long culvert back to the road (red line shows approximate location of culvert)
Bottom: Existing swale where the culvert will dump into.

SITE A3 – TOWN HILL ROAD (UPPER SECTION) DITCHES PHASE 2

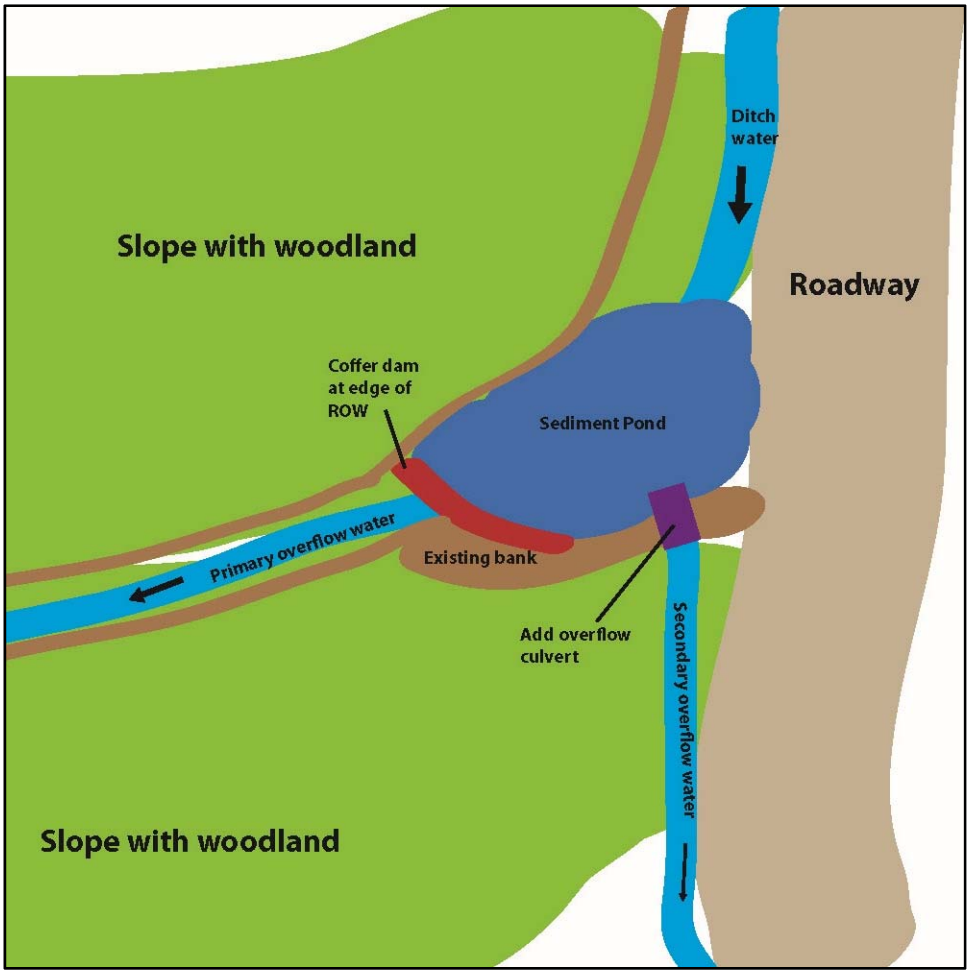
See "Site A – Town Hill Road" for description of issue.

GPS coordinates: N 43.50187 W 72.57923

Proposed solution

This project assumes that the work of project A1 has been completed – particularly the creation of the coffer dam with sediment pond. This project would install a small culvert or spillway/ swale near the top of the check dam to create a secondary place for excess water to flow. This water would flow into a stone lined ditch which would travel approximately 20ft before the next turn out into the woods.

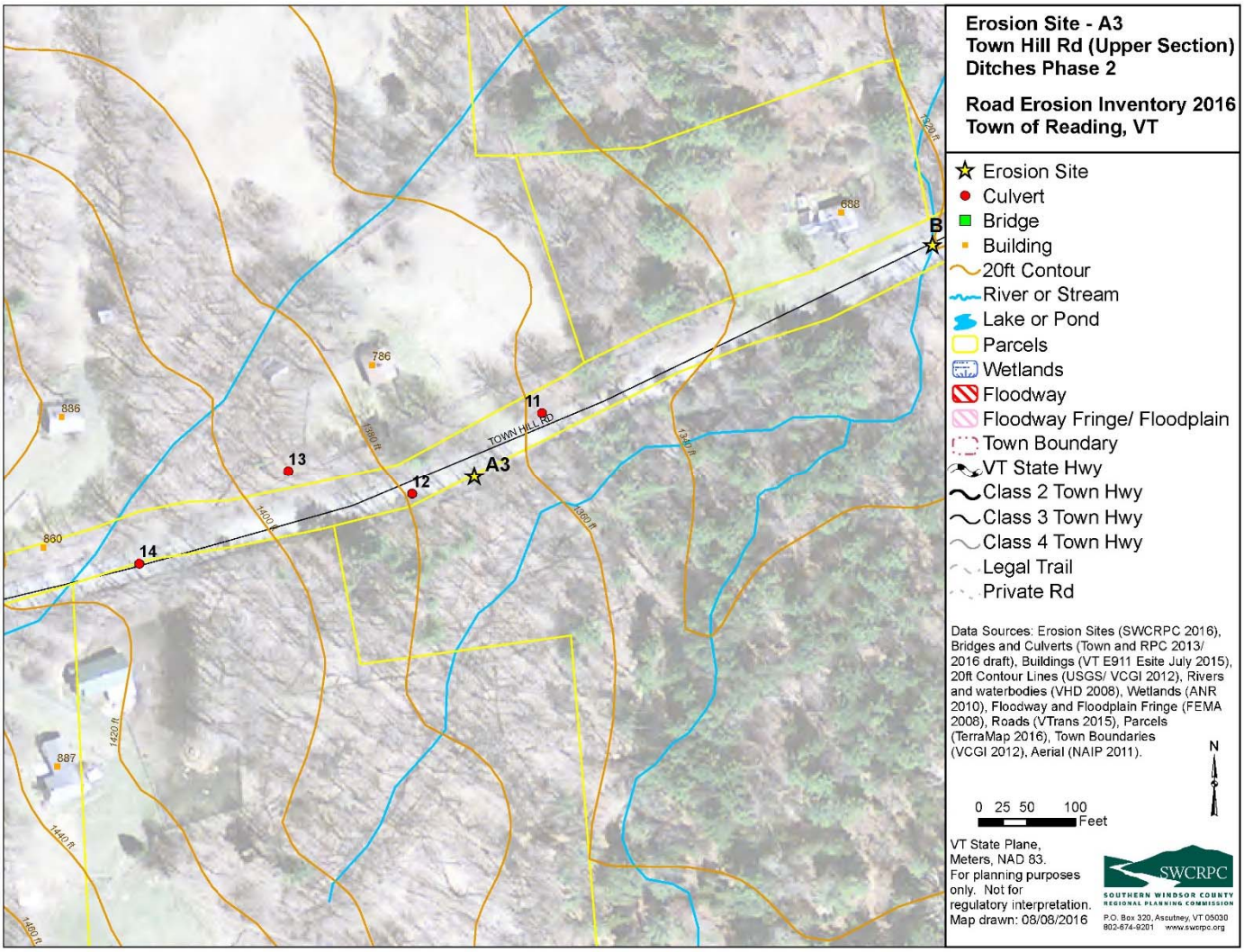
Illustration shows how projects A1 and A3 would interact



Cost Estimate

Costs for this project are unknown as the Town would need a contractor to complete the work.

Maps

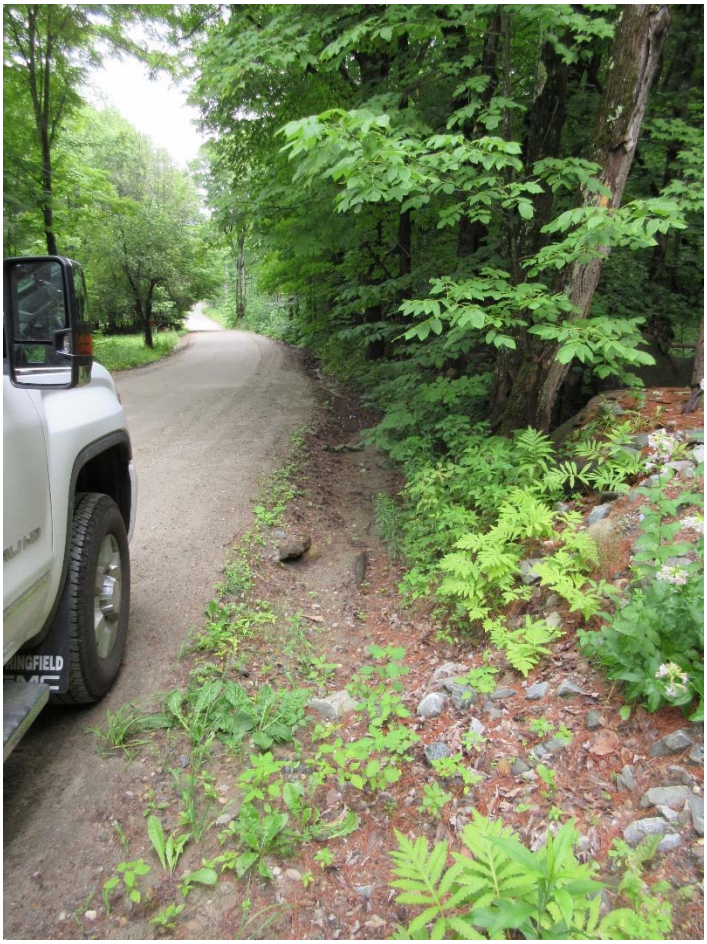

Erosion Site - A3
Town Hill Rd (Upper Section)
Ditches Phase 2
Road Erosion Inventory 2016
Town of Reading, VT
Erosion Site
Culvert
Bridge
Building
20ft Contour
River or Stream
Lake or Pond
Parcels
Wetlands
Floodway
Floodway Fringe/ Floodplain
Town Boundary
VT State Hwy
Class 2 Town Hwy
Class 3 Town Hwy
Class 4 Town Hwy
Legal Trail
Private Rd
Data Sources: Erosion Sites (SWCRPC 2016), Bridges and Culverts (Town and RPC 2013/ 2016 draft), Buildings (VT E911 Esite July 2015), 20ft Contour Lines (USGS/ VCGI 2012), Rivers and waterbodies (VHD 2008), Wetlands (ANR 2010), Floodway and Floodplain Fringe (FEMA 2008), Roads (VTrans 2015), Parcels (TerraMap 2016), Town Boundaries (VCGI 2012), Aerial (NAIP 2011).
N
0 25 50 100
Feet
VT State Plane, Meters, NAD 83.
For planning purposes only. Not for regulatory interpretation.
Map drawn: 08/08/2016
SWCRPC
SOUTHERN WINDSOR COUNTY REGIONAL PLANNING COMMISSION
P.O. Box 320, Ascutney, VT 05030
802-674-9201 www.swcrpc.org
TOWN HILL RD
A3
B
11
12
13
14
786
886
688
860
887
1400 ft
1360 ft
1340 ft
1420 ft
1440 ft
1460 ft

Photographs

Top left: Red dot shows the approximate location for the overflow culvert coming out of the sediment pond. See Site A for photographs of existing site.

Bottom left: Looking down the ditch which would be stone lined and take the secondary water flow from the sediment pond.

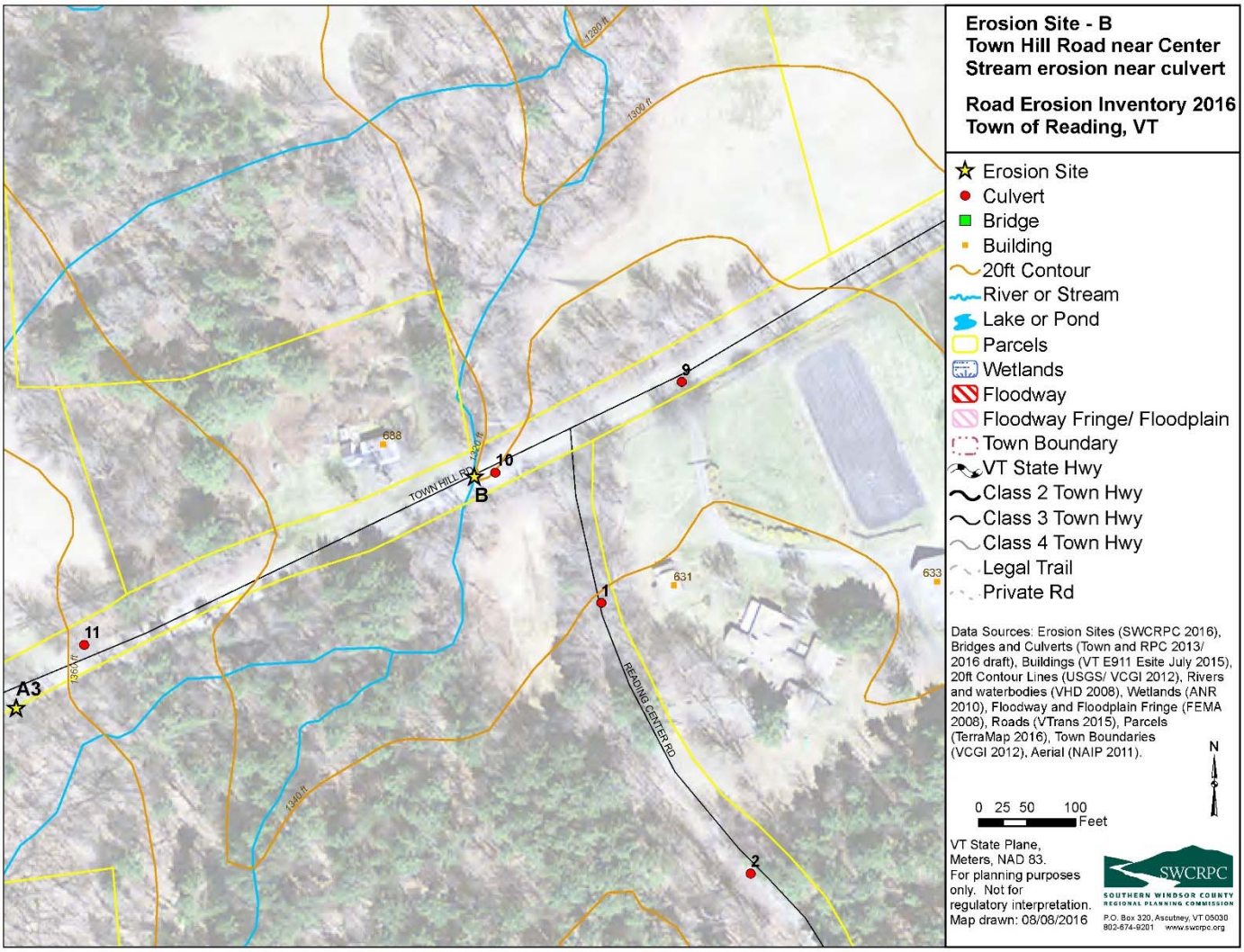
Bottom right: Looking slightly further down the stone lined ditch. The turn out would be approximately where the yellow dot is.



