Middlebury Creek Road Erosion Stability Study for Addison County Regional Planning Commission Transportation Advisory Committee Meeting

January 17, 2018

Presented By:
Scott A. Williams, P.E. (Pathways)

Pathways Consulting, LLC

Headwaters Hydrology PLLC

Overall Project Team

Addison County Regional Planning Commission (Sponsoring Agency)

- Josh Donabedian, Transportation Planner
- Overall project coordination

Town of Middlebury (Project Sponsor)

- Kathleen Ramsey, Town Manager
- Dan Werner, Public Works Planning Director
- Town Infrastructure Committee

Pathways Consulting, LLC (Lead Firm)

- Scott Williams, P.E. – project manager for Pathways work
- Responsible for overall project management and delivery including field work, research, mapping, alternative analysis

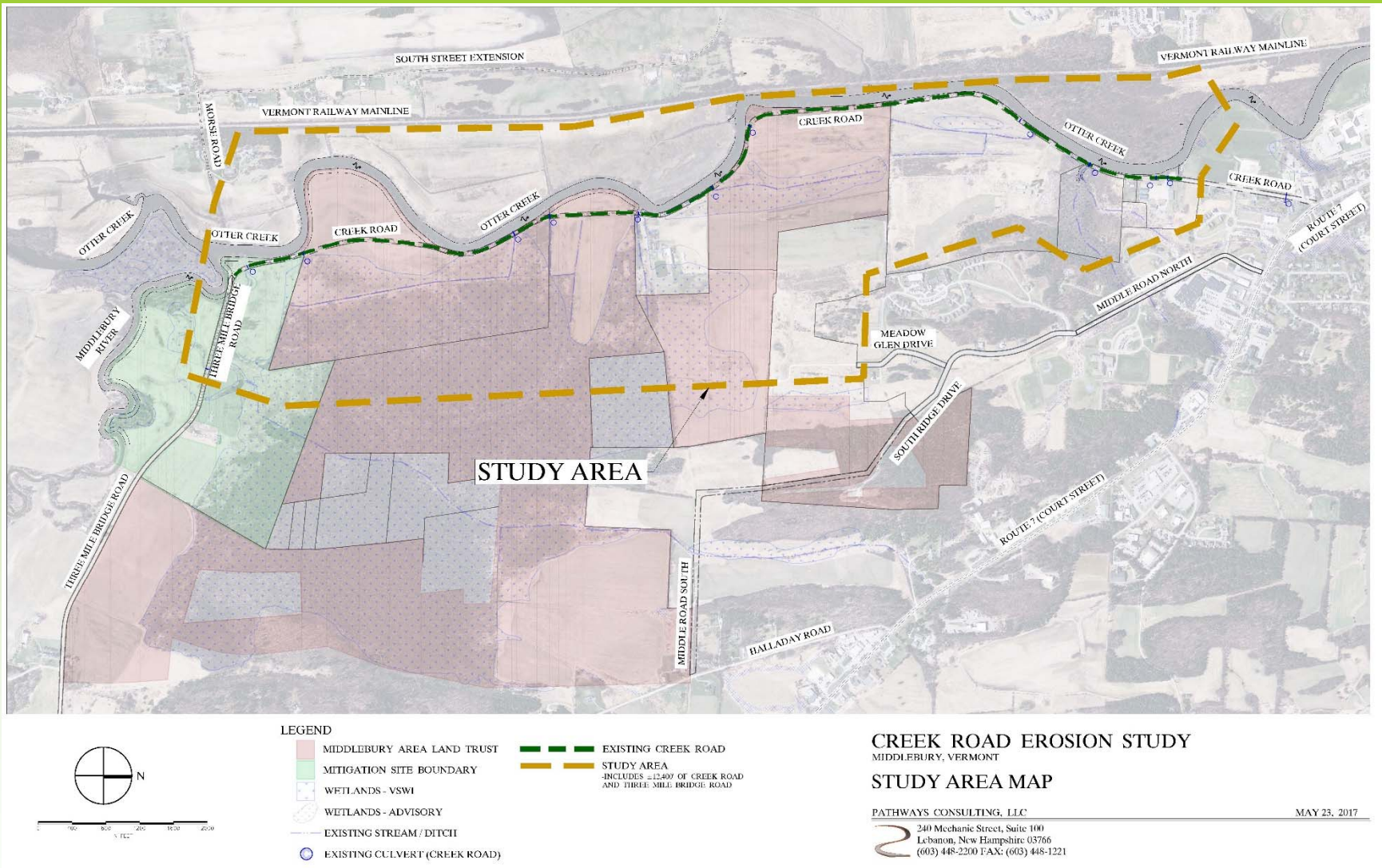
Headwaters Hydrology, PLLC (Subconsultant for Pathways)

- Sean Sweeney, P.E., CWS – stream geomorphology subconsultant
- Completion of stream assessment, preliminary recommendations

Project Goals

- **STUDY AREA:** Creek Road (2.8 miles) beginning 0.4 miles south of Court Street (Route 7) to Three Mile Bridge Road, including 500 feet of Three Mile Bridge Road along Middlebury River
- Assess Extent, Frequency and Causes of Flooding
- Review Extent of Damage to Otter Creek, Middlebury River, Creek Road, and Adjacent Properties
- Review Alternatives for Reducing Flooding and Erosion
- Review Alternatives for Repairing and/or Relocating Creek Road to Re-open Creek Road and Increase Long-term Stability
- Determine Costs and Potential Funding Sources
- Seek Input and Involve Adjacent Property Owners and Community in Study Process

Study Area Map



Project Approach and Scope of Work

- **Kickoff Meeting with ACRPC and Town (March 3, 2016)**
- **Existing Data Collection – reviewed tax maps, aerials, wetlands, LiDAR, FEMA flood maps, soils, conservation easements, flood data, etc. (March to September 2016)**
- **Site Reconnaissance and Field Data Collection - site visits, limited field surveying (April to September 2016)**
- **Stream Geomorphic Assessment (SGA) with Headwaters**
  - ❖ **Stream characterization, reviewed channel bed/bank materials**
  - ❖ **Hydrologic and hydraulic modeling**
  - ❖ **Estimated peak flows, calibrated flows from stream gage data**
  - ❖ **Historic channel migration (reviewed aerials back to 1942)**
  - ❖ **Surficial geology, topography, and floodplain map review**
  - ❖ **Identified erosion areas, causes, and recommended alternatives**
  - ❖ **produced Fluvial Erosion Hazard and Corridor map**
  - ❖ **Completed April to June 2016**

Project Approach and Scope of Work Cont.

- **Base Mapping – combined field data, maps, research, other data into comprehensive resource and base maps (July 2016)**
- **Conceptual Alternative Analysis - conceptual alternatives for relocating or converting Creek and Three Mile Bridge Road, enhancing buffer, stabilizing banks (August 2016)**
- **Prioritization Process – established criteria for analyzing alternatives High, Moderate, Low, None (August 2016)**
- **Public Involvement Process & Meetings**
  - ❖ **Direct contact with abutting property owners (July to August 2016)**
  - ❖ **Interested Stakeholder Questionnaire (July to August 2016)**
  - ❖ **Public Meeting (September 7, 2016)**
  - ❖ **Town and ACRPC Steering Committee Meeting (October 18, 2016, February 2, 2017 and March 2, 2017)**

Project Approach and Scope of Work Cont.

Through Phase 2 Funding

- **Final Creek Road Erosion Study Report (June 16, 2017):**
  - Conceptual Alternative Analysis
  - Design Recommendation Comparison Table
  - Plans, Cross Sections, Typical Details for Alternatives
  - Conceptual Engineer's Opinion of Probable Cost (EOPC) Documents
  - Overall Design Recommendations
  - Regulatory, Permitting, and Environmental Review (Federal, State, and local agencies)
  - Potential Funding Sources
  - Future Steps
  - Compilation of all background data and information
- **Separate Executive Summary of Report (June 16, 2017)**
- **Future Project Review (beyond project scope) – Town Budget and Infrastructure Committees, Selectboard, and staff**

Site Photographs from February 25, 2016

North end of project area <10 foot buffer

Middle of project area <10 foot buffer

South end of project area <10 foot buffer

Banks along Middlebury River <10' buffer

Summary of Stream Assessment Results

- **Otter Creek**
  - Channel generally stable horizontally and vertically
  - Little channel migration over past 70 years
  - Banks consist of soils naturally resistant to erosion
  - Active erosion in 7% of banks (1,000 feet on road side)
  - River corridor confined on west by railroad embankment
  - Creek Road does not confine river since not elevated
  - Erosion primarily due to lack of riparian vegetation, close proximity of Creek Road preventing vegetated buffer critical to bank stability and river health

