Mount Holly ER STP 0133(8)
Vegetated Slope Stabilization along VT Route 155

AC EC VT 5th Annual Technical Transfer Presentation

March 11, 2020
Introduction

Project Owner
VTrans
- Bruce Martin, P.E. – Project Manager

Engineers of Record
Green International Affiliates, Inc.
- Thomas Bigelow, P.E.
Milone & MacBroom
- Roy Schiff, P.E, Phd
Agenda

• Project Purpose
• Pre-Construction Conditions and Issues
• Proposed Design
  • Stream geomorphology
  • Stone toe design
  • Vegetated slope design
  • Culvert and slope swale design
• Constructability Considerations
• Final Condition
• Lessons Learned
GREEN INTERNATIONAL AFFILIATES, INC.

Rebuild and stabilize the failing roadway embankment
Create a resilient roadway and slope
Reconstruct the failing roadway (VT Route 155)
Replace undersized culverts
Project Location

(vtransmaps.vermont.gov)
Add callouts to the project site, Manchester, VT 100, VT 11 and VT 30 and US RRoute 7
Erik C. Atkins, P.E., 2/14/2019
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Erik C. Atkins, P.E., 2/14/2019
Project Location

(GoogleEarth)
Horatio Earle was born in 1855 Mount Holly.

Known as the “Father of Good Roads”

Created the world’s first mile of concrete road in Detroit, MI
Mill River

- The Mill River was once a major avenue of transportation for the Algonquin and Iroquois people.
- In the late 1700’s colonist settlements were established near gristmills and sawmills at suitable sites along the river.
- There were at least a dozen mills working along the river during the 18th and 19th centuries.
- While the mills were at work utilizing the water in the river, transportation routes were being established in the valley carved by the Mill River and its tributaries.
VT Route 155

- 10 miles of two-lane highway constructed in May 1961
- The roadway was previously designated VT Route 8 until the section between Weston and Wallingford was re-designated as VT Route 155.
- Much of it borders the Green Mountain National Forest
- Important regional north/south Route east of US Route 7
Tropical Storm Irene

- Tropical Storm Irene struck Vermont on August 29
- Irene dumped as much as 11 inches of rain on parts of Vermont
- Resulted in $733 million in damage.
Project Site in 2011, After Irene

(Slope Failure)

(Google Earth)
Project Site in 2013

- Additional Slope Failure
- Vegetation beginning to fall into Mill River

(Google Earth)
Project Site in 2013

- Additional Slope Failure
- Vegetation beginning to fall into Mill River
Slope moving closer to roadway

(Google Earth)
Project Site in 2018 prior to Construction
Cross Section of Slope Failure

Slope before failure

Mill River

VERMONT 155
Cross Section of Slope Failure

Slope before failure

Slope after failure
Project originally scoped as typical slope stabilization with bulk stone toe and stone fill slope.

Green and MMI approached VTrans with the Vegetated Slope Concept

Prepared analysis that weighed Pros, Cons and potential for cost savings

Worked with VTrans to determine effects of vegetated slope design on overall slope stability
Preliminary Design

- Stream geomorphology
- Stone toe design
- Vegetated slope design
- Culvert and slope swale design
Stream Geomorphology

- Riffle-pool channel
- Barlow Road Bridge opening width = 36 feet
- Bankfull channel width = 65-70 feet
- River erosion of bottom of slope led to mass failure
- Large floodplain on the eastern bank, across from failure 3-4 feet above channel bottom
- Replicate steep forested banks with downed trees that are stable
Stream Geomorphology
Stream Geomorphology
Stream Geomorphology

(FEA, 4/29/2014)
Stream Geomorphology

(FEA, 4/29/2014)
Stream Geomorphology
Stream Geomorphology

- Road
- Slope 66%
- Soil/vegetation
- Th 28'
- Tip sheet
- B.9'
- Type IV
- W target 65-70' @ slide area
- 4-5' dip
Stream Geomorphology

1. FP elevation relative to channel
   - check field notes
   - check GIS

W_{target} \approx 65-70\,ft
Stream Geomorphology

- Maintain rough/irregular bed
- Establish low spot to concentrate flow for habitat during extreme low flow
- Match/blend to adjacent channel
- Vary bench width as needed

Low Flow Channel
- \( W \sim 1.5' \left( \frac{1}{3} W_{b kf} \right) \)
- \( D_{max} \sim 1.5' \left( \frac{1}{2} D_{b kf} \right) \)
Preliminary Slope Concepts
Preliminary Slope Concepts