SITE B – TOWN HILL ROAD STREAM EROSION

Road Name: Town Hill Road **TH Number:** 8 **TH Class:** 3
GPS coordinates: N 43.50253 W 72.57744
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: Low

Site Map



Site Visits

- August 2016 – Alan May (Better Roads Program), Bob Allen (Town Selectboard Chair), Glen Towne (Town Road Foreman), Todd Menees (Stream Alteration Engineer), Katharine Otto (SWCRPC), and Chris Yurek (SWCRPC).

Description of problem

Site has undercut streambank erosion as a result of a culvert. This increases downstream erosive force during high flow events, and exacerbates upstream flooding.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?	X			
Erosion problem?		X		
Waterbody affected?	X			
ANR Road Erosion Risk rankings?	X			Low Risk
Further Engineering needed?		X		
Need cost estimates?		X		Small project that can be done by Road Crew
VTrans Hydraulics Study needed?		X		Keep existing culvert
ANR Stream Alteration Permit needed?	X			
Army Corp permission needed?			X	
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?	X			

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown		X	
Ditches non-existent		X	
Ditched not stoned or grass lined		X	
Town culvert less than 18”		X	
Town culvert not hydrologically big enough		X	
Town culvert does not have header	X		
Town culvert end treatment	X		
Town culvert is not stabilized with stone apron, splash pad, etc.	X		
Driveway/private culvert issue		X	
Gully erosion	X		
Road drainage not filtered before entering waterbody	X		
Stream bank	X		

Proposed Solutions

- Downstream end of the culvert should be rip-rapped for stabilization and sediment filtration. Could use concrete blocks
- Build up header

Cost Estimates

The Town Road Foreman estimated time and equipment costs, but could not estimate material amounts. Given the material costs for Site C, total project cost is likely $4,000 - $6,000. For budgeting purposes we will use $6,000.

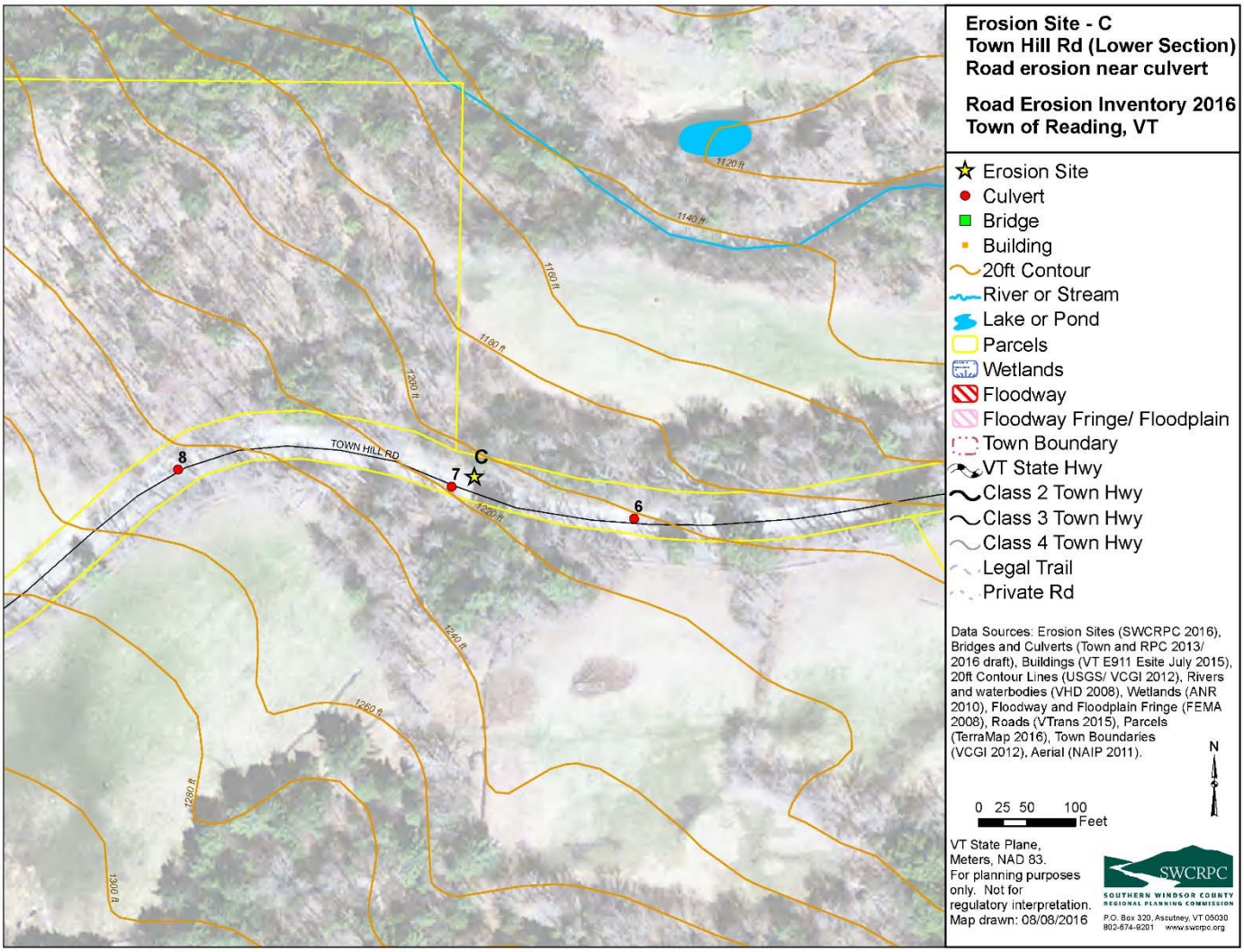
Site Photographs

Downstream end of culvert

SITE C – TOWN HILL ROAD EROSION NEAR CULVERT

Road Name: Town Hill Road **TH Number:** 8 **TH Class:** 3
GPS coordinates: N 43.50398 W 72.57306
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: Low

Site Map



Site Visits

- August 2016 – Alan May (Better Roads Program), Bob Allen (Town Selectboard Chair), Glen Towne (Town Road Foreman), Todd Menees (Stream Alteration Engineer), Marie Caduto (Watershed Coordinator), Katharine Otto (SWCRPC), and Chris Yurek (SWCRPC).

Description of problem

This site has road surface and stream bank erosion around and below a steel culvert. The culvert discharge is leading to severe downhill gullying.

This is a an issue that was created in Tropical Storm Irene – this small section of Town Hill Road was not damaged severely like the remainder of the roadway, but the gullying was caused by the excessive water during the event.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?	X			
Erosion problem?	X			
Waterbody affected?	X			
ANR Road Erosion Risk Ranking?	X			Low Risk
Further engineering needed?		X		
Need cost estimates?	X			
VTrans Hydraulic study needed?	X			Not a marked stream, but meets the criteria for a perennial stream
ANR Stream Alteration Permit needed?	X			
Army Corp permission needed?		X		
MRGP Potentially Hydrologically Connected Road Segment?		X		
Proposed solution fully within Town ROW?			X	

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown		X	
Ditches non-existent		X	
Ditched not stoned or grass lined		X	
Town culvert less than 18”		X	
Town culvert not hydrologically big enough		X	
Town culvert does not have header	X		
Town culvert end treatment	X		
Town culvert is not stabilized with stone apron, splash pad, etc.	X		
Driveway/private culvert issue		X	
Gully erosion	X		
Road drainage not filtered before entering waterbody	X		
Stream bank	X		

Proposed Solutions

- Existing culvert would remain in place since it is good condition
- Build up slope with stone and toe-in the base
- Add a small berm around the top of the slope where the culvert is to stop water flowing straight over side into the water.
- Maybe add a cement lined footer if needed

Note: There is a field just downstream of the gully where the water from the gully disperse before it reaches the major stream. Due to the gully’s proximity to the downhill field, this issue was determined to be a minor water quality impairment.

Estimated Costs

Alan May (VTrans) estimated $3,000-$4,000 to fix using town crew.

The following cost estimate was created by the Town Road Foreman

Labor	**Rate**	**# Hours**	**Total (Rate x Hours)**
Town Road Foreman	$34.00	10	$340.00
Town Road Crew	$19.00	10	$190.00
Traffic Control by Town Crew	$19.00	10	$190.00
		Labor Total	**$720.00**
Equipment	**Rate**	**# Hours**	**Total (Rate x Hours)**
Contractor Excavator	$165.00	10	$1,650.00
Town Dump Truck	$43.70	10	$437.00
		Equipment Total	**$2,087.00**
Materials	**Rate**	**Amount**	**Total (Rate x Amount)**
10 blocks ($50 per block and $400 for trucking			$900.00
Stone (yards)	$16.75	14	$234.50
		Materials Total	$1,134.50
Miscellaneous	**Rate**	**Amount**	**Total (Rate x Amount)**
None			
		Miscellaneous Total	$0.00
		Grand Total	$3,941.50

Site Photographs

Top left and bottom left: Road material flowing into stream next to culvert

Top right: Side view of road material flowing over side of river into culvert

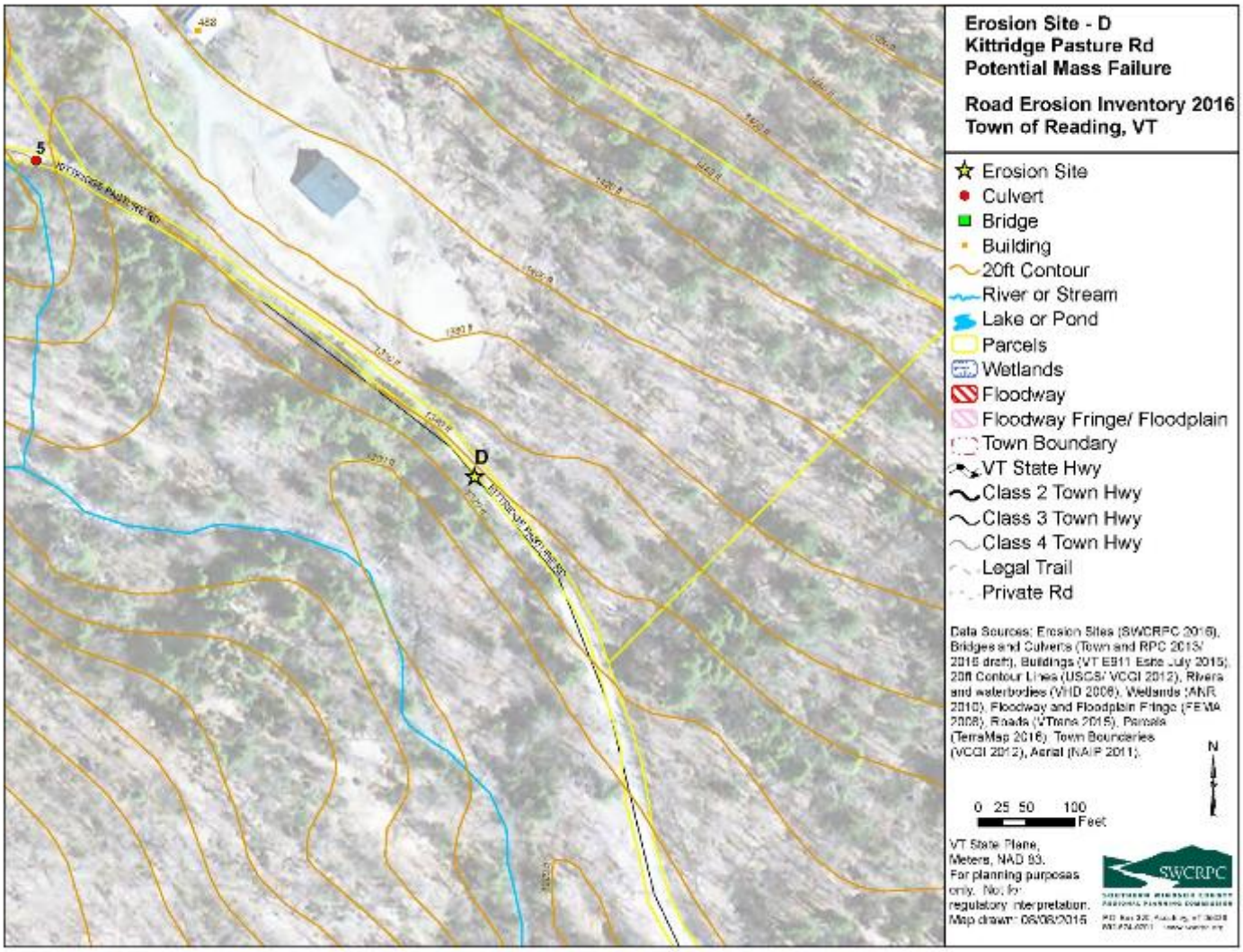
Bottom right: Ditch on other side of road

SITE D – KITTRIDGE PASTURE ROAD POTENTIAL MASS FAILURE

Road Name: Kittridge Pasture Rd **TH Number:** 17 **TH Class:** 3
GPS coordinates: N 43.51189 W 72.58372
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: Monitor only

Project identified in other plans: 2015 Mill Brook River Corridor Plan – Site RE25. Medium hazard mitigation priority. Low ecological benefits priority.

Site Map



Site Visits

- Summer 2014 – Fieldwork for 2015 Mill Brook River Corridor Plan by Fitzgerald Environmental Associates
- August 2016 – Alan May (Better Roads Program), Bob Allen (Town Selectboard Chair), Glen Towne (Town Road Foreman), Todd Menees (Stream Alteration Engineer), Marie Caduto (Watershed Coordinator), Chris Bump and Mike Blakslee (VTrans District 4), Katharine Otto (SWCRPC), and Chris Yurek (SWCRPC).