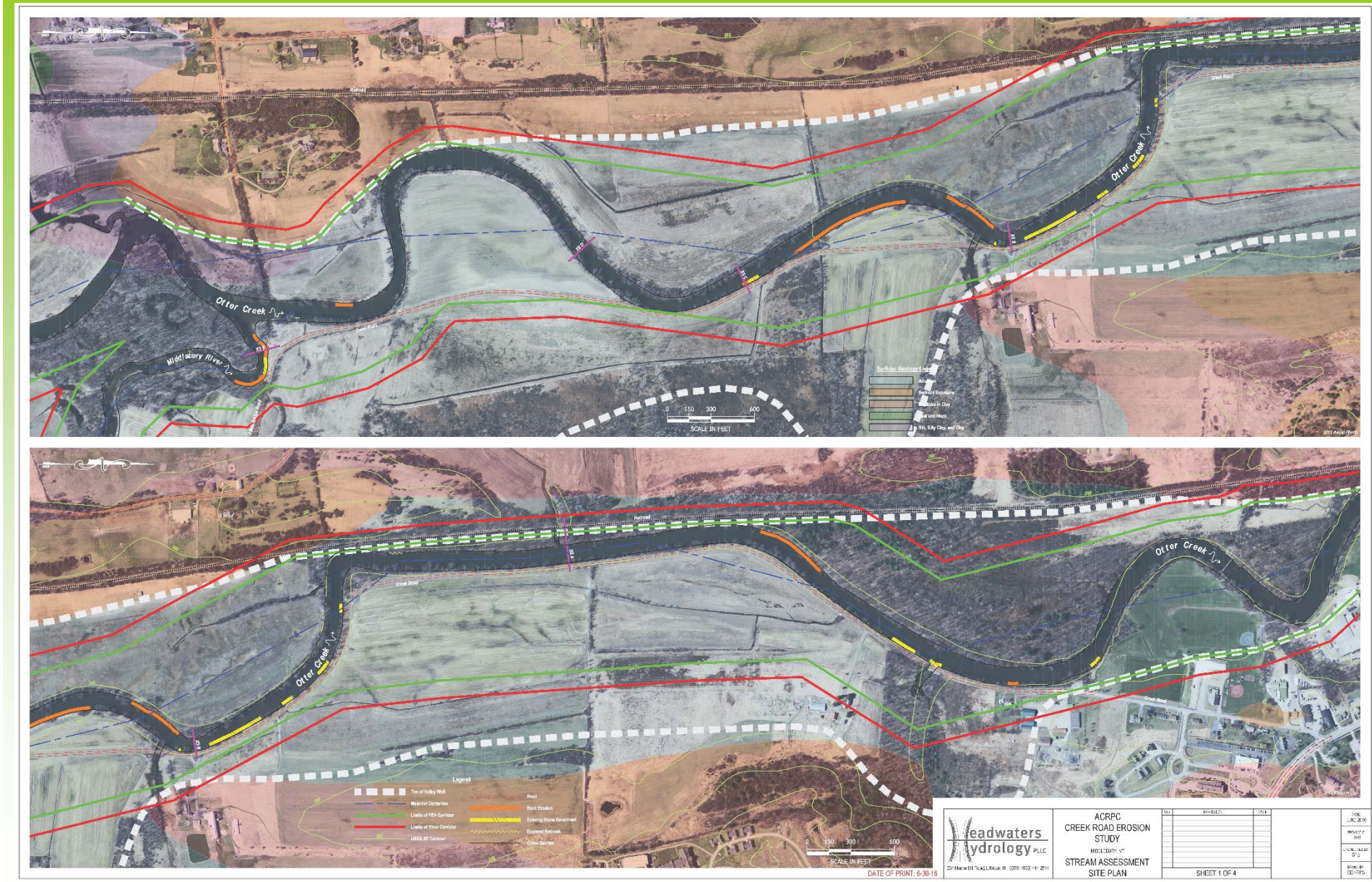
- **Middlebury River**
  - Channel unstable horizontally and vertically
  - Active channel migration and adjustment
  - Channel bend has shifted 160 feet toward road since 1942
  - Current erosion in most banks (500 feet on Creek Road)
  - Banks too high along Creek Road and confined by road
  - Creek Road on outside of meander bend
  - Erosion primarily due to channel migrating toward Creek Road, channel deepening at bank toe, lack of riparian vegetation, increased scour on banks

Stream Assessment Recommendations

- **Otter Creek Corridor:**
  - Meander Belt Corridor = 960 feet (to accommodate channel in stable condition)
  - River Corridor = 1,200 feet (with buffer for channel to evolve, maintain stability)
  - Otter Creek currently occupies full river corridor, road prevents adequate buffer
  - Recommendations:
    - 1st Priority to relocate Creek Road outside river corridor
    - If not feasible, shift road as far as possible (at outside of meander bends), stabilize river banks, and restore 25-foot vegetated buffer with native plantings
    - Bank stabilization (hard armoring) where road not moved
    - Maintain current road elevation to prevent floodplain cutoff

- **Middlebury River Corridor:**
  - Meander Belt Corridor = 550 feet
  - River Corridor = 750 feet
  - River will continue to migrate within corridor, confined by road with no buffer
  - Recommendations for Middlebury River:
    - 1st Priority to relocate Creek Road outside river corridor
    - If not feasible, relocate road outside meander belt corridor
    - If not feasible, shift road as far as possible (75 feet), stabilize with bioengineered banks
    - Avoid stabilizing bank in current location to prevent disruption of adjustment process
    - Bank stabilization (hard armoring) if road not moved at least 75 feet
    - Lower bank height by excavating floodplain bench

Stream Assessment Plan



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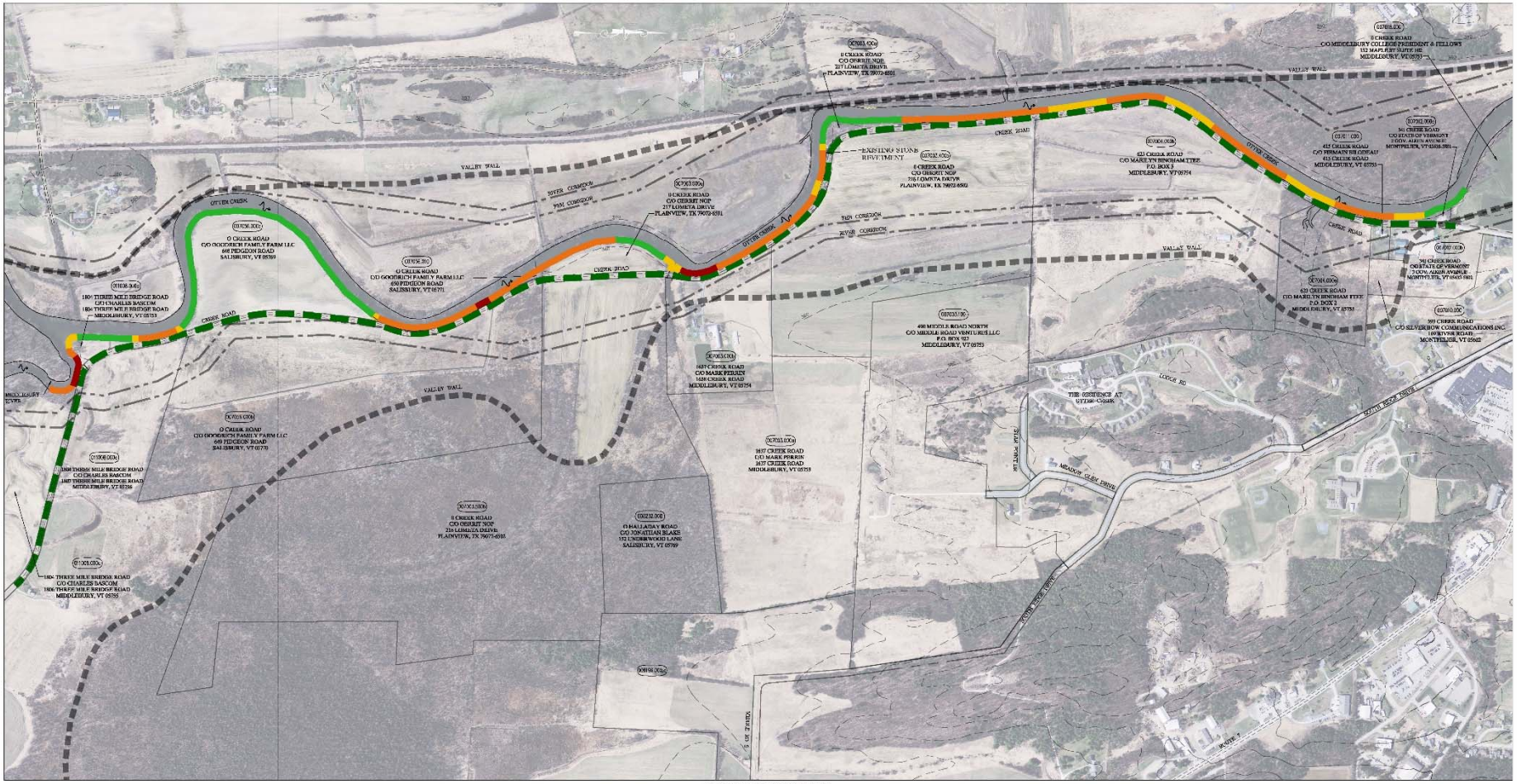
Prioritization Criteria for Study Area

Established 4 priority levels to determine critical focus areas, magnitude of issues (i.e., road damage), feasibility, and related costs, PRIORITY PLAN

- **HIGH PRIORITY (RED = 700 feet):**
  - ❖ Area of active bank erosion
  - ❖ Less than 10 feet of riparian buffer between road and bank
  - ❖ Road at top of bank
  - ❖ Current damage to road and/or bank
  - ❖ No vegetation in limited riparian buffer
- **MODERATE PRIORITY (ORANGE = 7,000 feet):**
  - ❖ Some limited bank erosion
  - ❖ Between 10 to 25 feet of riparian buffer
  - ❖ Road separated minimally from top of bank
  - ❖ Limited vegetation in riparian buffer
- **LOW PRIORITY (YELLOW = 2,300 feet):**
  - ❖ No active bank erosion
  - ❖ 25 feet or greater width of riparian buffer
  - ❖ Adequate vegetation in riparian buffer
- **NONE (GREEN = 4,900 feet):**
  - ❖ No bank erosion
  - ❖ Adequate riparian buffer
  - ❖ Significant separation (>100 feet) between road and river

Conceptual Priorities Plan



PRIORITY CRITERIA

LEGEND

EXISTING CREEK ROAD

N

0 300 600 900 1200 1500
IN FEET

HIGH (RED) - 700 L.F.
- AREAS OF ACTIVE BANK EROSION
- LESS THAN 10' OF RIPARIAN BUFFER
- ROAD AT TOP OF BANK AND/OR RESULTING ROAD DAMAGE
- NO VEGETATION IN LIMITED RIPARIAN BUFFER