1. UNDISTURBED SUBGRADE
2. GRANULAR BORROW
3. 9" MAX. LANDSCAPE BACKFILL
4. NATIVE STEEP SLOPE (SEED MIX)
5. PROVIDE 12" OF LANDSCAPE BACKFILL AROUND ENTIRE PERIMETER OF ROOT BALL (TPR)
6. EROSION LOG (CDR LOG)
7. 2" BARK MULCH
8. PROPOSED LANDSCAPE TREES
9. PROPOSED LANDSCAPE SHRUBS
10. 1" STABIL MULCH PLACED OVER SEEDING
11. CUT INTO TRUNK (MAINTAIN CUT BRANCHES & ROOT WAD)

SEEDED AREAS
LIVE FASCINES
MULCH MATTING
1. BIODEGRADABLE PLANTING AREAS (COMPOSTS)
2. PATTERN TIPS

VERMONT AGENCY OF TRANSPORTATION
ACEC
American Consulting Engineering Company
of Vermont
Balsam Fir  White Pine  Red Maple  Red Oak  Paper/Gray Birch  Redtwig/Gray Dogwood  Nannyberry Viburnum
Winter Rye (annual)  Indian Grass  Big Bluestem  Tridens  Rudbeckia  Monarda  Liatris
Global stability of the design was reviewed by VTrans.

Initial design proposed 1.5H:1V slopes with a bench.

Recommended 2H:1V slope.
Global stability of the design was reviewed by VTrans.

Initial design proposed 1.5H:1V slopes with a bench.

Recommended 2H:1V slope.
Culvert Design

- Existing culverts determined to be undersized
- 36” CMP Culvert
  - Slope failure deformed existing culvert
  - Ending service life
  - 15’ from finished grade to bottom of culvert
  - Exceeded Hw/D Ratio
  - Did not provide bank full width
• Replaced with a new 3’ x 5’ box culvert
• Headwater Depth = 4.1(100 Year Storm)
• Provides bank full width
Culvert Design
Steep 2H:1V Slope
100 CFS from 3’ x 5’ box culvert
Sized stone using HEC-15
D50 stone of 2.75-feet
Reduce Velocities
Prevent scour and erosion of the slope
Designed for 100-Year Storm
**100 year @ MM5.61**  
7.5-foot bottom width channel

<table>
<thead>
<tr>
<th>Trapezoidal</th>
<th>Highlighted</th>
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<tbody>
<tr>
<td>Bottom Width (ft) = 7.50</td>
<td>Depth (ft) = 1.09</td>
</tr>
<tr>
<td>Side Slopes (z:1) = 1.50, 1.50</td>
<td>Q (cfs) = 100.00</td>
</tr>
<tr>
<td>Total Depth (ft) = 4.00</td>
<td>Aarea (sqft) = 0.96</td>
</tr>
<tr>
<td>Invert Elev (ft) = 1430.30</td>
<td>Velocity (ft/s) = 10.04</td>
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<tr>
<td>Slope (%) = 56.00</td>
<td>Wetted Perim (ft) = 11.43</td>
</tr>
<tr>
<td>N Veloc = 8.100</td>
<td>Grt Depth, Yc (ft) = 1.50</td>
</tr>
<tr>
<td>Calculations</td>
<td>Top Width (ft) = 10.77</td>
</tr>
<tr>
<td>Compute by: Known Q</td>
<td>EGL (ft) = 2.66</td>
</tr>
<tr>
<td>Known Q (cfs) = 100.00</td>
<td></td>
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</tbody>
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![Graph of Elevation and Depth over Reach](image-url)
Slope Swale Design

Stones protruding 6” – 12” above bottom of swale

Stones embedded below channel bottom

Rough Channel Bottom

Stone shall be embedded so
at least 1/4 of the cross
sectional area is below the
profile grade line

12” – Special Provision
(Granular Borrow)
Access Road

- Access Road on west bank
- Construct access road from top to bottom of slope
- Access Road on east bank
- Ford River at sand bar

(GoogleEarth)
Access Road
Access Road
Permitting

- Northern Long-Eared bat
- Time of Year Restrictions
  - Bats
  - River work
- Army Corp
- Title 19
- ANR stream
Construction Considerations

- Time of Year Restrictions
- Placing large tree trunks on the slope
- Groundwater and slope stability
- Washing in E-Stone
- Gaining access to entire slope
Understanding river and floodplain morphology is key to developing holistic solutions to river/road conflicts.

Designing with nature can jump start a self-sustaining slope.

Vegetated slopes can be as resilient as stone slopes in the long term.

Mitigate groundwater during construction.

Consider tighter seasonal restrictions (if feasible).
Questions

Thank you!