Description of problem

According to the 2015 Mill Brook River Corridor Plan, "a 80ft tall mass failure is close to threatening Kittridge Pasture Road. It is not possible to stabilize the valley wall, therefore the road should be monitored and potentially moved east if necessary" (page 131).

The August 2016 field visit indicated that the erosion issue at the base of the steep slope is not currently affecting the public ROW. The steep slope appears to be vegetating and currently stable but should be periodically monitored.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?		X		
Erosion problem?	X			But not currently affecting roadway. Erosion caused by stream not roadway.
Waterbody affected?		X		
ANR Road Erosion Risk Ranking?	X			Low Risk
Further engineering needed?	X			If bank further destabilizes
Need cost estimates?	X			
VTrans Hydraulic study needed?	X			Not a marked stream, but meets the criteria for a perennial stream
ANR Stream Alteration Permit needed?	X			
Army Corp permission needed?	X			
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?		X		

Proposed Solutions and Estimated Costs

The 2015 Mill Brook River Corridor Plan suggests "monitoring the mass failure and moving the road if necessary" (page 131). Engineering would be required to determine the solution and costs if the bank destabilizes again.

Site Photographs

Left: Looking uphill along road. Stream is considerably below the roadway at the base of the steep slope
Right: Looking downhill

Stream: Bailey Brook | **Reach:** T4.01.C | **Town:** Reading | **Date Assessed:**08/28/14

Channel Length (ft): 3,743 | Channel Slope (%): 2.1 | **Sinuosity:** 1.1 | **Watershed Area (mi²):** 5.36

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Plane Bed
Median Substrate	Cobble	Cobble
Stream Type	B	D

Ph2 Cross-Section Data

Curve Width (ft)	27.4
Bankfull Width (ft)	46
Max Depth (ft)	2.2
Width/Depth Ratio	42.7
Entrenchment Ratio	2.5
Incision Ratio	1.7

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

# of Other Constrictions:1
# of Grade Controls: 2
# of Beaver Dams: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	26	16
2	86	11
3	13	2
4	45	0
5	8	0
6	6	0
7	-	0
#/mile	259	40

Number of Debris Jams: 9

Step 6/7 Summary

RHA Score/Condition	50/Fair
Habitat Type Departure	Plane Bed
RGA Score / Condition	31/Poor
Dominant Adjustment	Aggradation
CEM Model Stage	D/IIc
Stream Type Departure	B to D
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor Land Cover	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- **Project RE 24:** Buffer Planting - A large mass failure is carving into a hayfield along Kittridge Pasture Rd. Buffer plantings may help slow this process and reduce sediment inputs to the channel.
- **Project RE 25:** Road Stabilization - A large mass failure is potentially threatening Kittridge Pasture Rd. and should be assessed and monitored.

Reach Highlights: This reach also massively widened during TSI, scouring from valley wall to valley wall throughout. Huge volumes of cobbles and gravels were deposited and continue to work through the reach. This segment is very different from T4.01B. However, the ongoing deposition is filling the channel leading to floodplain access and planform adjustment. Some grade control was observed and huge debris jams were also helping to hold the bed in place and allow for aggradation. This widening, aggradation, and planform adjustment led to a B to D departure and an assessment at type IIc.

LWD and huge gravel deposits

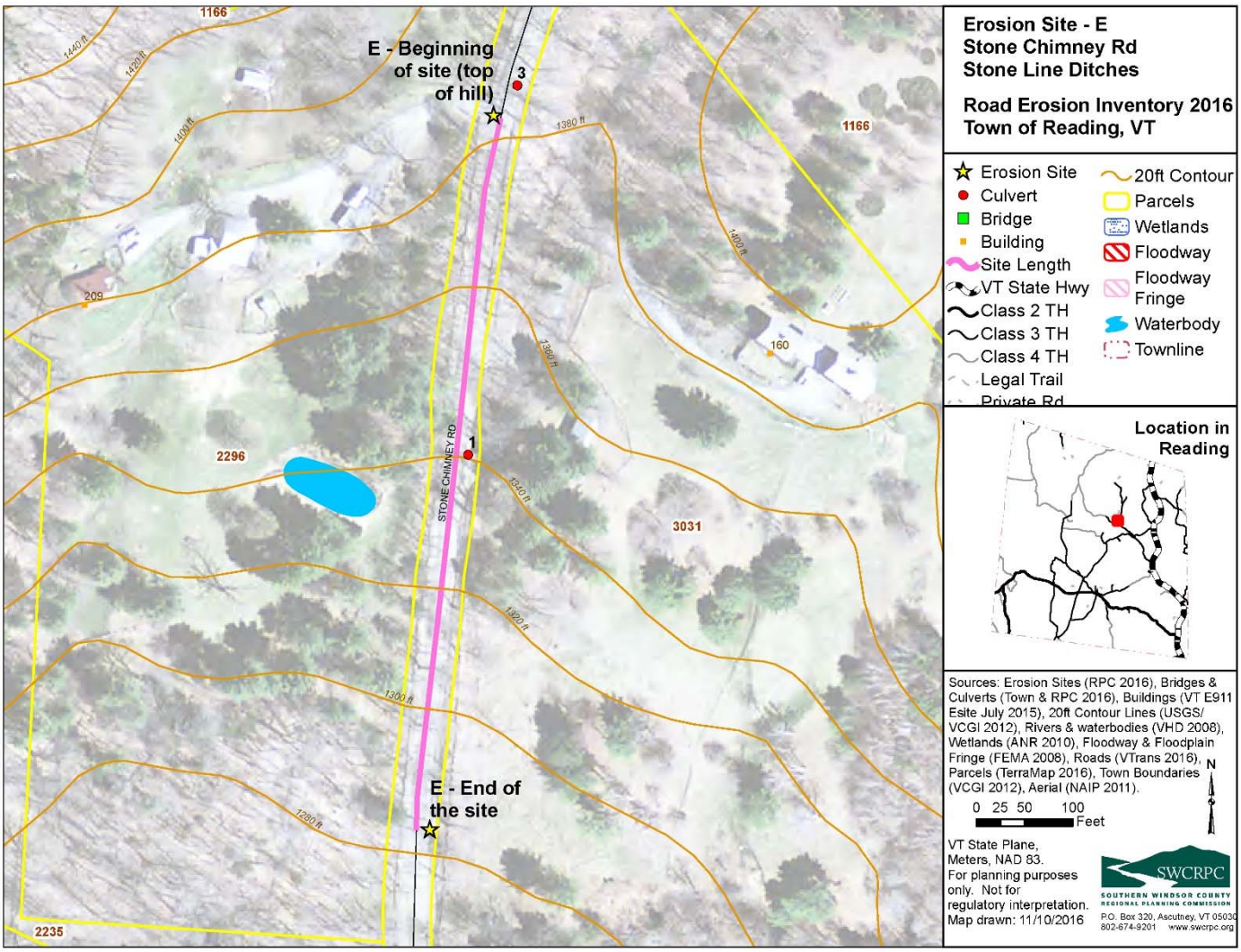
Ongoing widening and erosion/mass failure

SITE E – STONE CHIMNEY ROAD DITCHES NEAR KITTERIDGE PASTURE RD

Road Name: Stone Chimney Road **TH Number:** 18/ 19 **TH Class:** 3
GPS coordinates: From: N 43.51148 W 72.57687 To: N 43.50944 W 72.57711
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: High

This project would be done in conjunction with Sites F and G which are nearby.

Site Map



Site Visits

- August 2016 – Glen Towne (Town Road Foreman), and Chris Yurek (SWCRPC)
- October 2016 – Glen Towne (Town Road Foreman), Mark Bithrow (Town Road Crew), and Katharine Otto (SWCRPC)

Description of problem

This section of roadway between Kitteridge Pasture Road and the driveway of house 209 has a steep gradient and the drainage needs to be improved – the east side of road has a stone line ditch while the west side has a small, unlined ditch.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?	X			
Erosion problem?	X			
Waterbody affected?		X		
ANR Road Erosion Risk Ranking?	X			Medium Risk
Further engineering needed?		X		
Need cost estimates?		X		
VTrans Hydraulic study needed?		X		
ANR Stream Alteration Permit needed?		X		
Army Corp permission needed?		X		
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?	X			

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown		X	
Ditches non-existent		X	
Ditched not stoned or grass lined	X		
Town culvert less than 18”		X	
Town culvert not hydrologically big enough		X	
Town culvert does not have header		X	
Town culvert end treatment		X	
Town culvert is not stabilized with stone apron, splash pad, etc.		X	
Driveway/private culvert issue		X	
Gully erosion		X	
Road drainage not filtered before entering waterbody	X		
Stream bank		X	

Proposed Solutions

- Stone line ditch on the western side of the road – approximately 750 ft from the driveway of house 209 to the last turnout before Kitteridge Pasture Rd

Estimated Costs

The following are three estimates that give an idea of approximate costs. Given the range of estimates, $8,500 seems a reasonable estimate for budgeting purposes.

Estimate 1 - $6,405.70 (Lowest)

Town labor and equipment costs estimated by Town Road Foreman. Amount of stone needed was estimated by SWCRPC using costs from 2015 Chester Road Erosion Report sites that required ditching that were similar in character to Stone Chimney Road (Pleines and Miner Roads).

Labor	Rate	# Hours	Total (Rate x Hours)
Town Road Foreman	$34.00	20	$680.00
Town Road Crew	$19.00	20	$380.00
Traffic Control by Town Crew	$19.00	20	$380.00

		Labor Total	**$1,440.00**
Equipment	**Rate**	**# Hours**	**Total (Rate x Hours)**
Contractor Excavator	$165.00	20	$3,300.00
Town Dump Truck	$43.70	20	$874.00
		Equipment Total	**$4,174.00**
Materials	**Rate**	**Amount**	**Total (Rate x Amount)**
7-9 inch stone	$11.31	70	$791.70
		Materials Total	$791.70
Miscellaneous	**Rate**	**Amount**	**Total (Rate x Amount)**
None			
		Miscellaneous Total	$0.00
		Grand Total	$6,405.70

Estimate 2 - $9,937.50 (Highest)
In 2015 the Town of Chester installed a new ditch line from scratch when they relocated a section of Popple Dungeon Road. Their Town Road Foreman estimated the cost per 100ft of new ditch was approximately $1,325 when stone cost $11.31 per ton. With this estimate in mind, the cost of addressing the ditch issue on Stone Chimney Road could cost up to $9,937.50.

Estimate 3 - $8,520.83 (Middle)
VTrans often use their VTrans Estimating Resources website for cost estimates. The cost estimates "in-place costs" ie the total cost for material, equipment and labor combined. It does not include costs for mobilization/demobilization or traffic control. For this cost estimate the 2 year English average from http://vtrans.vermont.gov/cost-estimating and the FEMA cost estimate for ditch cleaning.

Item	**Unit of Measurement**	**Unit Cost**	**Length**	**Width**	**Depth**	**Volume**	**Cost**
Ditch Cleaning & Shaping	Linear Feet	$3.25	750			750.0	$2,437.50
Stone, Type I	Cubic Yards	$43.80	750	5	1	138.9	$6,083.33
						Total Cost	**$8,520.83**

Site Photographs

Top: Looking down the hill from the top of the site. Ditch to be stone lined is on the right side of the photograph. A stone lined ditch already exists on the left side of the photograph just beyond the small embankment and continues to the bottom of the hill.

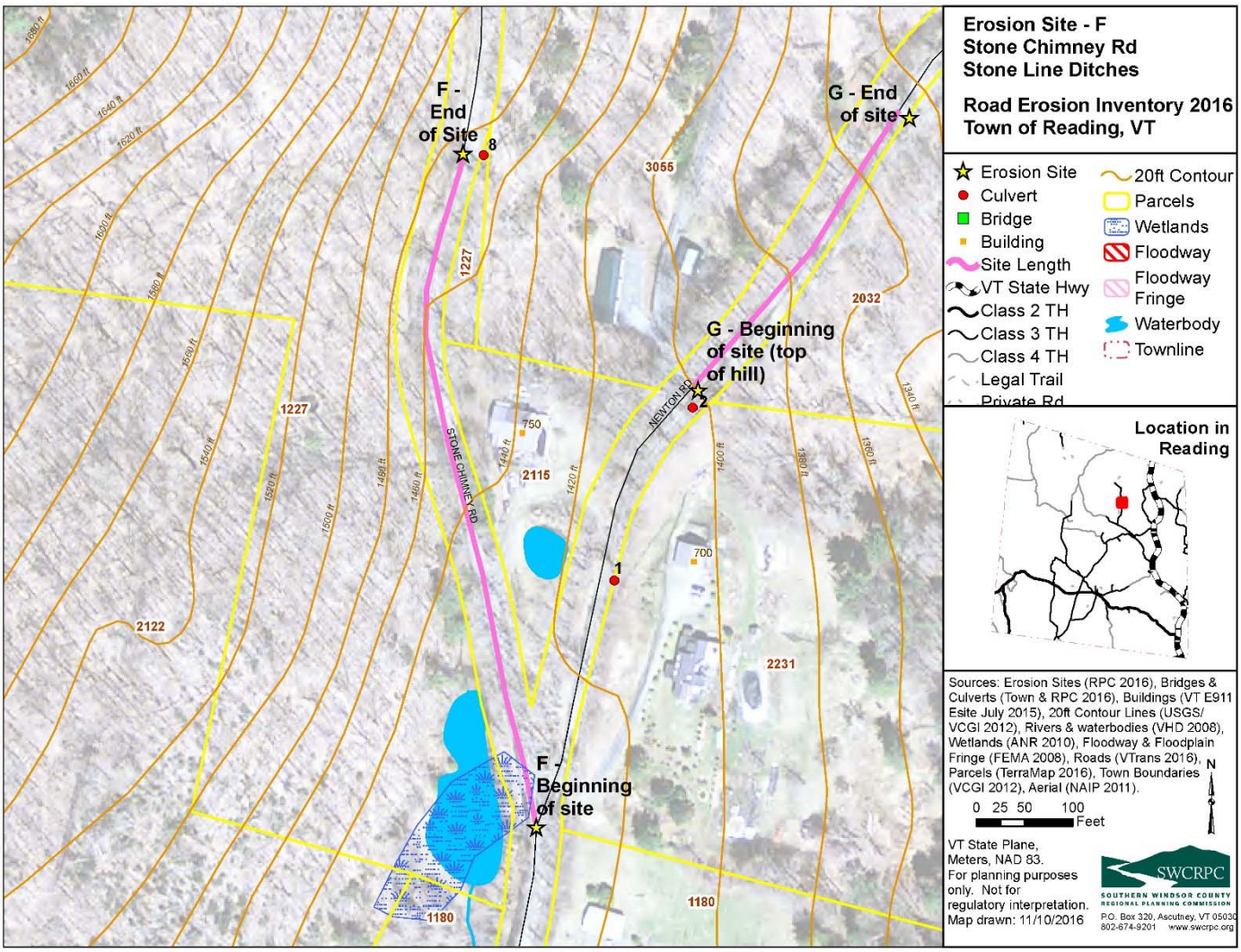
Bottom left: The turn out at the bottom of the site.
Bottom right: The flatter road section just above the site.