MODERATE (ORANGE) - 7000 L.F.
- SOME BANK EROSION
- 10'-25' OF RIPARIAN BUFFER
- LIMITED VEGETATION IN RIPARIAN BUFFER
- ROAD SEPARATED FROM BANK

LOW (YELLOW) - 2300 L.F.
- NO BANK EROSION
- 25' OR GREATER OF RIPARIAN BUFFER
- ADEQUATE VEGETATION IN RIPARIAN BUFFER

NONE (GREEN) - 4900 L.F.
- NO BANK EROSION
- ADEQUATE BUFFER
- ROAD OUTSIDE RIVER CORRIDOR

CREEK ROAD EROSION STUDY
MIDDLEBURY, VERMONT
CONCEPTUAL PRIORITIES PLAN
PATHWAYS CONSULTING, LLC SEPTEMBER 7, 2016

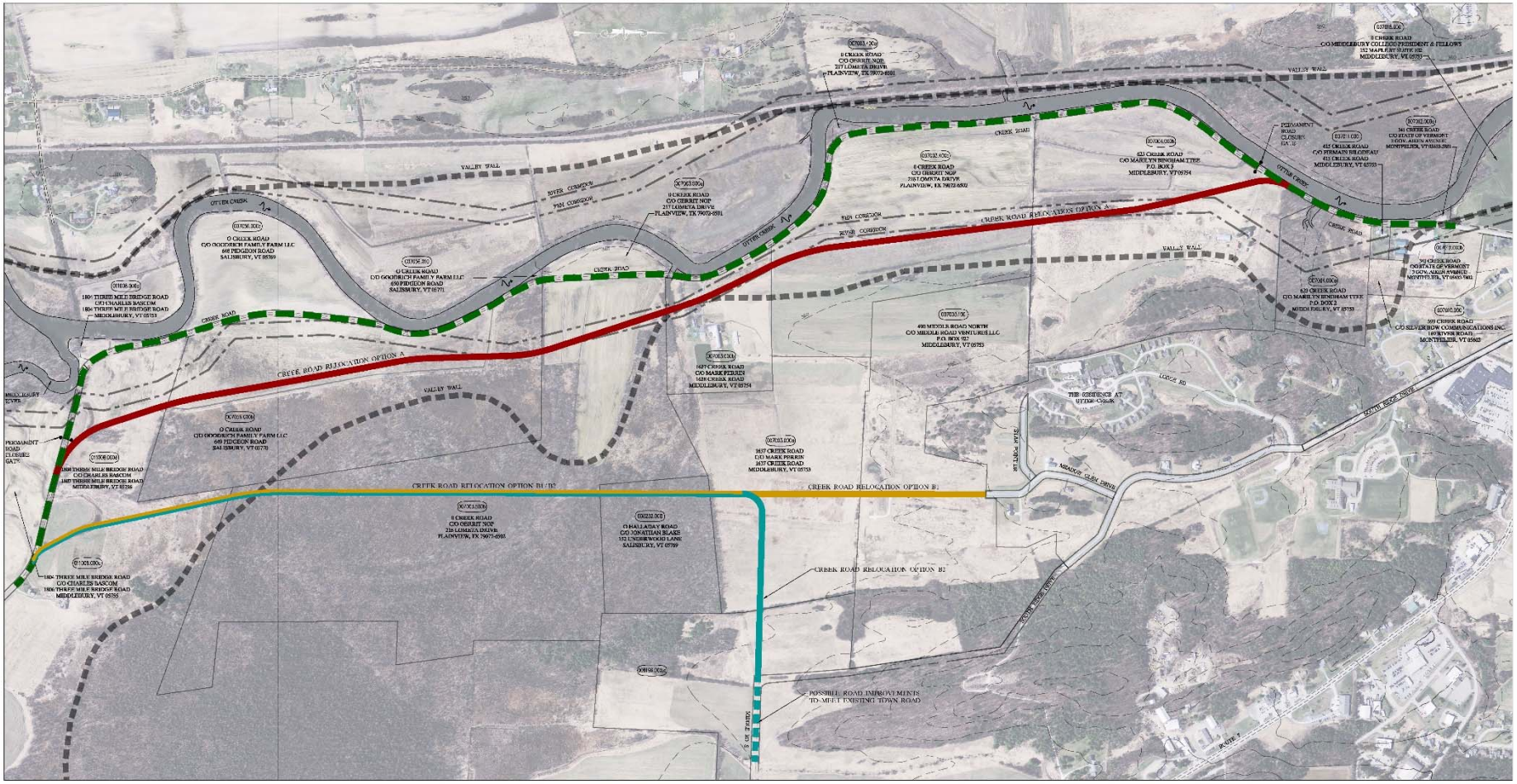
240 Mechanic Street, Suite 100
Lebanon, New Hampshire 03766
(603) 448-2200 FAX: (603) 448-1221

Initial Conceptual Alternatives Considered

- **Alternative #1 – Relocation of Road Outside Corridor**
  - Option A – 10,600 feet of new road = $1,500,000
  - Option B1 – 8,000 feet of new road = $1,275,000
  - Option B2 – 7,500 feet of new road = $1,258,000
- **Alternative #2 – Shift Road to Restore 25 foot Buffer**
  - Shift 8,000 feet of road = $995,000 (w/o bank stabilization)
- **Alternative #3 – Bank Stabilization on Existing Road**
  - 700 to 4,200 feet (depending on priority) = $420,000 to $2,520,000

- **Other Possible Alternatives Not Initially Studied:**
  - Full Road Closure – affects access to abutting properties
  - Conversion of Road to Multi-Use Path – same as above
  - Limited Road Improvements – maintaining road in-place with drainage improvements, resurfacing and/or raising road (not advisable due to active floodplain), viewed as short-term approach

Conceptual Alternative #1 – Road Relocation Plan



LEGEND

- EXISTING CREEK ROAD
- CREEK ROAD RELOCATION OPTION A
- CREEK ROAD RELOCATION OPTION B1
- CREEK ROAD RELOCATION OPTION B2

CREEK ROAD EROSION STUDY
MIDDLEBURY, VERMONT
CONCEPTUAL ALTERNATIVE #1 - ROAD RELOCATION OPTIONS
PATHWAYS CONSULTING, LLC
SEPTEMBER 7, 2016

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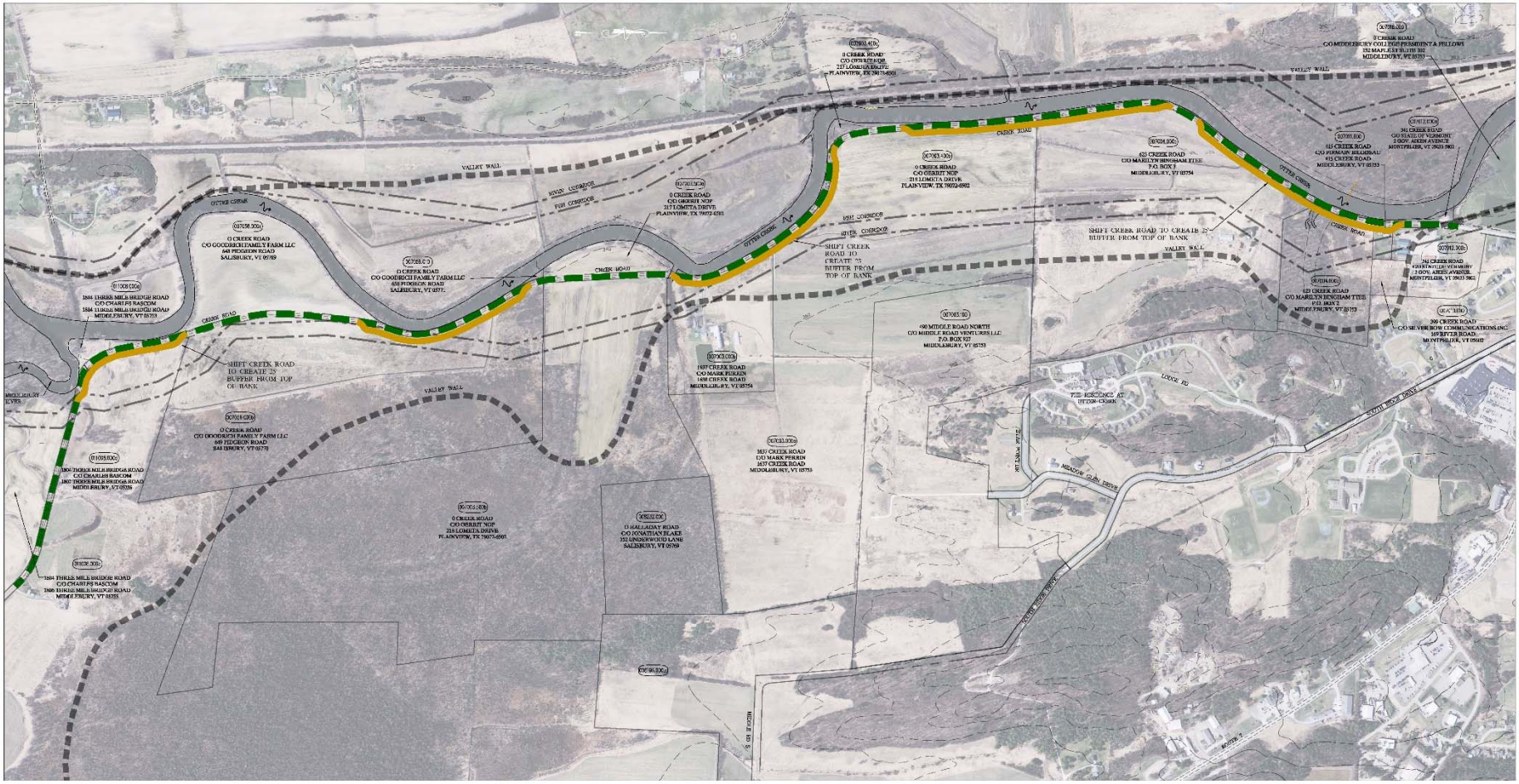
(603) 448-2200 FAX: (603) 448-1221