SITE F – STONE CHIMNEY ROAD DITCHES NEAR NEWTON RD

Road Name: Stone Chimney Road **TH Number:** 18/ 19 **TH Class:** 3
GPS coordinates: From: N 43.51811 W 72.57390 To: N 43.52003 W 72.57418
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: High

This project would be done in conjunction with Sites E and G which are nearby.

Site Map



Site Visits

- August 2016 – Glen Towne (Town Road Foreman), and Chris Yurek (SWCRPC).
- October 2016 – Glen Towne (Town Road Foreman), Mark Bithrow (Town Road Crew), and Katharine Otto (SWCRPC)

Description of problem

This narrow section of roadway (12ft width) between Newton Road and the crest of the hill has a very steep gradient of approximately 8% and the drainage needs to be improved. There is a steep, yet stable, slope on the east side of the road with good tree and vegetation cover. The west side of the road would benefit from a better ditch.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?	X			
Erosion problem?	X			
Waterbody affected?		X		
ANR Road Erosion Risk Ranking?	X			Medium Risk
Further engineering needed?		X		
Need cost estimates?		X		
VTrans Hydraulic study needed?		X		
ANR Stream Alteration Permit needed?		X		
Army Corp permission needed?		X		
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?	X			

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown		X	
Ditches non-existent		X	
Ditched not stoned or grass lined	X		
Town culvert less than 18"		X	
Town culvert not hydrologically big enough		X	
Town culvert does not have header		X	
Town culvert end treatment		X	
Town culvert is not stabilized with stone apron, splash pad, etc.		X	
Driveway/private culvert issue		X	
Gully erosion		X	
Road drainage not filtered before entering waterbody	X		
Stream bank		X	

Proposed Solutions

- Stone line the ditch on the western side of the road from Newton Road to the top of the main slope where the ledge starts.

Estimated Costs

Note: Traffic control is not needed at this location as there are only 3 residents beyond this site.

The following are three estimates of cost that give an idea of approximate costs. Cost estimates vary greatly – from a low of $3,352 to a high of $9,540. The town did estimate that costs would be less – just one day of labor, rather than the two needed at the other section of Stone Chimney Road. For the purposes of budgeting we will use an average estimate of about $6,500.

Estimate 1 - $3,352 (Lowest)

Town labor and equipment costs estimated by Town Road Foreman. Amount of stone needed was estimated by SWCRPC using costs from 2015 Chester Road Erosion Report sites that required ditching that were similar in character to Stone Chimney Road (Pleines and Miner Roads).

Labor	Rate	# Hours	Total (Rate x Hours)
Town Road Foreman	$34.00	10	$340.00
Town Road Crew	$19.00	10	$190.00
		Labor Total	**$530.00**
Equipment	**Rate**	**# Hours**	**Total (Rate x Hours)**
Contractor Excavator	$165.00	10	$1,650.00
Town Dump Truck	$43.70	10	$437.00
		Equipment Total	**$2,087.00**
Materials	**Rate**	**Amount**	**Total (Rate x Amount)**
7-9 inch stone	$11.31	65	$735.15
		Materials Total	$735.15
Miscellaneous	**Rate**	**Amount**	**Total (Rate x Amount)**
None			
		Miscellaneous Total	$0.00
		Grand Total	$3,352.15

Estimate 2 - $9,540 (Highest)
In 2015 the Town of Chester installed a new ditch line from scratch when they relocated a section of Popple Dungeon Road. Their Town Road Foreman estimated the cost per 100ft of new ditch was approximately $1,325 when stone cost $11.31 per ton. With this estimate in mind, the cost of addressing the ditch issue on Stone Chimney Road could cost up to $9,540.00.

Estimate 3 - $7,012 (Middle)
VTrans often use their VTrans Estimating Resources website for cost estimates. The cost estimates "in-place costs" ie the total cost for material, equipment and labor combined. It does not include costs for mobilization/demobilization or traffic control. For this cost estimate the 2 year English average from http://vtrans.vermont.gov/cost-estimating and the FEMA cost estimate for ditch cleaning.

Given the narrow road, the "width" of stone has been decreased from 5ft to 4ft.

Item	Unit of Measurement	Unit Cost	Length	Width	Depth	Volume	Cost
Ditch Cleaning & Shaping	Linear Feet	$3.25	720			720.0	$2,340.00
Stone, Type I	Cubic Yards	$43.80	720	4	1	106.7	$4,672.00
						Total Cost	**$7,012.00**

Site Photographs

Top: Stone Chimney Road from near Newton Road intersection. Left side of photo is the west side which needs improved ditches. Right side of photo is the steep, yet stable, bank with good tree and vegetation cover.

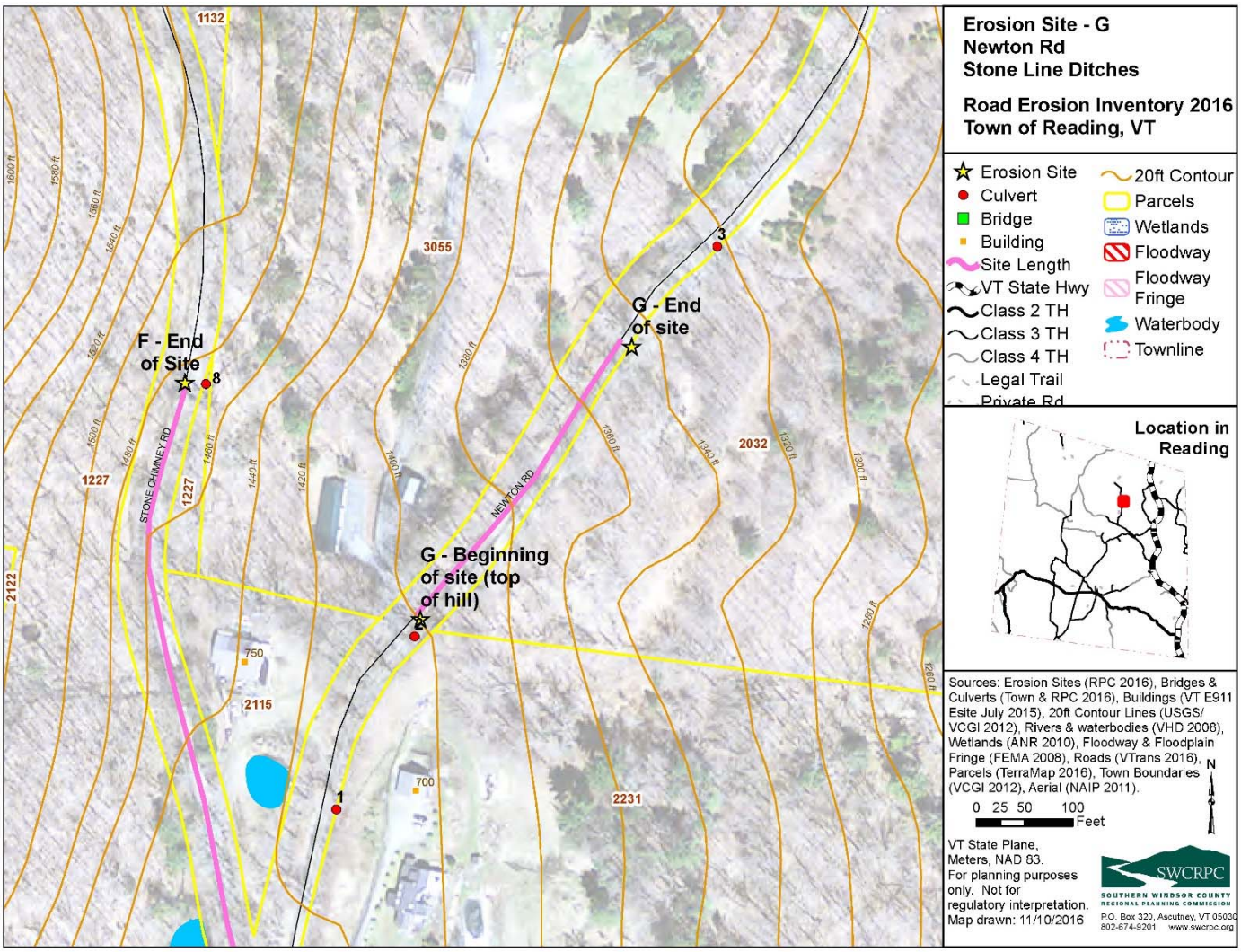
Bottom: Stone Chimney Road near the top of the site, clearly showing the top of the main slope. The ditch that needs improvement is on the left side of the photograph.

SITE G – NEWTON ROAD STONE LINE DITCHES

Road Name: Newton Road **TH Number:** 18 **TH Class:** 3
GPS coordinates: From: N 43.51936 W 72.57326 To: N43.52014 W 72.57244
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: High

This project would be done in conjunction with Sites E and F which are nearby.

Site Map



Site Visits

- August 2016 – Glen Towne (Town Road Foreman), and Chris Yurek (SWCRPC).
- October 2016 – Glen Towne (Town Road Foreman), Mark Bithrow (Town Road Crew), and Katharine Otto (SWCRPC)

Description of problem

This section of roadway from the top of the hill just beyond Stone Chimney Road to the driveway of house 77 has a steep gradient and the drainage needs to be improved. There are currently 8 small turnouts along this section of road, but a better ditch would help with drainage.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?	X			
Erosion problem?	X			
Waterbody affected?		X		
ANR Road Erosion Risk Ranking?	X			Medium Risk
Further engineering needed?		X		
Need cost estimates?		X		
VTrans Hydraulic study needed?		X		
ANR Stream Alteration Permit needed?		X		
Army Corp permission needed?		X		
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?	X			

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown		X	
Ditches non-existent		X	
Ditched not stoned or grass lined	X		
Town culvert less than 18"		X	
Town culvert not hydrologically big enough		X	
Town culvert does not have header		X	
Town culvert end treatment		X	
Town culvert is not stabilized with stone apron, splash pad, etc.		X	
Driveway/private culvert issue		X	
Gully erosion		X	
Road drainage not filtered before entering waterbody	X		
Stream bank		X	

Proposed Solution

- Stone line approximately 360 feet of ditch on the western side of the road from Stone Chimney Road to house 77.
- Keep existing small turn outs along east side of road which help keep water flowing off the roadway.

Estimated Costs

Note: Traffic control is not needed at this location as there are few residents beyond this site.

The following are three estimates of cost that give an idea of approximate costs. Cost estimates vary greatly – from a low of $3,013 to a high of $4,770. The town did estimate that costs would be less – just one day of labor, rather than the two needed at the other section of Stone Chimney Road. For the purposes of budgeting we will use an estimate of about $4,000.

Estimate 1 - $3,013 (Lowest)

Town labor and equipment costs estimated by Town Road Foreman. Amount of stone needed was estimated by SWCRPC using costs from 2015 Chester Road Erosion Report sites that required ditching that were similar in character to Stone Chimney Road (Pleines and Miner Roads).

Labor	Rate	# Hours	Total (Rate x Hours)
Town Road Foreman	$34.00	10	$340.00
Town Road Crew	$19.00	10	$190.00
		Labor Total	**$530.00**
Equipment	**Rate**	**# Hours**	**Total (Rate x Hours)**
Contractor Excavator	$165.00	10	$1,650.00
Town Dump Truck	$43.70	10	$437.00
		Equipment Total	**$2,087.00**
Materials	**Rate**	**Amount**	**Total (Rate x Amount)**
7-9 inch stone	$11.31	35	$395.85
		Materials Total	$395.85
Miscellaneous	**Rate**	**Amount**	**Total (Rate x Amount)**
None			
		Miscellaneous Total	$0.00
		Grand Total	$3,012.85

Estimate 2 - $4,770 (Highest)
In 2015 the Town of Chester installed a new ditch line from scratch when they relocated a section of Popple Dungeon Road. Their Town Road Foreman estimated the cost per 100ft of new ditch was approximately $1,325 when stone cost $11.31 per ton. With this estimate in mind, the cost of addressing the ditch issue on Stone Chimney Road could cost up to $4,770.00.

Estimate 3 - $3,506 (Middle)
VTrans often use their VTrans Estimating Resources website for cost estimates. The cost estimates "in-place costs" ie the total cost for material, equipment and labor combined. It does not include costs for mobilization/demobilization or traffic control. For this cost estimate the 2 year English average from http://vtrans.vermont.gov/cost-estimating and the FEMA cost estimate for ditch cleaning.

Given the narrow road, the "width" of stone has been decreased from 5ft to 4ft.