Conceptual Alternative #2 – Riparian Buffer Restoration with Road Shift



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LEGEND

EXISTING CREEK ROAD

SHIFT CREEK ROAD TO RESTORE 25-FOOT RIPARIAN BUFFER

CREEK ROAD EROSION STUDY
MIDDLEBURY, VERMONT
CONCEPTUAL ALTERNATIVE #2 - RIPARIAN BUFFER RESTORATION PLAN
PATHWAYS CONSULTING, LLC SEPTEMBER 7, 2016

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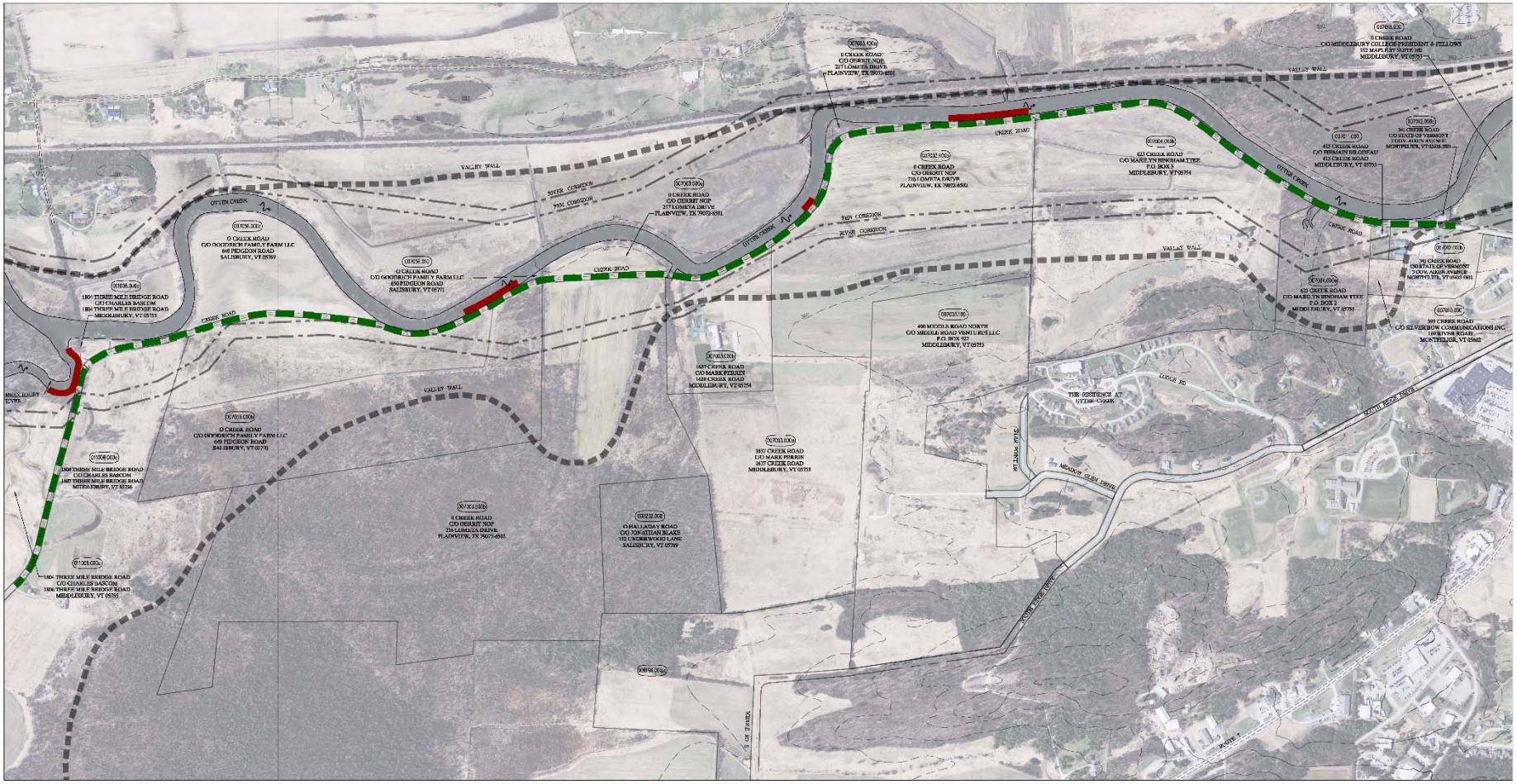
Conceptual Alternative #3 – Bank Stabilization



N

0 500 900 1200 1500
IN FEET

LEGEND

EXISTING CREEK ROAD
CRITICAL BANK STABILIZATION AREAS ALONG CREEK ROAD (TOTAL = 2,200 FEET)

CREEK ROAD EROSION STUDY
MIDDLEBURY, VERMONT
CONCEPTUAL ALTERNATIVE #3 - BANK STABILIZATION PLAN
PATHWAYS CONSULTING, LLC
SEPTEMBER 7, 2016

240 Mechanic Street, Suite 100
Lebanon, New Hampshire 03766
(603) 448-2200 FAX: (603) 448-1221

Conceptual Alternative Analysis

- **Conceptual alternatives revised following feedback from public and Steering Committee to consider:**
  - ❖ Additional Meadow Glen Road connection
  - ❖ Abandoning all or part of existing road for relocation options
  - ❖ Revised relocation options based on feasibility
  - ❖ Add option for converting road to multi-use path
  - ❖ Add option for maintaining road with minimum improvements
- **Engineer's Opinion of Probable Cost documents prepared for each alternative**
- **Comparison Chart prepared to aid review and comparison**
- **3 previous alternatives expanded to 8:**
  - ❖ Road relocation alternatives #1A to 1D with variations for maintaining, shifting, and implementing bank stabilization for remaining road
  - ❖ Other alternatives #2-5 for road shift, bank stabilization, conversion of road to multi-use path, and maintaining in-place

Conceptual Alternative Comparison Table

CONCEPTUAL ALTERNATIVE COMPARISON TABLE
FOR
ADDISON COUNTY REGIONAL PLANNING COMMISSION - MIDDLEBURY CREEK ROAD EROSION STABILITY STUDY
CREEK ROAD, MIDDLEBURY, VERMONT

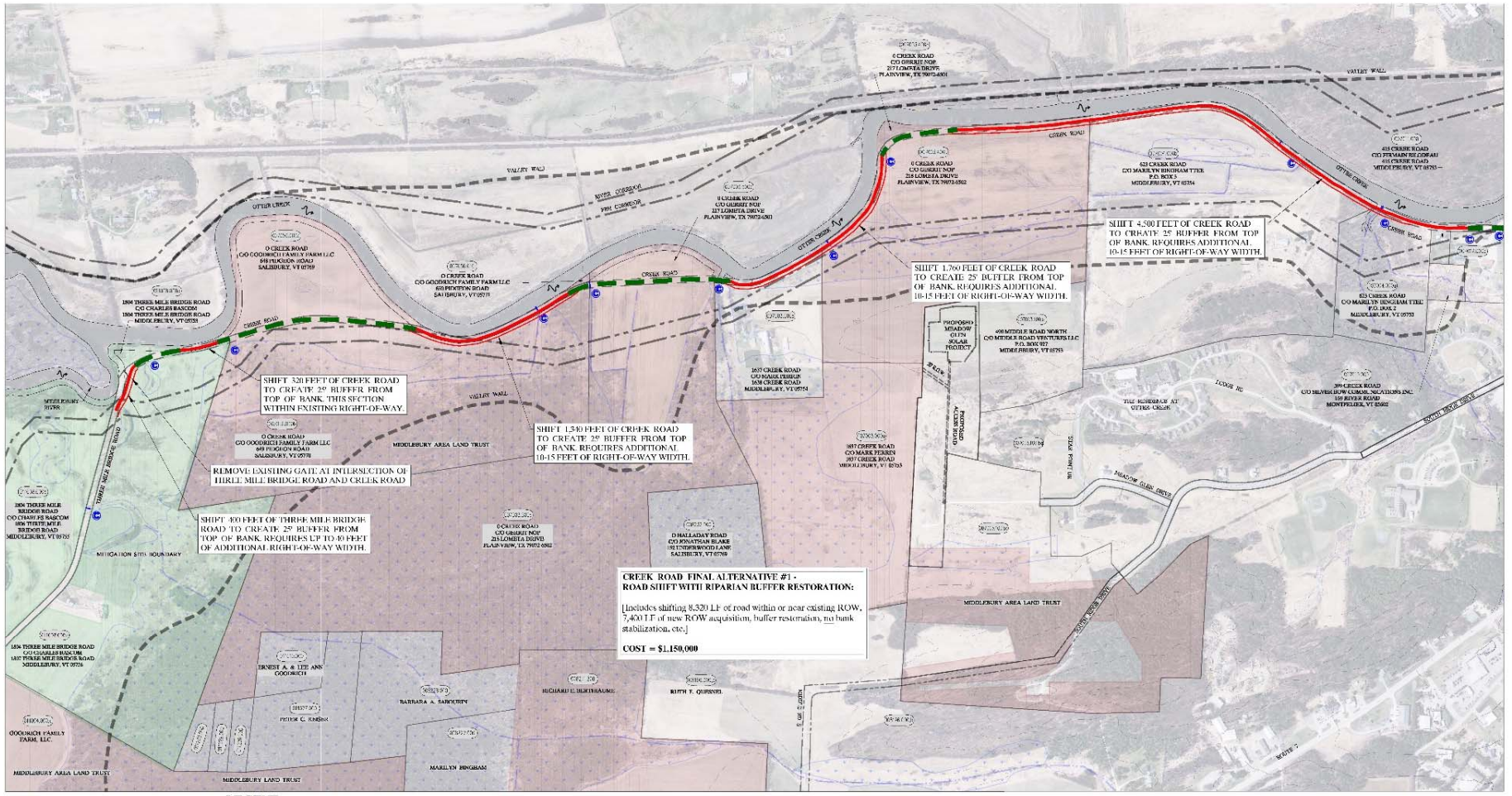
PREPARED BY PATHWAYS CONSULTING, LLC (Project No. 11926)
PATHWAYS PROJECT NO. 12688
DATED: MARCH 13, 2017

	CONCEPTUAL ALTERNATIVES								
	NO BUILD	OPTION 1A	OPTION 1B	OPTION 1C	OPTION 1D	OPTION 2	OPTION 3	OPTION 4	OPTION 5
CRITERIA	Existing Creek Road	Construct new 2,000 LF road connection from middle of Creek Road to Meadow Glen Drive (excludes changes to existing Creek Road)	Construct new 4,320 LF road connection from northern Creek Road to Meadow Glen Drive (excludes changes to existing Creek Road)	Construct new 7,100 LF road bypass from Three Mile Bridge Road to Middle Road South (excludes changes to existing Creek Road)	Construct new 10,500 LF road from northern Creek Road to Three Mile Bridge Road (excludes changes to existing Creek Road)	Shift 8,320 LF of existing Creek Road to east within or near existing right-of-way to restore 25-foot riparian buffer between Creek Road and Otter Creek	Complete limited bank stabilization measures on 2,200 LF (critical areas) of Creek Road/Otter Creek	Convert 10,500 LF of Creek Road to 10 foot Multi-Use Path	Implement minimum maintenance measures on 12,400 LF of Creek Road
DESIGN AND CONSTRUCTION IMPACT									
New Road Alignment Required	None	2,000 LF	4,320 LF	7,100 LF	10,500 LF	8,320 LF (partial)	None	None	None
Right-of-Way (ROW) or Easement Acquisition Required	None	2,000 LF of 50-foot ROW on two private properties	4,320 LF of 50-foot ROW on 4 private properties	7,100 LF of 50-foot ROW on 9 private properties	10,500 LF of 50-foot ROW on 6 private properties	7,400 LF of ROW (average 10-15 foot width) on 7 private properties	None	None	None
Change to Private Property Access	None	One new driveway required; 5 properties impacted	One new driveway required; 5 properties impacted	One new driveway required; 5 properties impacted	4 properties impacted	None	None	One new driveway required; 5 properties impacted	None
Construction Cost (including Engineering/Permitting)	None	$492,000 (plus existing Creek Road)	$940,000 (plus existing Creek Road)	$1,543,000 (plus existing Creek Road)	$2,003,000 (plus existing Creek Road)	$1,150,000	$1,206,000.00	$993,000	$330,000
Level of Future Maintenance/Cost (High/Medium/Low/None)	High	Low/Medium	Low/Medium	Medium	Medium	Low	Medium	Low	High
Construction Duration (assuming single phase)	None	3 months	6 months	12 months	18 months	12 months	6 months	6 months	6 months
Level of Regulatory Review (High/Moderate/Low/None)	None	Low	Low	High	High	Low	Moderate	Low	Low
Permitting Duration (High/Moderate/Low/None)	None	Low	Low	High	High	Moderate	High	Low	Low
Potential for Grant Funding	None	Possible	Possible	Yes	Yes	Yes	Possible	Yes	No
Require Private Land Owner Approval	None	Yes	Yes	Yes	Yes	Yes	No	No	No
Drainage Improvements Along Creek Road (Significant/Limited/None)	None	Limited	Limited	None	Limited	Signifcant	Limited	Limited	Significant
RESOURCE IMPACT									
Impact on River Corridor	None - 12,000 LF of Creek Road remains in River Corridor	Removes 5,700 to 6,300 LF of Creek Road from River Corridor	Removes 10,500 LF of Creek Road from River Corridor	Removes 10,500 of Creek Road from River Corridor	Removes 8,700 LF of Creek Road from River Corridor	None	None	Removes 10,500 LF of Creek Road from River Corridor	None - 12,000 LF of Creek Road remains in River Corridor
Water Quality Improvements in Otter Creek & Middlebury River (Significant/Limited/None)	None	Limited	Limited	Significant	Significant	Significant	Limited	Limited	Limited
Reduce Erosion Along Otter Creek & Middlebury River (High/Moderate/Low/None)	None	Low	Low	Moderate	Moderate	High	Moderate	Moderate	Low
Wetland Impacts	None	0.5 acres	None	5.5 acres	4.2 acres	1.1 acres	0.5 acres	0.2 acres	1.5 acres
Floodplain Impacts (Significant/Limited/None)	None	Limited	Limited	Limited	Significant	Limited	None	None	Limited
Conservation Easement Impacts (Significant, Limited, None - Property Identify)	None	Limited - MALT (Candido)	Limited - MALT (Candido)	Significant - MALT (Seeley, Berthiaume, Hathaway), Ducks Unlimited Mitigation Site	Significant - MALT (Seeley), Ducks Unlimited Mitigation Site	Limited - MALT (Candido & Seeley), Ducks Unlimited Mitigation Site	None	None	None
Enhancement of Public Amenities/Access	None	Yes	Yes	Possible	Possible	No Change	No Change	Yes	No Change
Creek Road Remain Open to Vehicular Traffic	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Impact to Current Traffic Patterns	No	Yes	Yes	Yes	No	No	No	Yes	No

Final Design Recommendations Considered

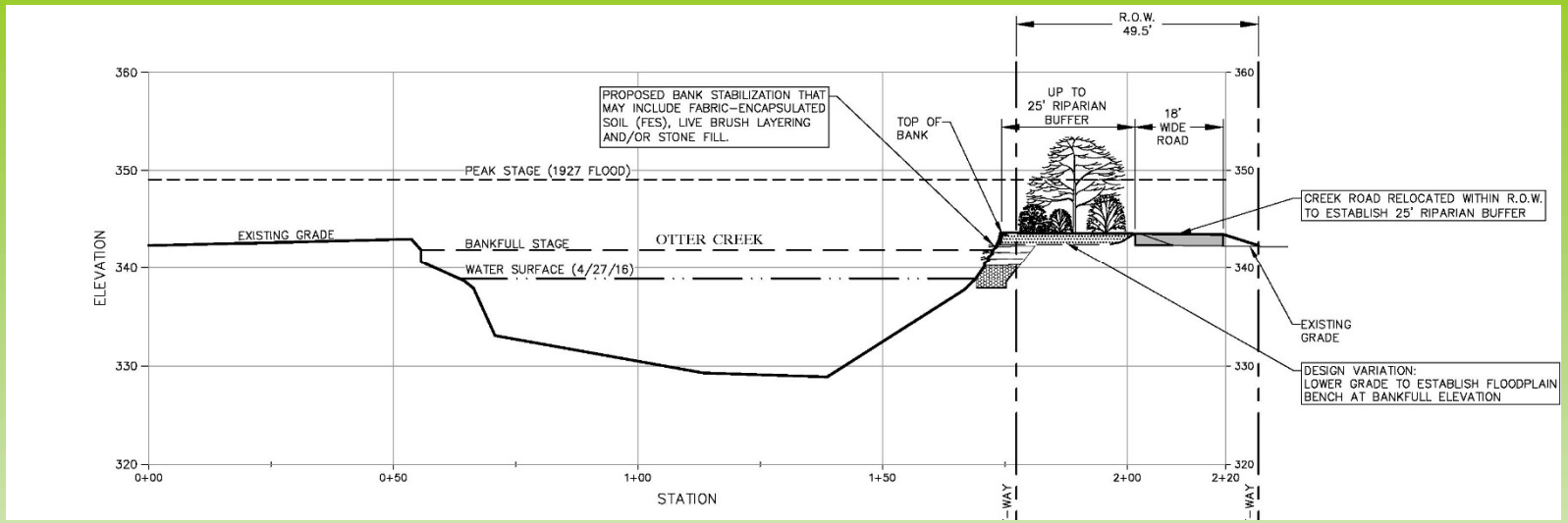
- Design Recommendation #1 – Road Shift with Riparian Buffer Restoration
- Design Recommendation #2 – Bank Stabilization and Minimum Roadway Improvements
- Design Recommendation #3 – Meadow Glen Drive Road Connection With Road Shift and Riparian Buffer Restoration on North/South Creek Road
- Design Recommendation #4 – Maintaining Creek Road In-Place