Item	Unit of Measurement	Unit Cost	Length	Width	Depth	Volume	Cost
Ditch Cleaning & Shaping	Linear Feet	$3.25	360			360.0	$1,170.00
Stone, Type I	Cubic Yards	$43.80	360	4	1	53.3	$2,336.00
						Total Cost	**$3,506.00**

Site Photographs

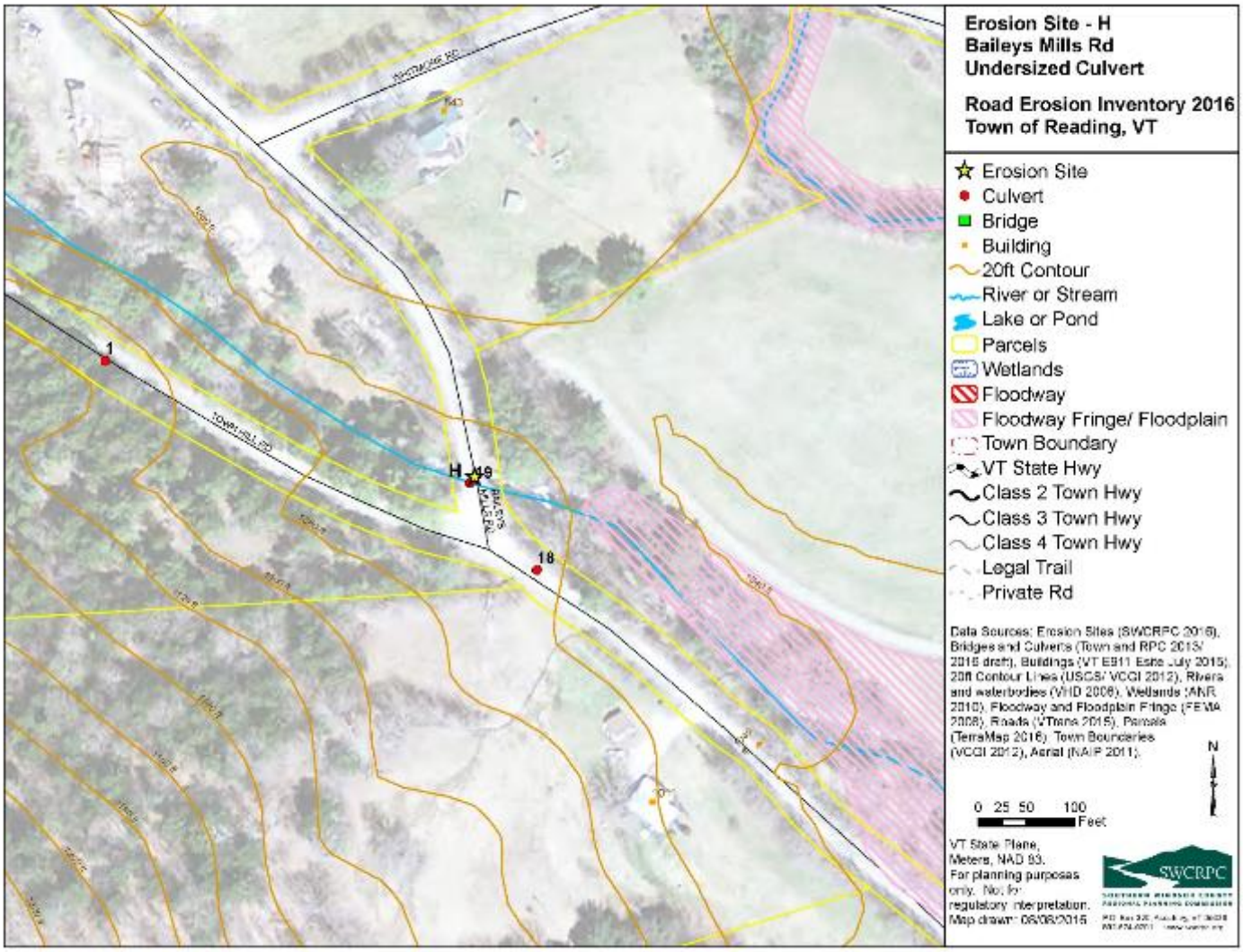
Top: Site from halfway down hill. Existing turnouts on east side of road (right side of photograph). Left side needs improved ditching.
Bottom Left: Looking up hill just above where site would start
Bottom Right: Turn out on west side of the road which would mark the bottom of the new ditchline.

SITE H – BAILEYS MILLS ROAD UNDERSIZED CULVERT

Road Name: Baileys Mills Road **TH Number:** 8/ 9 **TH Class:** 3
GPS coordinates: N 43.50220 W 72.56552
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: Low

Project identified in other plans: 2015 Mill Brook River Corridor Plan – Site RE20. High hazard mitigation priority. Low ecological benefits priority.

Site Map



Site Visits

- Summer 2014 – Fieldwork for 2015 Mill Brook River Corridor Plan by Fitzgerald Environmental Associates
- August 2016 – Alan May (Better Roads Program), Bob Allen (Town Selectboard Chair), Glen Towne (Town Road Foreman), Todd Menees (Stream Alteration Engineer), Marie Caduto (Watershed Coordinator), Katharine Otto (SWCRPC), and Chris Yurek (SWCRPC).

Description of problem

According to the 2015 Mill Brook River Corridor, the existing arch culvert is "installed on a bedrock grade control and represents a moderate constriction (69%) based on reference width. However the current channel width in the segment varies from 40 to 50 feet. The channel is situated on an alluvial fan and has a massive upstream sediment load. The arch led to increased flooding and sediment deposition during Tropical Storm Irene" (Page 129).

This culvert survived Tropical Storm Irene, although water did flow around the culvert, thereby destroying the road next to it (primarily due to debris dam upstream). Culvert has been at this location since before 1973 and survived that storm too. Culvert is at least 40 years old and approximately halfway through its useful life.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?		X		
Erosion problem?	X			
Waterbody affected?	X			
ANR Road Erosion Risk Ranking?	X			Low Risk
Further engineering needed?	X			
Need cost estimates?	X			
VTrans Hydraulic study needed?	X			
ANR Stream Alteration Permit needed?	X			
Army Corp permission needed?	X			
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?			X	

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown		X	
Ditches non-existent		X	
Ditched not stoned or grass lined		X	
Town culvert less than 18"		X	
Town culvert not hydrologically big enough	X		
Town culvert does not have header		X	
Town culvert end treatment		X	
Town culvert is not stabilized with stone apron, splash pad, etc.		X	
Driveway/private culvert issue		X	
Gully erosion		X	
Road drainage not filtered before entering waterbody	X		
Stream bank		X	

Proposed Solutions

- Increase size of culvert/ install a bridge.
- The Town would like to see the downstream Agony Hill Road Culvert upsized before they resolve this issue – otherwise the increased water flow during high-water events would cause issues there instead.

The 2015 Mill Brook River Corridor suggests "alternatives analysis to reconstruct a channel with sufficient width to accommodate the ongoing sediment load, removing berms to reconnect floodplains, install

floodplain benches for additional storage, and plant area with rigorous native vegetation. Dead trees could be cut and used for log structures within the reach to sediment/ debris capture and improve habitat" (page 129). This would "increase sediment storage capacity, restore floodplain access, and reduce risk of catastrophic damage during the next large flood" (page 129).

Estimated Costs

The 2012 Mill Brook River Corridor Plan estimated the cost of replacement to be $350,000. Would need scoping and engineering before proceeding.

Site Photographs

Top: Culvert from intersection of Baileys Mills Road and Town Hill Road

Top: Upstream end of culvert

Bottom: Stream out of equilibrium upstream from the undersized culvert. Majority of the debris and damage due to heavy water flows during Tropical Storm Irene.

Stream: Bailey Brook | **Reach:** T4.01.A | **Town:** Reading | **Date Assessed:**08/28/14

Channel Length (ft): 2,130 | Channel Slope (%): 2.1 | **Sinuosity:** 1.1 | **Watershed Area (mi²):** 5.36

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Broad	Broad
Bedform	Riffle-Pool	Braided
Median Substrate	Gravel	Gravel
Stream Type	C_b	D

Ph2 Cross-Section Data

Curve Width (ft)	27.4
Bankfull Width (ft)	45.9
Max Depth (ft)	3
Width/Depth Ratio	41.7
Entrenchment Ratio	1.2
Incision Ratio	1.2

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
A	Baileys Rd	70%	D, R/R, S
B	Private	74%	D, E, S

# of Other Constrictions:0
# of Grade Controls: 1
# of Beaver Dams: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	10	5
2	7	3
3	2	0
4	5	2
5	0	0
6	0	0
7	-	0
#/mile	59	24

Number of Debris Jams: 2

Step 6/7 Summary

RHA Score/Condition	40/Fair
Habitat Type Departure	Braided
RGA Score / Condition	21/Poor
Dominant Adjustment	Aggradation
CEM Model Stage	D/IId
Stream Type Departure	B to D
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor Land Cover	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- **Project RE 19:** Bank Stabilization - Two areas of major bank erosion are threatening the Smith property driveway and potentially utilities.
- **Project RE 20:** Arch Replacement - The Baileys Mills Road arch is undersized and increased deposition and scour during T.S. Irene.
- **Project RE 21:** Channel and Floodplain Restoration - The floodplain and channel upstream of the arch were buried in sediment and debris during T.S. Irene, floodplain is now largely inaccessible.

Reach Highlights: Severe vertical and lateral adjustments throughout reach due to alluvial fan setting, undersized crossing, and post-flood recovery work that left channel prone to ongoing erosion. In lower segment below Bailey's Mills Road, entrenchment ratios are <2.0 due to severe channel widening. Upstream of Bailey's Mills Road, some berms left from flood recovery work are confining flood flows. Stream type departure varies between C->D and C->F depending on limits of berming. D-type departure chosen due to severe aggradation and braiding throughout, and presence of grade controls.

Widening, deposition, and severe erosion

Widening, deposition, and severe erosion

Projects RE 20 and RE 21 – Bailey Brook Alluvial Fan Restoration and Flood Mitigation

Bailey Brook flows out of steep, mountainous terrain and reaches a significant transition point near the intersection of Baileys Mills Road and Town Farm Road. At this point (Segment T4.01.A), the slope of the river decreases and the river valley widens. In geologic terms, this area is referred to as an "alluvial fan," where the sediment and debris carried by the brook settles out across the valley. Exacerbating this natural deposition process is a bridge-arch structure underneath Baileys Mills Road that is undersized for the channel. The post-Irene channel width varies between 40 and 50 feet in segment T4.01.A, while the arch width is only 19 feet. During Tropical Storm Irene flooding, tremendous amounts of sediment and debris generated from upstream mass failures along Bailey Brook were deposited over this alluvial fan. The debris field extended over 1,000 feet upstream along Bailey Brook and Town Farm Road. The channel is actively carving and braiding through these deposits. Many of the trees within the pine/hemlock floodplain forest along Town Hill Road are dead due to girdling from flood sediments. Berms are disconnecting the floodplain in one location, and bank erosion is severe throughout.

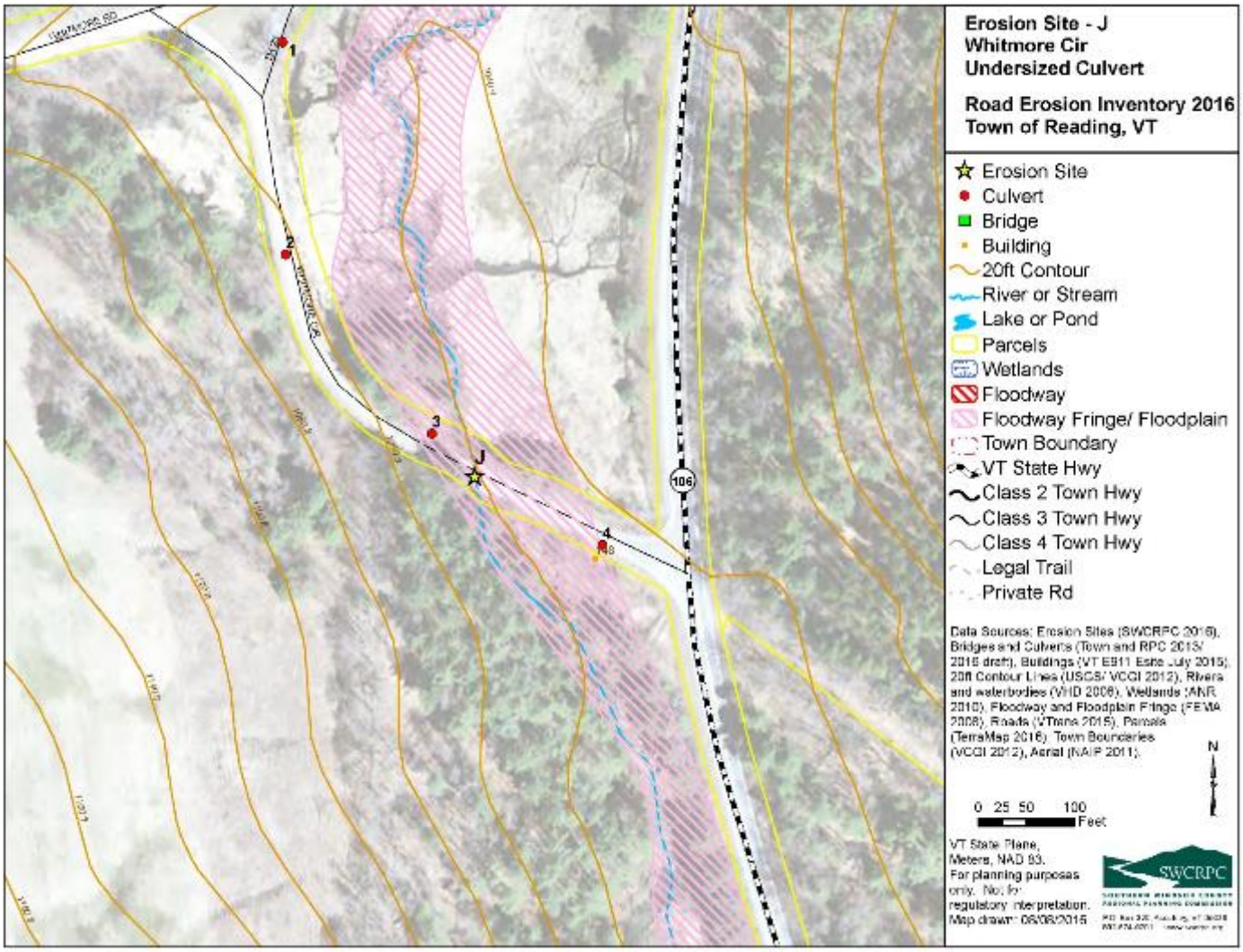
Given the severe instability of the upstream banks and valley walls, and the amount of sediment and debris in the river corridor waiting to be carried down to the alluvial fan in the next flood, we expect the degree of risk and conflict at this site to worsen during future floods. We recommend that the Town complete an alternatives analysis to evaluate options for alluvial fan management. Options may include: 1) Replace arch with a larger structure to maximize capacity over the bedrock grade control; 2) Road or intersection realignment to southwest to accommodate alluvial fan flooding; 3) Berm removal, dead tree removal, and re-vegetation of the floodplain along Town Farm Road. With any of these alternatives, local flood hydraulics and sediment transport will need to be analyzed carefully to ensure that risks to downstream property are not increased. If this area has experienced repeat flood damage, it may be eligible for FEMA funding. The Town of Reading should coordinate with SWCRPC to determine other potential funding sources.

SITE J – WHITMORE CIRCLE UNDERSIZED CULVERT

Road Name: Whitmore Circle **TH Number:** 7/ 23 **TH Class:** 3
GPS coordinates: N 43.50534 W 72.55405
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: Low

Project identified in other plans: 2015 Mill Brook River Corridor Plan – Site RE15. Medium hazard mitigation priority. Medium ecological benefits priority.

Site Map



Site Visits

- Summer 2014 – Fieldwork for 2015 Mill Brook River Corridor Plan by Fitzgerald Environmental Associates
- October 2016 – Glen Towne (Town Road Foreman), Mark Bithrow (Town Road Crew), and Katharine Otto (SWCRPC)

Description of problem

According to the 2015 Mill Brook River Corridor Plan, the culvert under Whitmore Circle is a "major constriction (25% of bankfull width). This constriction is leading to upstream deposition and downstream scour, and likely exacerbates flooding impacts" (page 127).

The 2016 field visit showed the site with an existing beaver dam covering the 4ft culvert entrance. This area has a significant issue with beavers who dam the stream and the culvert at various points nearby. With beaver dams being dismantled periodically some stretches of stream appear to be naturally wider than under usual stream flow. It is a perennial stream with a usual width of 2-3ft.

This site is not a high priority since there is an easy alternate driving route nearby, and solving the beaver issue is not easy.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?		X		
Erosion problem?	X			
Waterbody affected?	X			
ANR Road Erosion Risk Ranking?	X			Medium Risk
Further engineering needed?	X			
Need cost estimates?	X			
VTrans Hydraulic study needed?	X			
ANR Stream Alteration Permit needed?	X			
Army Corp permission needed?	X			
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?			X	

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown		X	
Ditches non-existent		X	
Ditched not stoned or grass lined		X	
Town culvert less than 18"		X	
Town culvert not hydrologically big enough	X		
Town culvert does not have header		X	
Town culvert end treatment		X	
Town culvert is not stabilized with stone apron, splash pad, etc.		X	
Driveway/private culvert issue		X	
Gully erosion		X	
Road drainage not filtered before entering waterbody		X	
Stream bank		X	

Proposed Solutions

According to the 2015 Mill Brook River Corridor Plan, the culvert should be "replaced with a larger structure designed to be geomorphically compatible with the stream dimensions" (page 127). This would "improve sediment and floodwater conveyance and reduce sediment inputs to channel" (page 127). Until the beaver issue is mitigated, increasing the size of the structure would probably not help.

Estimated Costs

The site would need hydraulics study and engineering before a bigger structure could be installed.

Site Photographs

Top: Beaver dam blocking the culvert entrance with water trapped in adjacent wetland.
Bottom: Water trapped in adjacent wetland upstream from culvert blocked by beaver dam.

Top: Culvert outlet at the same time that beaver dam blocks inlet
Bottom: Downstream from culvert showing a much narrower stream beyond the influence of previous beaver dam ponds.

Stream: Reading Hill Brook | **Reach:** T3.03 | **Town:** Reading | **Date Assessed:**08/07/14

Channel Length (ft): 3,090 | Channel Slope (%): 0.5 | **Sinuosity:** 1.3 | **Watershed Area (mi^2):** 2.68

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Very Broad	Very Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	E	E

Ph2 Cross-Section Data

Curve Width (ft)	20.2
Bankfull Width (ft)	11
Max Depth (ft)	1.8
Width/Depth Ratio	8.0
Entrenchment Ratio	17.9
Incision Ratio	1.4

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
C	Rt 106	59%	D
C	Whitmore	24%	D, E, AOP

# of Other Constrictions:
# of Grade Controls: 10
# of Beaver Dams: 3

Rapid Habitat Assessment

Rank	LWD	Pools
1	30	7
2	24	16
3	11	2
4	4	1
5	0	3
6	0	0
7	-	0
#/mile	117	49

Number of Debris Jams: 8

Step 6/7 Summary

RHA Score/Condition	61/Fair
Habitat Type Departure	None
RGA Score / Condition	51/Fair
Dominant Adjustment	Planform
CEM Model Stage	F/IV
Stream Type Departure	None
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor Land Cover	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- **Project RE 14c:** Corridor Protection - Large areas of wet meadow provide valuable floodplain functions and should be protected from future development.
- **Project RE 15:** Replace Culvert - The Whitmore Circle culvert is a major constriction causing scour, deposition, and is a flood damage risk.

Reach Highlights: The lower portion of the reach has one recently removed beaver dam and alternates between reference C and reference E. Above the Whitmore Circle culvert the reach flows through an active beaver meadow. Much of this portion is highly impacted by beaver dams with multiple channels and deep deposition. The cross-section was collected near the top of the reach where the channel returns to a single thread and is E-type.

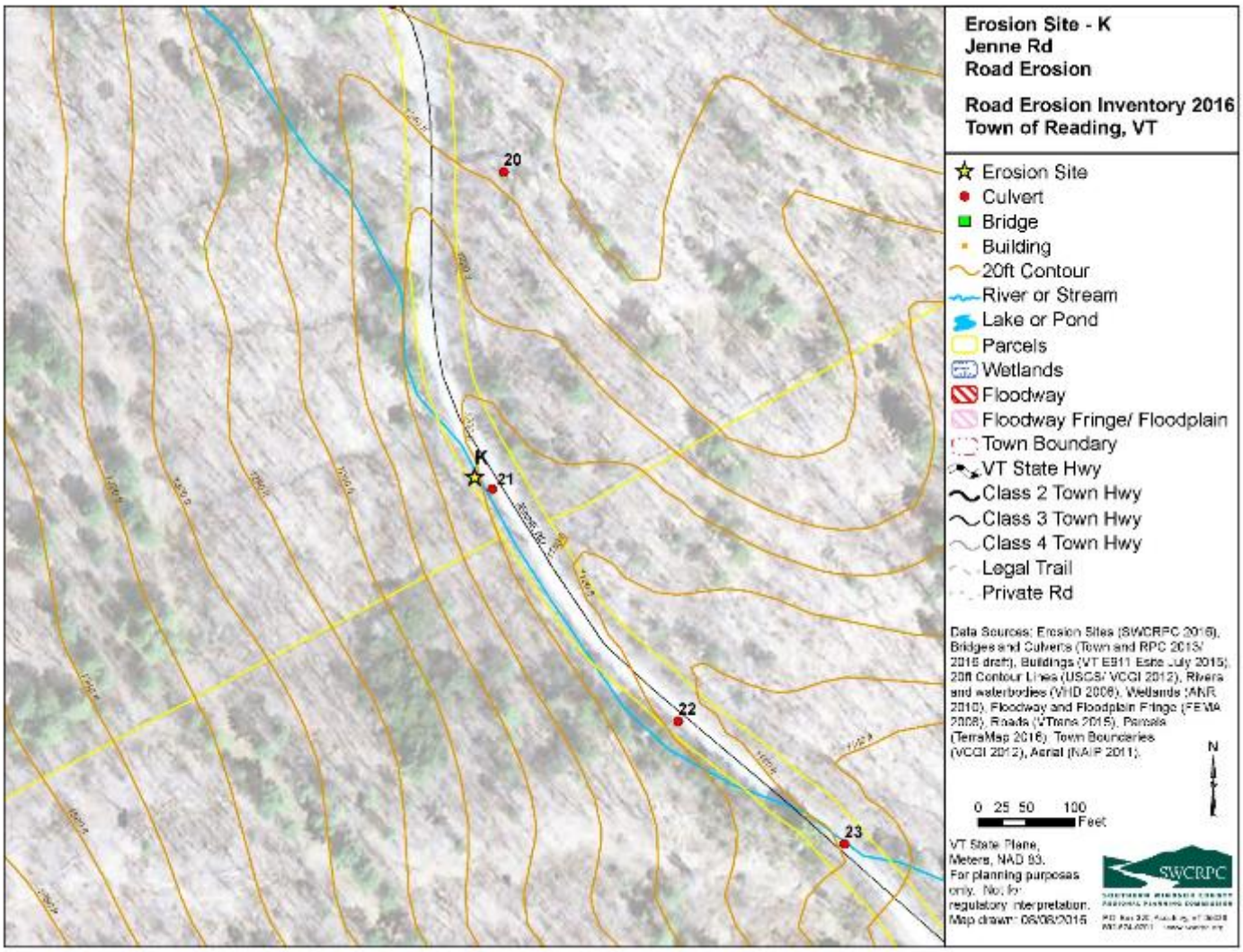
Large beaver dam in upper reach

Multi-thread channel through a beaver meadow

SITE K – JENNE ROAD EROSION

Road Name: Jenne Road **TH Number:** 21 **TH Class:** 3
GPS coordinates: N 43.51078 W 72.55679
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: Low

Site Map



Site Visits

- August 2016 – Alan May (Better Roads Program), Bob Allen (Town Selectboard Chair), Glen Towne (Town Road Foreman), Todd Menees (Stream Alteration Engineer), Marie Caduto (Watershed Coordinator), Chris Bump and Mike Blakslee (VTrans District 4), Katharine Otto (SWCRPC), and Chris Yurek (SWCRPC).

Description of problem

Road and stream are very close in certain stretches of Jenne Road. Road runoff and material in some sections run straight over the bank into the stream. Stream bank is stable and there is no erosion. Canopy over roadway also helps to dissipate rainfall so roadway and stream cope with heavy rain events well.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?	X			
Erosion problem?		X		
Waterbody affected?	X			
ANR Road Erosion Risk Ranking?	X			Medium and High Risk
Further engineering needed?		X		
Need cost estimates?	X			
VTrans Hydraulic study needed?		X		
ANR Stream Alteration Permit needed?		X		
Army Corp permission needed?	X			
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?	X			

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown	X		
Ditches non-existent		X	
Ditched not stoned or grass lined	X		
Town culvert less than 18”		X	
Town culvert not hydrologically big enough		X	
Town culvert does not have header		X	
Town culvert end treatment		X	
Town culvert is not stabilized with stone apron, splash pad, etc.		X	
Driveway/private culvert issue		X	
Gully erosion		X	
Road drainage not filtered before entering waterbody	X		
Stream bank		X	

Proposed Solutions

- Short term – consider not grading the last 3-4 feet of roadway near the stream bank. The road has plenty of width to allow this. Also vegetate the areas of slope where vegetation has been lost.
- The road is currently graded so the crown is in the center of the roadway. Over time slowly grade the road so more water is directed to the non-stream side of the roadway.
- Stone-line ditch on non-stream side of roadway and add check dams where possible. Add check dams to reduce water speed where possible, although the prevailing slope is steep enough that this may not be feasible.
- If more water is directed onto the non-stream side of roadway, consider adding culverts periodically so water from ditch can be directed to the stream where there is significantly greater capacity to carry water.

Estimated Costs

Short term solutions related to grading would have no costs beyond regular maintenance. Longer term solution costs can be calculated if short term solutions do not work – installing ditches and many culverts would involve considerable work, and may require hydraulics studies or engineering.

Site Photographs

Top: Looking uphill with stream running at the bottom of the gully on the left in this photo. This section is an area where allowing the last 3-4ft of roadway to re-vegetate could help add space for road materials to filter

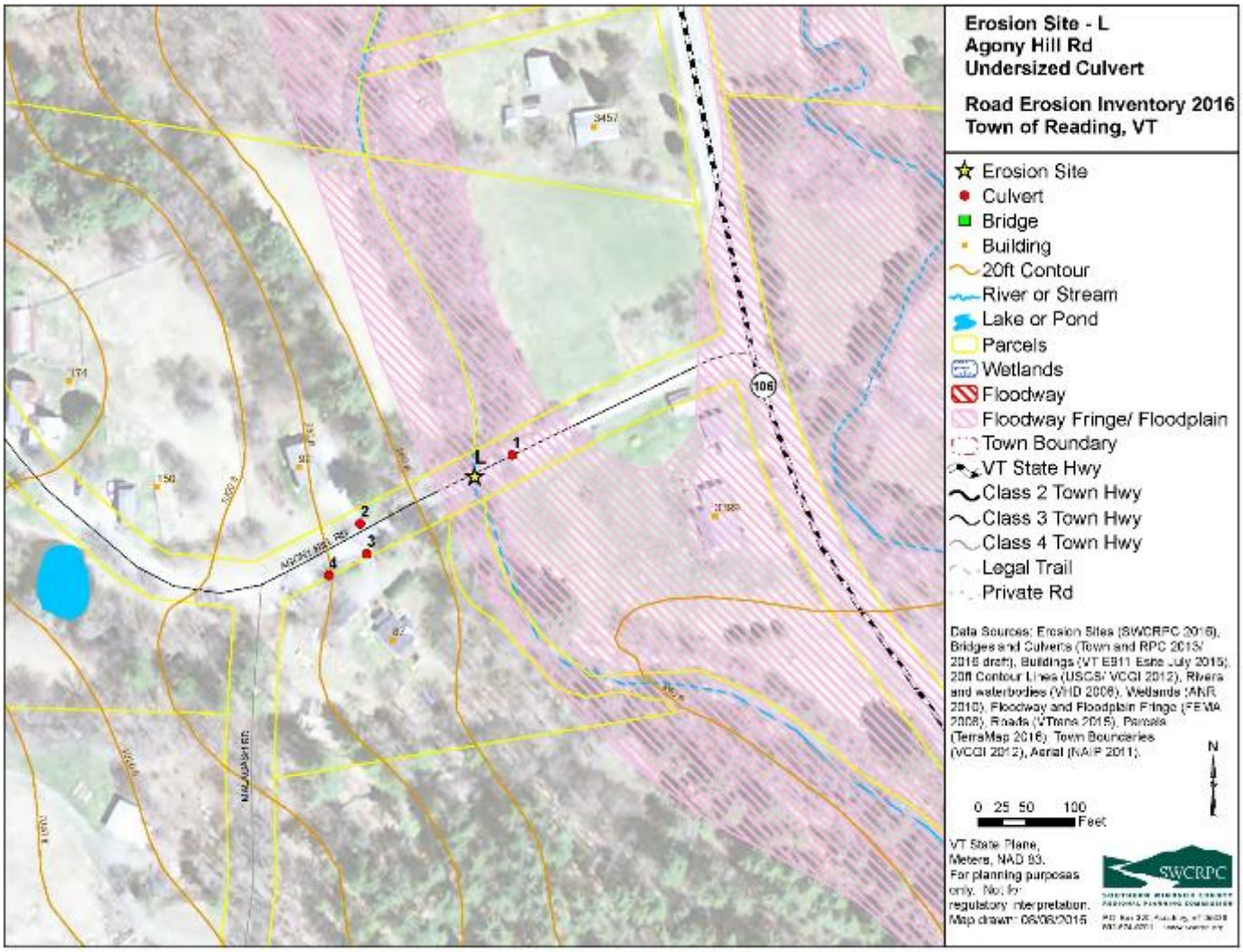
Bottom: Looking downhill with stream on right side of photograph.