Design Recommendation #1 – Road Shift with Riparian Buffer Restoration

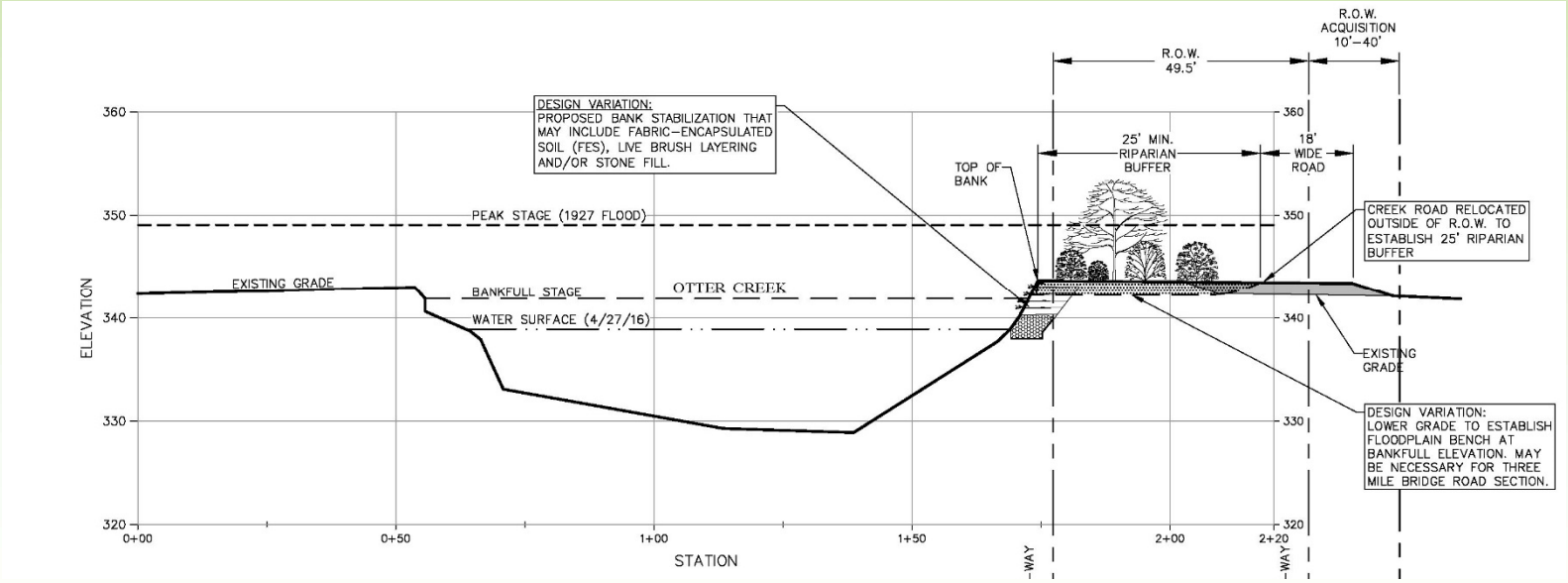


Pathways Consulting, LLC

Cross-Sections for Design Recommendation #1 –Road Shift with Buffer Restoration

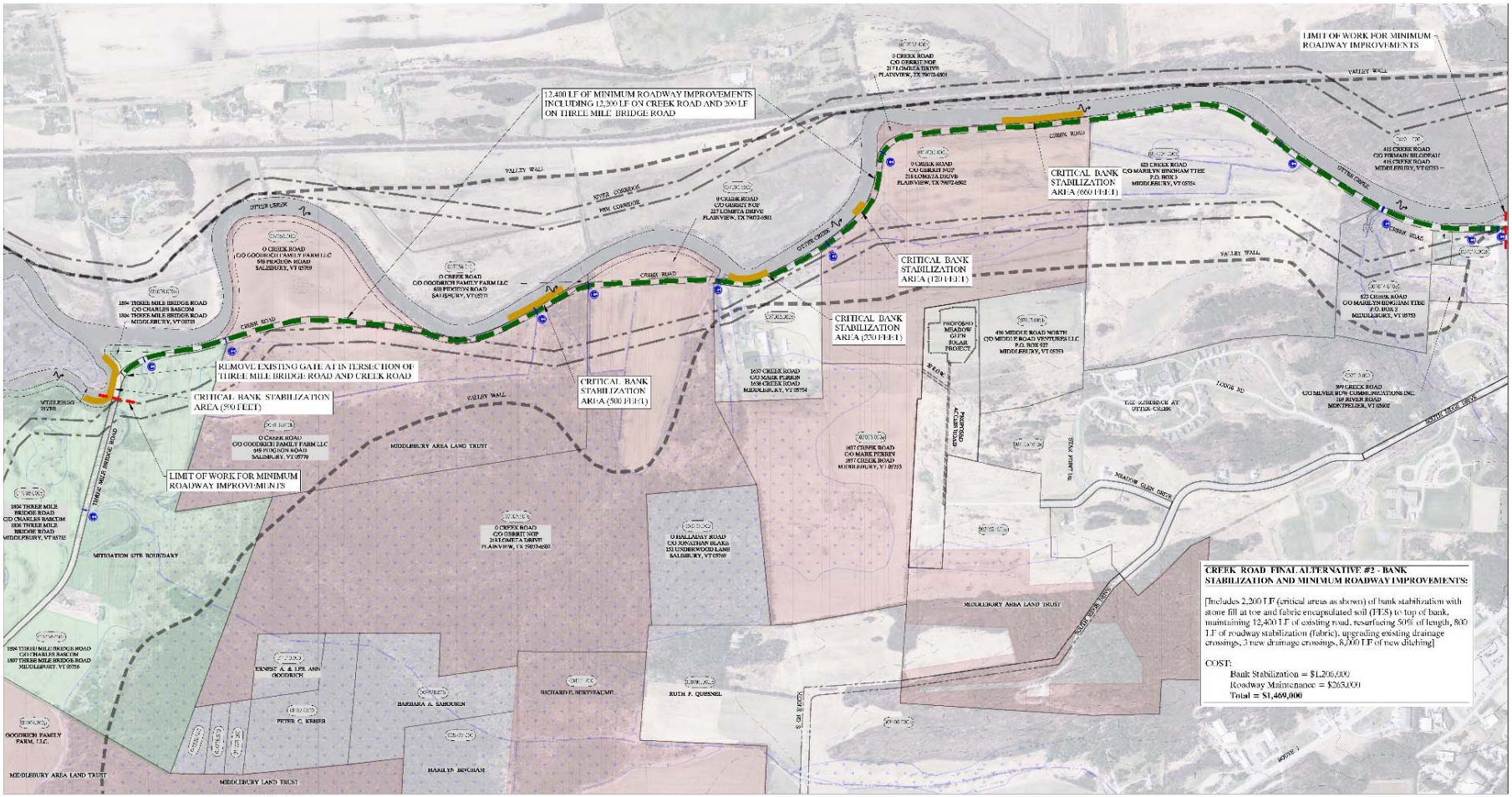


CROSS-SECTION – ROAD SHIFT WITHIN ROW WITH BANK STABILIZATION

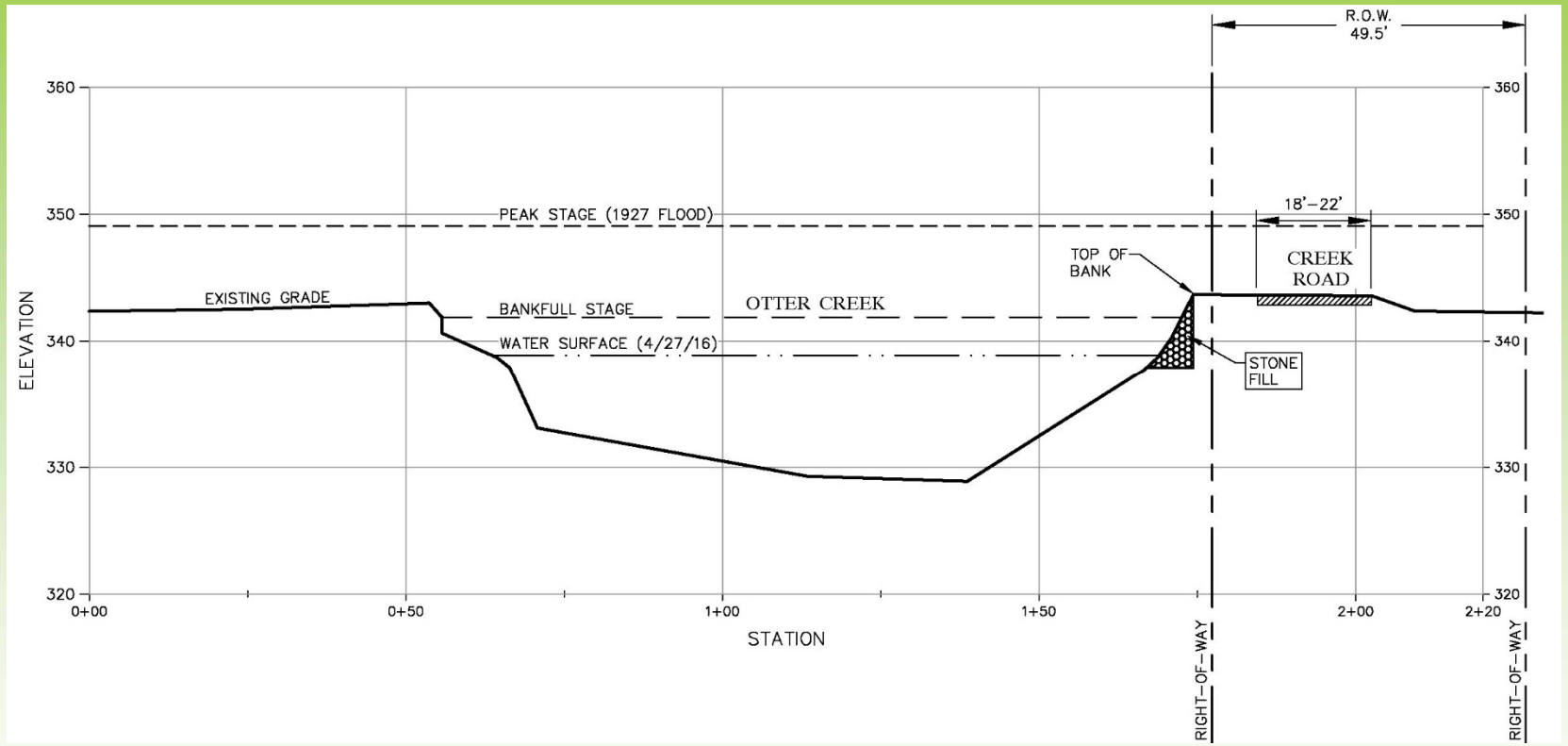


CROSS-SECTION – ROAD SHIFT OUTSIDE ROW WITH BANK STABILIZATION

Design Recommendation #2 – Bank Stabilization and Minimum Roadway Improvements



Cross-Section for Design Recommendation #2 – Bank Stabilization and Minimum Roadway Improvements