SITE L – AGONY HILL ROAD UNDERSIZED CULVERT

Road Name: Agony Hill Road **TH Number:** 51/ 16 **TH Class:** 3
GPS coordinates: N 43.48590 W 72.55463
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: High

Project identified in other plans: 2015 Mill Brook River Corridor Plan – Site RE3. High hazard mitigation priority. Low ecological benefits priority.

Site Map



Site Visits

- Summer 2014 – Fieldwork for 2015 Mill Brook River Corridor Plan by Fitzgerald Environmental Associates
- August 2016 – Glen Towne (Town Road Foreman), and Chris Yurek (SWCRPC).

Description of problem

According to the 2015 Mill Brook River Corridor Plan, the Agony Hill Road arch is "undersized based on reference width (70% of bankfull width) and is well undersized for the highly active and aggradational segment

(current channel width is 65 feet). The arch partially plugged during Tropical Storm Irene, exacerbating major overbank flooding, impacting multiple properties" (Page 124).

This culvert would need to be upsized before the Baileys Mills Culvert (Site H) – the Agony Hill Road culvert would take all the increased run-off allowed downstream by the upsized Baileys Mills Culvert. Agony Hill Road is a dead-end road with several houses so keeping the culvert/ bridge open is critical.

Other things to consider	**Yes**	**No**	**Unknown**	**Comments**
Water quality problem?		X		
Erosion problem?	X			
Waterbody affected?	X			
ANR Road Erosion Risk Ranking?	X			High Risk
Further engineering needed?	X			
Need cost estimates?	X			
VTrans Hydraulic study needed?	X			
ANR Stream Alteration Permit needed?	X			
Army Corp permission needed?	X			
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?			X	

Do any of the following issues potentially contribute to the erosion issue?	**Yes**	**No**	**Comments**
Grader berm		X	
Roadway crown		X	
Ditches non-existent		X	
Ditched not stoned or grass lined		X	
Town culvert less than 18"		X	
Town culvert not hydrologically big enough	X		
Town culvert does not have header		X	
Town culvert end treatment		X	
Town culvert is not stabilized with stone apron, splash pad, etc.		X	
Driveway/private culvert issue		X	
Gully erosion		X	
Road drainage not filtered before entering waterbody		X	
Stream bank		X	

Proposed Solutions

- Increase size of culvert/ install a bridge.
- The Town would like to see this culvert upsized before they resolve the Baileys Mills Culvert issue.

According to the 2015 Mill Brook River Corridor Plan, the arch culvert should be "replaced with a larger structure to better accommodate the large volume of sediments working through the reach. A secondary flow path over the road to the east should be stabilized to reduce erosion in future storms" (page 124). This would result in a "reduction of flooding", and "improved sediment and debris transport through the segment" (page 124).

Estimated Costs

The 2015 Mill Brook River Corridor Plan estimated the cost of replacement at $750,000. It would need scoping and engineering before proceeding.

In April 2016 a contractor estimated construction costs of approximately $600,000 and design and engineer costs at $180,000. This estimate was for a bridge with a span of 40-45 feet and about 6ft tall. It would be a bridge with concrete abutments and concrete wing walls, and tall headwalls to help hold the deep roadway fills above.

Excerpt from 2015 Mill Brook River Corridor Plan

See following pages.

Stream: Mill Brook | **Reach:** M14.A | **Town:** Reading | **Date Assessed:**07/22/14

Channel Length (ft): 1,999 | **Channel Slope (%):** 1.0 | **Sinuosity:** 1.1 | **Watershed Area (mi^2):** 9.74

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Very Broad	Broad
Bedform	Riffle-Pool	Plane Bed
Median Substrate	Gravel	Gravel
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	35.7
Bankfull Width (ft)	65
Max Depth (ft)	2.3
Width/Depth Ratio	60.3
Entrenchment Ratio	5.6
Incision Ratio	1.2

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
A	Agony Hill	70%	I, D, E, S

# of Other Constrictions: 0
# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	2	2
2	8	5
3	0	1
4	5	0
5	0	0
6	2	0
7	-	0
#/mile	44	21

Number of Debris Jams: 3

Step 6/7 Summary

RHA Score/Condition	53/Fair
Habitat Type Departure	Plane Bed
RGA Score / Condition	39/Fair
Dominant Adjustment	Planform
CEM Model Stage	F/III
Stream Type Departure	None
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor Land Cover	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- **Project RE 3:** Arch Replacement - Agony Hill Road arch is undersized and causing major sediment accumulation upstream and exacerbated flooding and road damage during T.S. Irene.
- **Project RE 4:** Conservation - Valuable forested floodplain on the right bank
- **Project RE 1 c+d**: Corridor Protection and Buffer Planting - Two large areas along the left bank have minimal woody vegetation and should be protected from future development.

Reach Highlights: This segment was highly active during TS Irene with major access to both floodplains, planform adjustments, and huge volumes of gravel/sand deposition. A large volume of floodwater spilled on the left floodplain upstream of the undersized Agony Hill Rd arch damaging adjacent properties and structures. The channel widened considerably and is currently aggrading and adjusting planform to accommodate the large volume of gravel and sand working through the reach. We assessed this segment as somewhere between stage III and IV due to ongoing aggradation and planform adjustments.

Widening and major deposition at the cross-section

Undersized arch and downstream mass failure

Project RE 3 - Agony Hill Road Arch

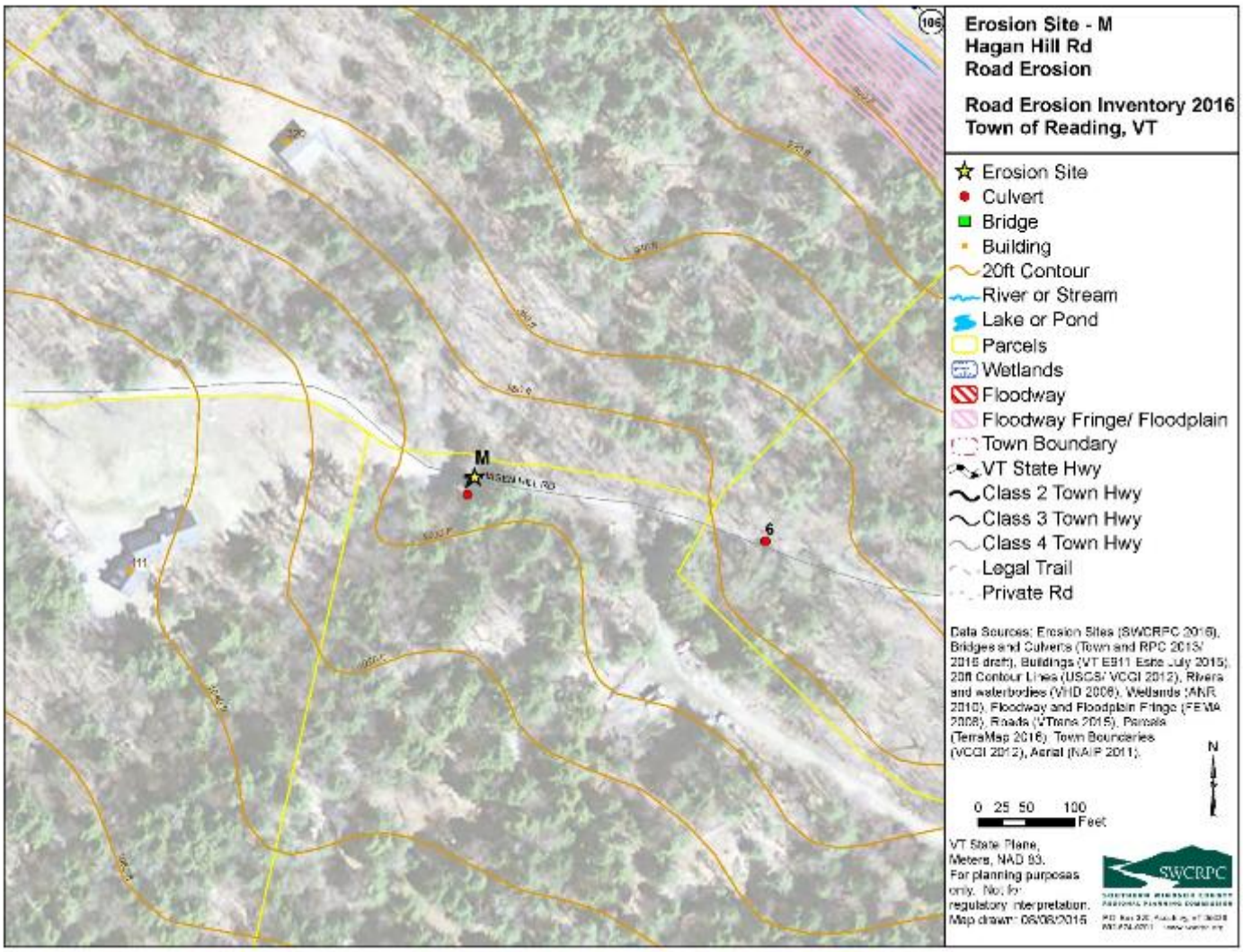
The steel arch under Agony Hill Road is a channel constriction (70% of bankfull width), poorly aligned, deformed, and filling in with sediment. The arch is located near the middle of segment M14.A which was likely historically straightened and incised. During T.S. Irene the channel widened dramatically and began to redevelop some meander bends. Overbank flooding deposited large volumes of sand and gravel over the forested right floodplain areas (orange areas in map to right) and buried three properties along the left bank. A low section of road bed along Agony Hill Rd served as a valuable flood relief area and likely reduced damage to the upstream properties. The channel remains highly active and continues to widen and adjust planform. Huge volumes of flood sediments are working through the segment, creating large bar features.

We recommend replacing the arch with a larger structure to better accommodate the large volumes of sediment working through the reach. A structure larger than the predicted bankfull channel width (36 feet) should be considered based on channel adjustment processes (Schiff *et al.*, 2014). The floodplain spillway over the road should be stabilized but not elevated. Additional projects to protect floodplain (RE 4) and stabilize and plant an eroding bank (RE 1d) should be considered for implementation before or during any structure replacement. VTrans and the Town of Reading are potential partners for this project.

SITE M – HAGEN HILL ROAD EROSION

Road Name: Hagen Hill Road **TH Number:** 61 **TH Class:** 3
GPS coordinates: N 43.47594 W 72.54359
Road Characteristics: Unpaved and uncurbed **Watershed:** Mill Brook
Priority Rank: Monitor only

Site Map



Site Visits

- August 2016 – Glen Towne (Town Road Foreman), and Chris Yurek (SWCRPC).

Description of problem

Hagen Hill is eroding underneath a log which was placed on the edge of the bank is an effort to mitigate road erosion. This erosion is depositing sediment into the flow of a culvert discharge which discharges runoff downhill and ultimately into surface waters, leading to sediment deposition and nutrient loading. The erosion is beginning to encroach upon the road's travel lane.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?	X			
Erosion problem?	X			
Waterbody affected?	X			
ANR Road Erosion Risk Ranking?	X			Low Risk
Further engineering needed?			X	
Need cost estimates?			X	
VTrans Hydraulic study needed?		X		
ANR Stream Alteration Permit needed?		X		
Army Corp permission needed?		X		
MRGP Potentially Hydrologically Connected Road Segment?		X		
Proposed solution fully within Town ROW?			X	

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown		X	
Ditches non-existent		X	
Ditched not stoned or grass lined		X	
Town culvert less than 18”		X	
Town culvert not hydrologically big enough		X	
Town culvert does not have header		X	
Town culvert end treatment		X	
Town culvert is not stabilized with stone apron, splash pad, etc.		X	
Driveway/private culvert issue		X	
Gully erosion		X	
Road drainage not filtered before entering waterbody	X		
Stream bank	X		

Proposed Solutions and estimated costs

The solutions and costs are to be determined if bank destabilizes. This site is a very low priority since the slope has been stable for a long time, there is now stream at the base of the slope and is on a class 4 town highway. Town does not grade this road.

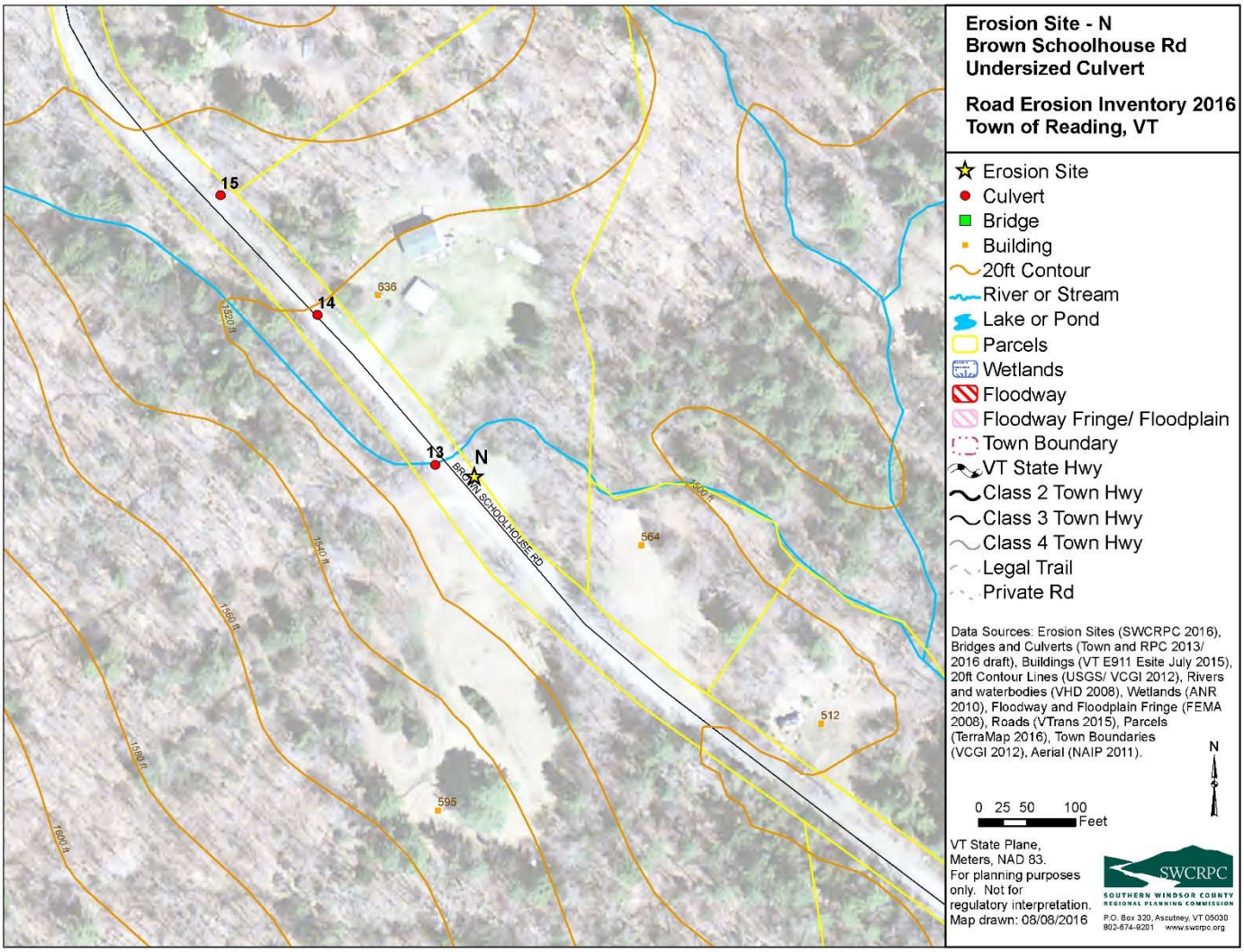
Site Photographs


Top left: Class 4 roadway shows signs of erosion at the edge of a steep bank
Top right: Large log just beyond edge of roadway, shielding the steep slope
Bottom: Class 4 roadway as seen from the side of the slope.

SITE N – BROWN SCHOOLHOUSE UNDERSIZED CULVERT

Road Name: Brown Schoolhouse Road **TH Number:** 39 **TH Class:** 3
GPS coordinates: N 43.48762 W 72.60903
Road Characteristics: Unpaved and uncurbed **Watershed:** North Branch Black River
Priority Rank: High

Site Map



Site Visits

- July 2016 – Glen Towne (Town Road Foreman), and Chris Yurek (SWCRPC).
- August 2016 – Alan May (Better Roads Program), Bob Allen (Town Selectboard Chair), Glen Towne (Town Road Foreman), Todd Menees (Stream Alteration Engineer), Marie Caduto (Watershed Coordinator), Katharine Otto (SWCRPC), and Chris Yurek (SWCRPC).

Description of problem

A large culvert on Brown Schoolhouse Road which conveys a perennial stream is failing – bottom is starting to rust and get holes, there is serious undercutting around the downstream end of the culvert, and part of the cover above the culvert is destabilizing at the edge of the roadway. Between visiting the site in late June and early August the edge of the roadway destabilized considerably.

The culvert is also significantly undersized, thereby constraining water during high water events. This increases the erosive force of the water downstream of the culvert, eroding the streambanks toward the edge of Brown Schoolhouse Road.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?	X			
Erosion problem?	X			
Waterbody affected?	X			
ANR Road Erosion Risk Ranking?	X			Medium Risk
Further engineering needed?	X			
Need cost estimates?	X			
VTrans Hydraulic study needed?	X			
ANR Stream Alteration Permit needed?	X			
Army Corp permission needed?	X			
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?			X	

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown		X	
Ditches non-existent		X	
Ditched not stoned or grass lined		X	
Town culvert less than 18”		X	
Town culvert not hydrologically big enough	X		
Town culvert does not have header		X	
Town culvert end treatment	X		
Town culvert is not stabilized with stone apron, splash pad, etc.	X		
Driveway/private culvert issue		X	
Gully erosion		X	
Road drainage not filtered before entering waterbody		X	
Stream bank	X		

Proposed Solutions

- Increase size of culvert/ install a bridge.
- Ledge may be an issue when evaluating what type of culvert can be used – squashed, arch, box, etc.

Estimated Costs

A hydraulic study and engineering is needed before costs can be estimated.

Site Photographs

Top: Downstream end of culvert. Culvert and headers are undercutting. Cover above the culvert is destabilizing at the edge of the roadway. August 2, 2016

Bottom left: More cover above the culvert when visiting 5 weeks earlier – June 30, 2016.

Bottom right: Looking down on destabilized culvert cover. August 2, 2016

Top left: Undercutting of culvert and headers.

Top right: Upstream end of culvert with concrete headers.

Bottom right: Looking upstream from the culvert.

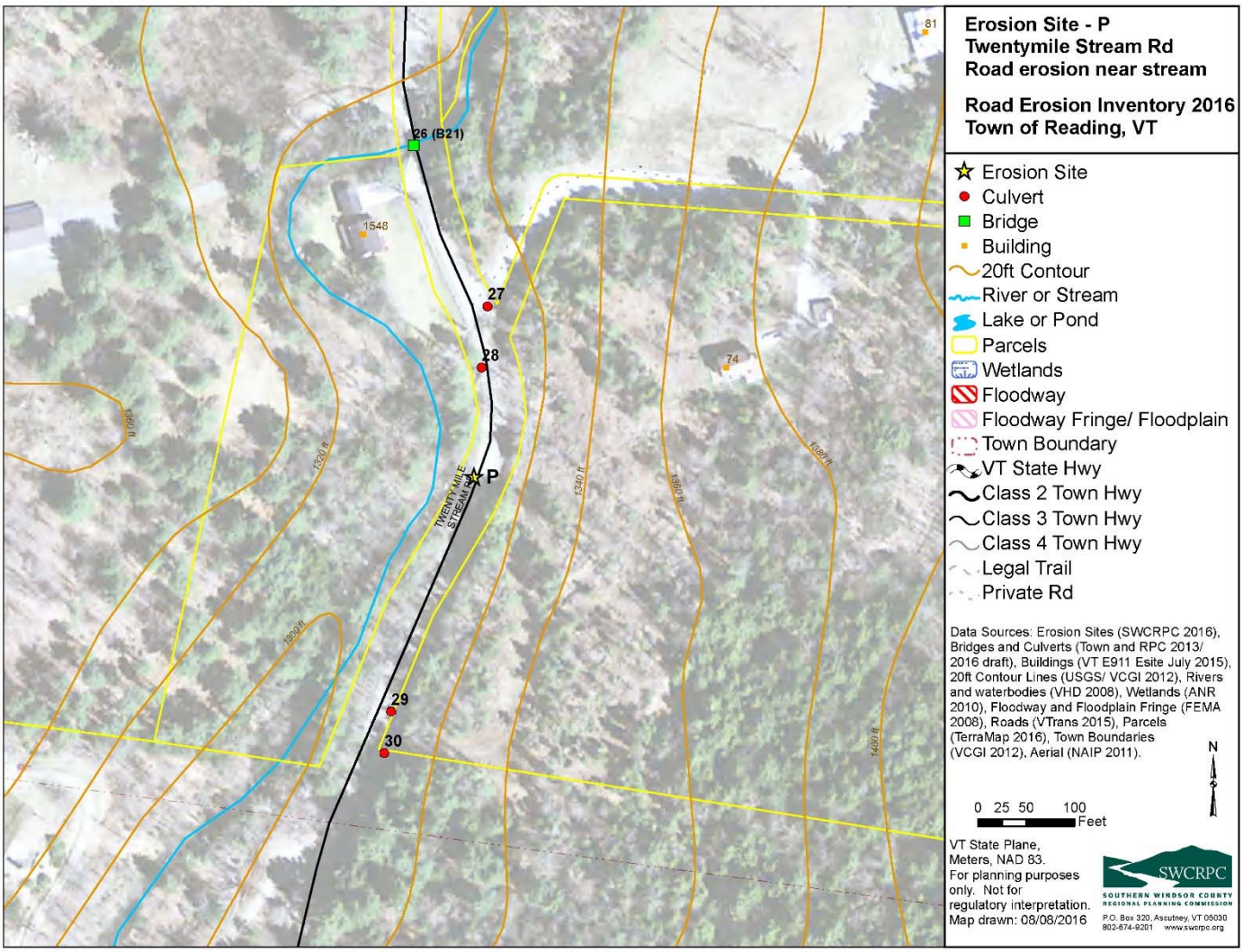
Top: Looking downstream from the culvert. Plunge pool is in the foreground and then the stream narrows up.

Bottom: Looking up the road (westward). Stream runs through the trees on the left.

SITE P – TWENTY MILE STREAM ROAD EROSION NEAR STREAM

Road Name: Twenty Mile Stream Road **TH Number:** 3 **TH Class:** 3
GPS coordinates: N 43.45688 W 72.64877
Road Characteristics: Unpaved and uncurbed **Watershed:** Black River/ Twentymile Stream
Priority Rank: High

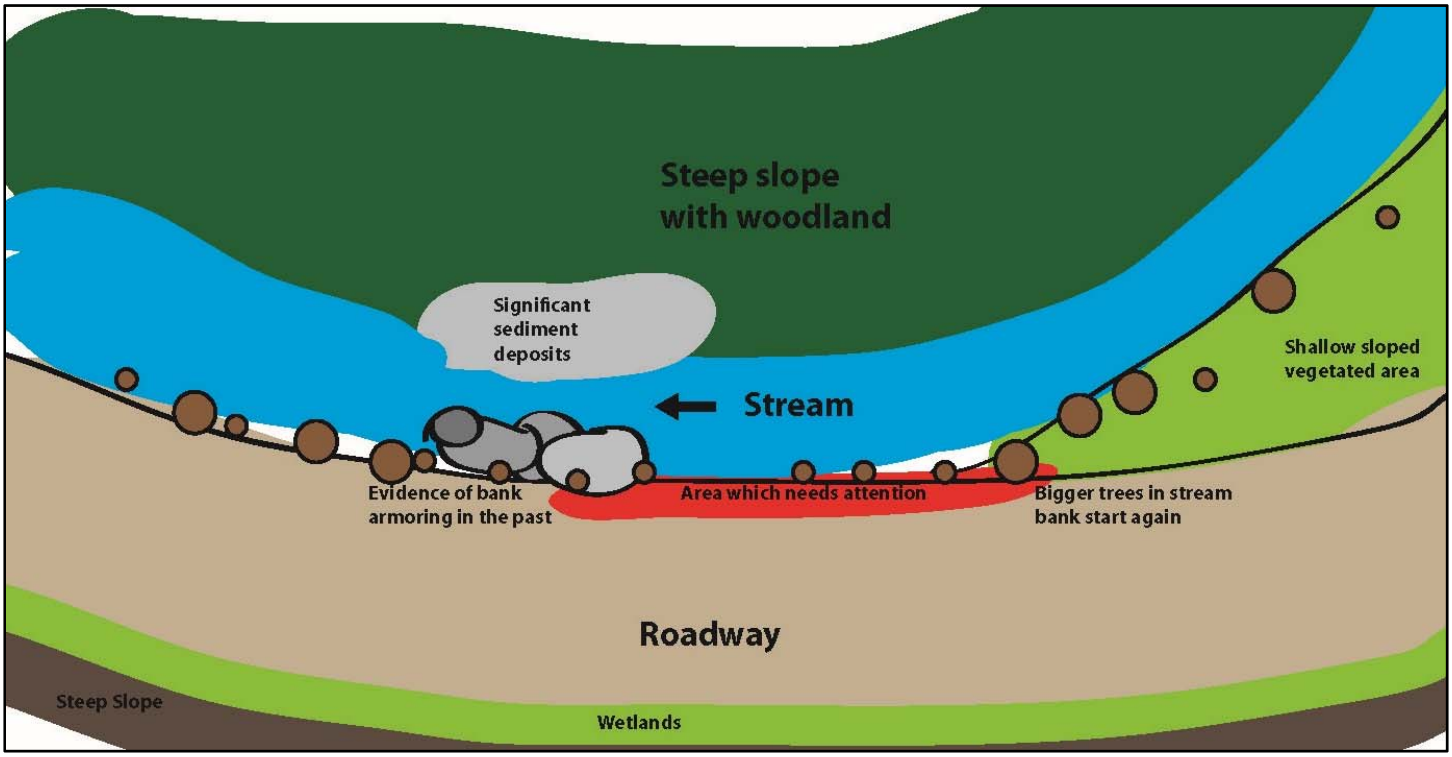
Site Map



Site Visits

- August 2016 – Alan May (Better Roads Program), Bob Allen (Town Selectboard Chair), Glen Towne (Town Road Foreman), Todd Menees (Stream Alteration Engineer), Marie Caduto (Watershed Coordinator), Katharine Otto (SWCRPC), and Chris Yurek (SWCRPC).

Site Sketch



Description of problem

Stream runs very close to the roadway. The stream bank is already beginning to fail along the roadway at a corner of the stream were there are insufficient trees and/or stone on the bank. The issue is being caused by the movement of the stream (the corner is slowly moving upstream) rather than the roadway. The stream will likely undercut the roadway if the bank is not stabilized or the road moved away from the edge of the stream.

The almost vertical drop between the roadway and stream is approximately 15ft. The length of the issue is about 12-15ft.

Other things to consider	Yes	No	Unknown	Comments
Water quality problem?	X			
Erosion problem?	X			
Waterbody affected?	X			
ANR Road Erosion Risk Ranking?	X			Low Risk
Further engineering needed?	X			
Need cost estimates?	X			
VTrans Hydraulic study needed?		X		
ANR Stream Alteration Permit needed?	X			
Army Corp permission needed?			X	
MRGP Potentially Hydrologically Connected Road Segment?	X			
Proposed solution fully within Town ROW?			X	

Do any of the following issues potentially contribute to the erosion issue?	Yes	No	Comments
Grader berm		X	
Roadway crown	X		
Ditches non-existent		X	
Ditched not stoned or grass lined		X	
Town culvert less than 18”		X	
Town culvert not hydrologically big enough		X	
Town culvert does not have header		X	
Town culvert end treatment		X	
Town culvert is not stabilized with stone apron, splash pad, etc.		X	
Driveway/private culvert issue		X	
Gully erosion		X	
Road drainage not filtered before entering waterbody	X		
Stream bank	X		

Proposed Solutions

- The roadway is sitting in wetlands so relocating the road away from the stream would be very hard.
- Rip rap the slope where it is de-stabilizing and toe-in the base of the slope with rip-rap and then armor the slope large stone.
- A short term solution which could help a little is to let the last 2-3ft of roadway next to the stream re-vegetate.

Estimated Costs

Engineering is needed before costs can be solidified, but likely to cost $10,000 - $15,000 according to the August 2016 group who visited the site.

Site Photographs

All: Bank destabilizing where trees stop.

Right and Bottom: Major destabilization next to person's boot

Top and Bottom: Stream curve next to roadway. Areas with bigger trees are holding well. Areas with smaller trees or no trees are unstable.