CROSS-SECTION – BANK STABILIZATION

Bank Restoration Examples

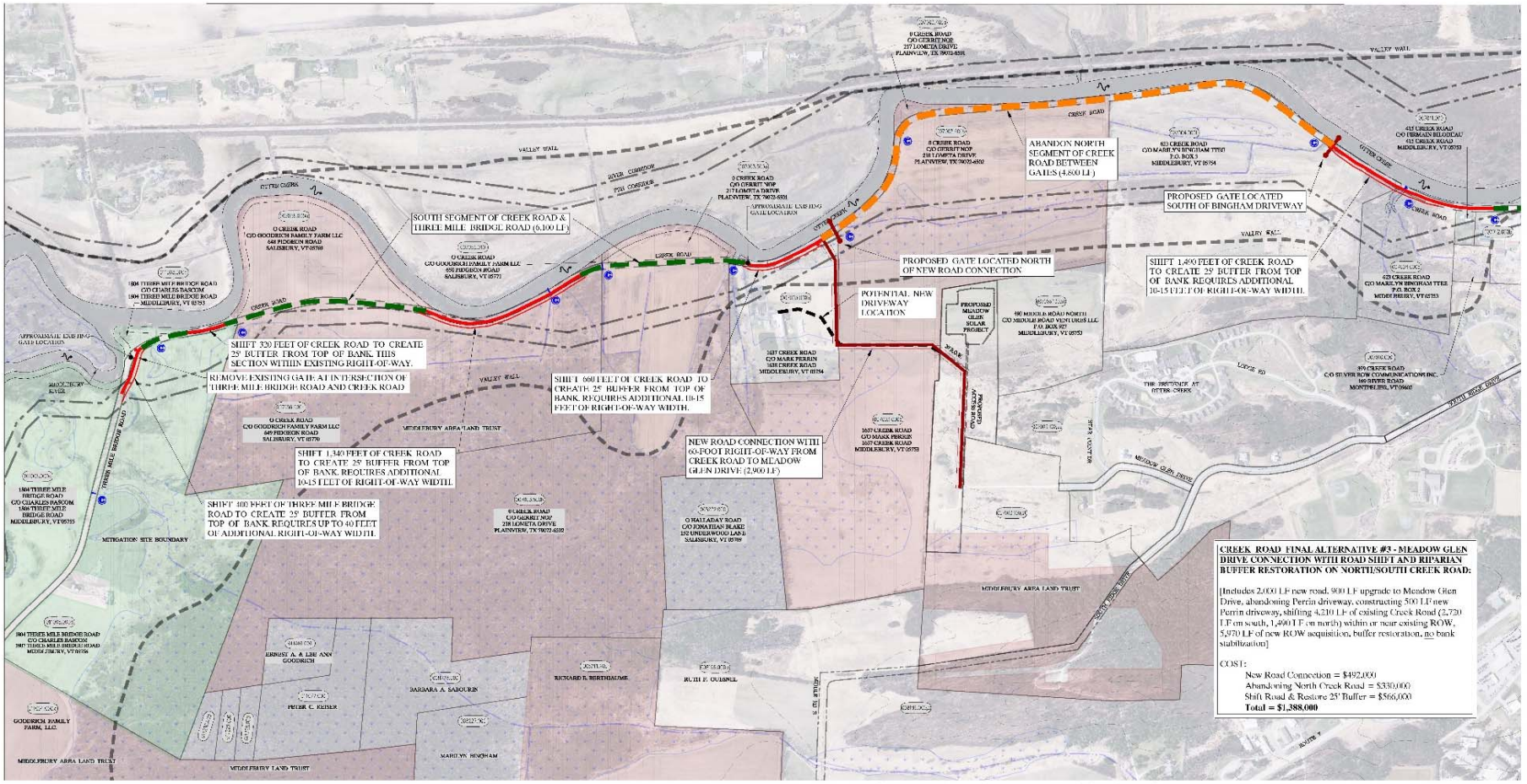
Fabric Encapsulated Soil (FES)

FES with Floodplain Bench

FES with Stone Fill, Floodplain Bench

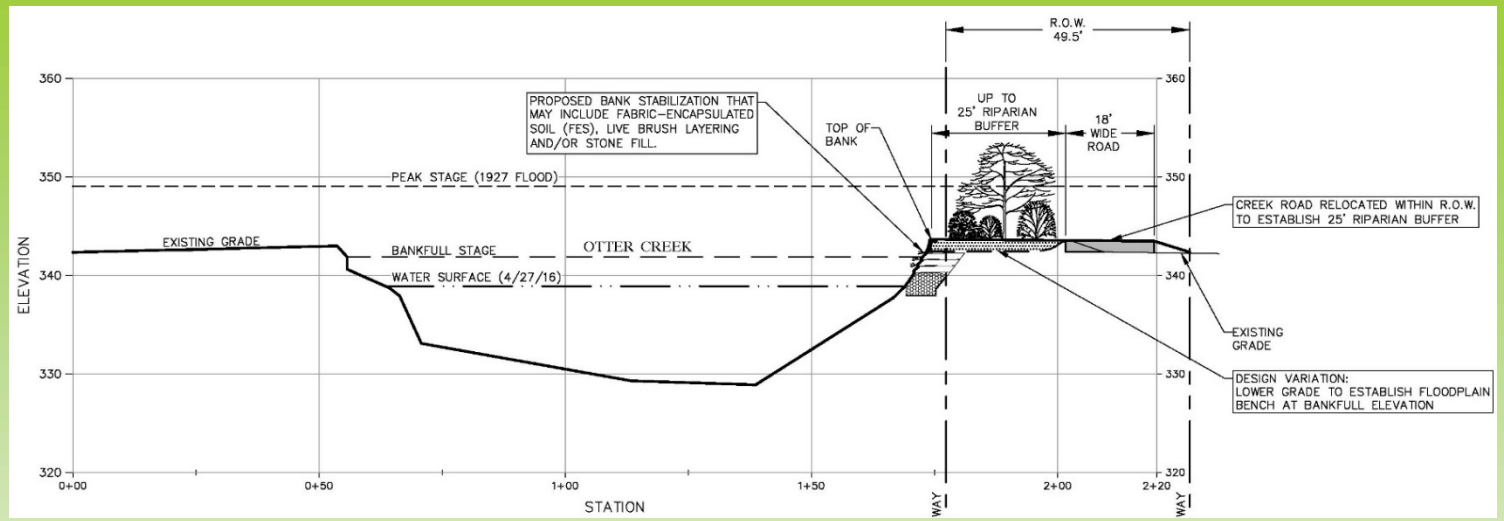
Stone Fill with Loam & Vegetation

Design Recommendation #3 – Meadow Glen Drive Connection with Road Shift and Riparian Buffer Restoration on North/South Creek Road

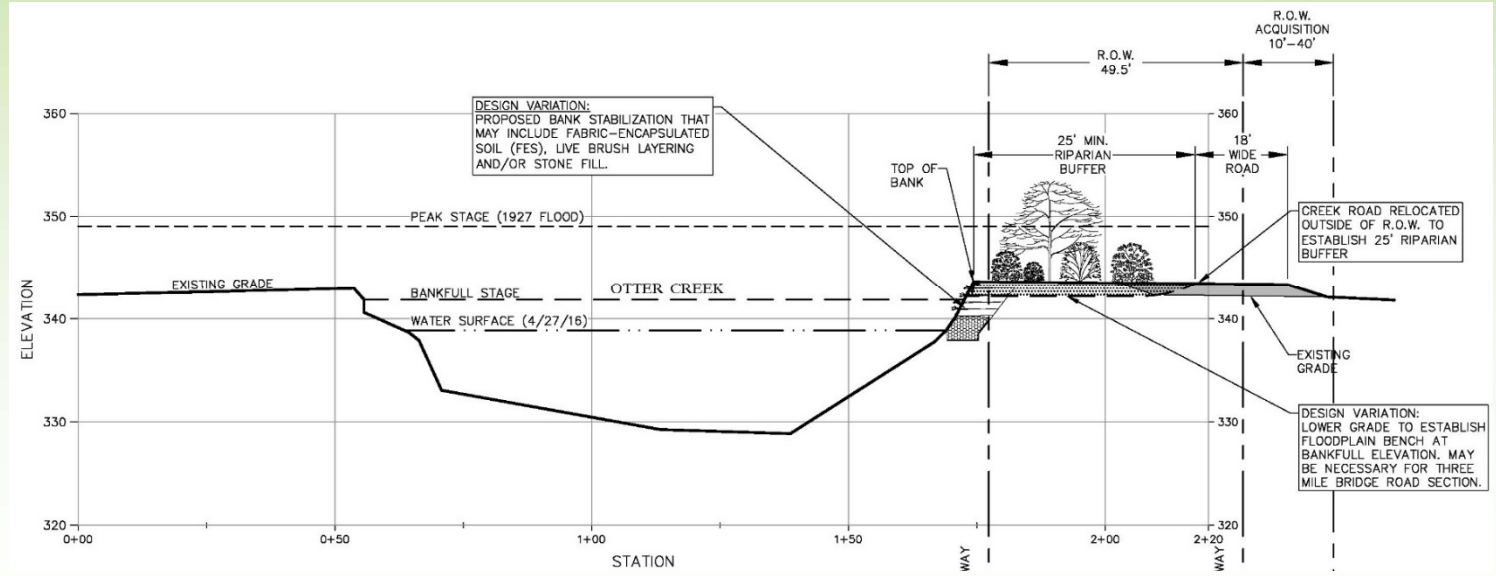


Pathways Consulting, LLC

Cross-Sections for Design Recommendation #3 – Meadow Glen Drive Connection with Road Shift and Riparian Buffer Restoration on North/South Creek Road

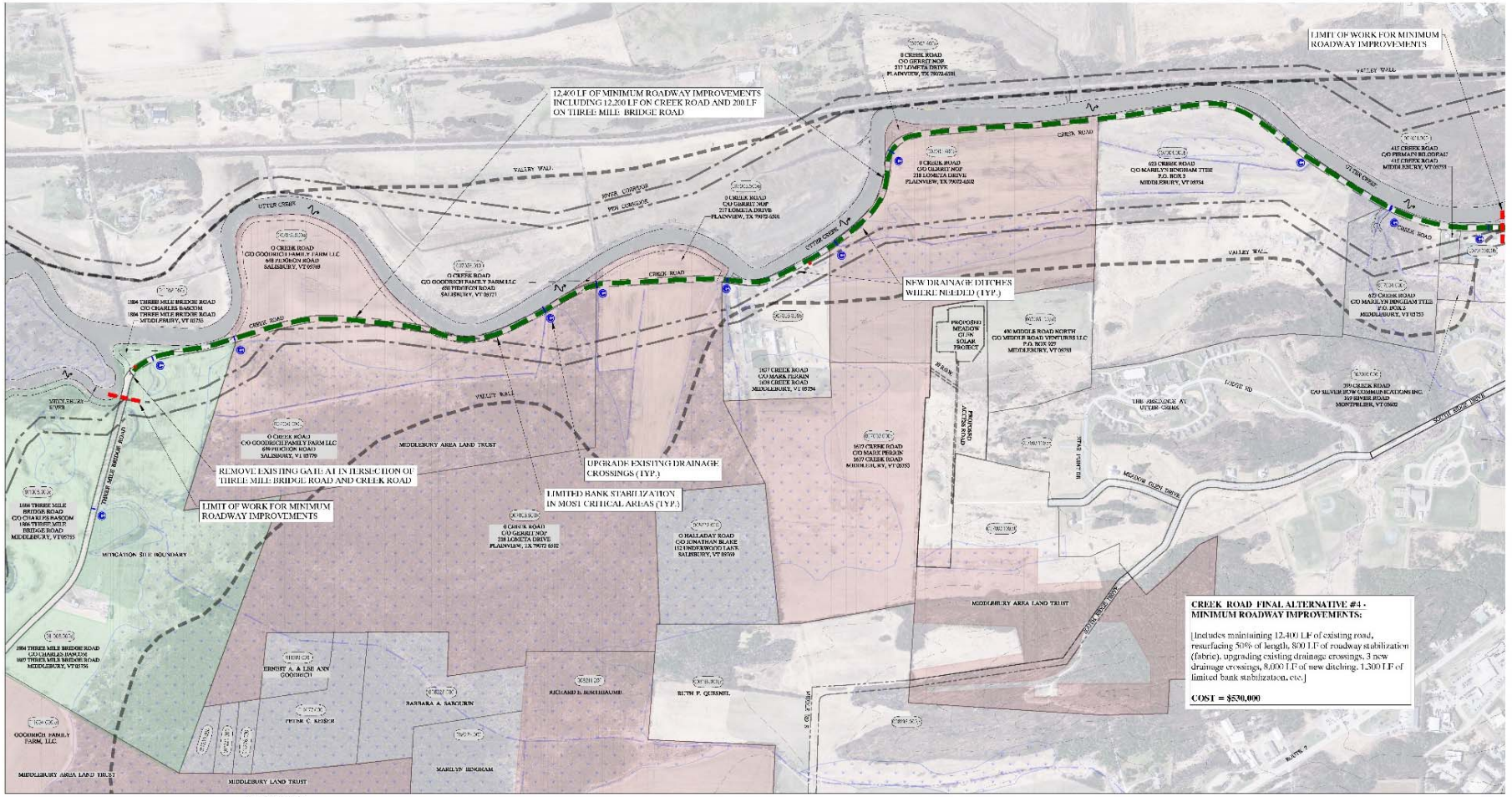


CROSS-SECTION – ROAD SHIFT WITHIN ROW WITH BANK STABILIZATION



CROSS-SECTION – ROAD SHIFT OUTSIDE ROW WITH BANK STABILIZATION

Design Recommendation #4 – Minimum Roadway Improvements To Maintain Creek Road In-Place



LEGEND

- MIDDLEBURY AREA LAND TRUST
- MITIGATION SITE BOUNDARY
- WETLANDS - VSWI
- WETLANDS - ADVISORY
- EXISTING STREAM / DITCH
- EXISTING CULVERT (CREEK ROAD)
- EXISTING CREEK ROAD

CREEK ROAD EROSION STUDY
MIDDLEBURY, VERMONT
FINAL ALTERNATIVE #4 PLAN - MINIMUM ROADWAY IMPROVEMENTS TO MAINTAIN CREEK ROAD IN-PLACE
PATHWAYS CONSULTING, LLC MAY 23, 2017

240 Mechanic Street, Suite 100
Lebanon, New Hampshire 03766
(603) 448-2200 FAX: (603) 448-1221

Design Recommendations #1-4 Comparison Table

CRITERIA	NO BUILD	DESIGN #1	DESIGN #2	DESIGN #3	DESIGN #4
DESIGN AND CONSTRUCTION IMPACT					
New Road Alignment Required	None	8,320 LF (partial)	None	2,000 LF	None
Right-of-Way (ROW) or Easement Acquisition Required	None	7,400 LF of ROW (average 10-15 foot width) on 7 private properties	None	2,000 LF of 60-foot ROW on two private properties; and 3,970 LF (average 10-15 foot wide) on 6 private properties	None
Change to Private Property Access	None	None	None	One new driveway may be needed, 2 properties impacted	None
Construction Cost (including Engineering/Permitting)	None	$1,150,000	$1,469,000.00	$1,388,000	$530,000
Level of Future Maintenance/Cost (High/Medium/Low/None)	High	Low	Medium	Low	High
Construction Duration (assuming single phase)	None	12 months (two construction seasons)	6 months (one construction season)	12 months (two construction seasons)	6 months (one construction season)
Level of Regulatory Review (High/Moderate/Low/None)	None	Low	Moderate	Moderate	Low
Permitting Duration (High/Moderate/Low/None)	None	Moderate	High	Moderate	Low
Potential for Grant Funding	None	Yes	Possible	Possible	No
Require Private Land Owner Approval	None	Yes	No	Yes	No
Drainage Improvements Along Creek Road (Significant/Limited/None)	None	Significant	Significant	Limited	Significant
RESOURCE IMPACT					
Impact on River Corridor	None - 12,000 LF of Creek Road remains in River Corridor	None	None - 12,000 LF of Creek Road remains in River Corridor	Removes 4,800 LF of Creek Road from River Corridor	None - 12,000 LF of Creek Road remains in River Corridor
Water Quality Improvements in Otter Creek & Middlebury River (Significant/Limited/None)	None	Significant	Limited	Significant	Limited
Reduce Erosion Along Otter Creek & Middlebury River (High/Moderate/Low/None)	None	High	High	High	Low
Wetland Impacts	None	1.1 acres	2.0 acres	1.1 acres	1.5 acres
Floodplain Impacts (Significant/Limited/None)	None	Limited	Limited	Significant	Limited
Conservation Easement Impacts (Significant, Limited, None - Property Identify)	None	Limited - MALT (Candido & Seeley), Ducks Unlimited Mitigation Site	None	Significant - MALT (Candido & Seeley), Ducks Unlimited Mitigation Site	None
Enhancement of Public Amenities/Access	None	No Change	No Change	Yes	No Change
Creek Road Remain Open to Vehicular Traffic	No	Yes	Yes	Yes	Yes
Impact to Current Traffic Patterns	No	No	No	Yes	No

Comparison of Final Design Recommendations

- **Design Recommendation #1 – Road Shift with Riparian Buffer Restoration**
  - Shift 8,320 feet of Creek Road within, or near ROW
  - 7,400 feet of new ROW acquisition or easements (10 to 40 feet)
  - Restores 25-foot buffer between road and Otter Creek banks
  - Estimated Cost = $1,150,000

- **Design Recommendation #2 – Bank Stabilization and Minimum Roadway Improvements**
  - Implement 2,200 feet of bank stabilization along critical sections including stone fill toe protection and fabric encapsulated soil (FES)
  - Minimum roadway improvements along 12,400 feet of road including resurfacing 50%, 800 feet of fabric road stabilization, upgrading drainage crossings, adding three new drainage crossings, new ditching
  - Estimated Cost = $1,469,000

Comparison of Final Design Recommendations (Cont.)

- **Design Recommendation #3 – Meadow Glen Drive Road Connection With Road Shift and Riparian Buffer Restoration on North/South Creek Road**
  - Constructing new 2,000-foot road connection between Meadow Glen Drive and Creek Road
  - Shift 4,210 feet of Creek Road within, or near ROW
  - Abandon and restore 4,800 feet of existing road to natural condition
  - 2,000 feet of new ROW acquisition (60 feet wide) for new road, 3,970 feet of additional ROW or easements (10 to 40 feet) for road shift
  - Restores 25-foot buffer between road and Otter Creek banks
  - Estimated Cost = $1,388,000
- **Design Recommendation #4 – Maintain Creek Road In-Place**
  - Implement minimum roadway improvements along 12,400 feet of road including resurfacing 50%, 800 feet of fabric road stabilization, upgrading drainage crossings, adding three new drainage crossings, 8,000 feet of new ditching , and 1,300 feet of bank stabilization
  - Estimated Cost = $530,,000

Regulatory, Permitting, and Environmental Review

- **Completed preliminary assessment of regulatory reviews and/or permits needed for designs #1-4:**
  - ❖ VANR and USACE Wetland permitting
  - ❖ VANR Stream Alteration permitting
  - ❖ Endangered and/or Threatened Species review
  - ❖ FEMA coordination and review
  - ❖ Town Zoning and Subdivision regulations review for farmland, wildlife habitat, shorelands, riparian buffers, floodplains, subdivisions
  - ❖ Town Conservation Commission
  - ❖ Conservation easement impact potential and negotiations (MALT, Ducks Unlimited, and others)
  - ❖ Historic Preservation review

Overall Recommendation

- **Design Recommendation #1 (Road Shift):**
  - ❖ Cost-effective and feasible
  - ❖ Restores riparian buffer, shifts road away from Otter Creek
  - ❖ Addresses current bank erosion areas
  - ❖ Lowest cost of long-term solutions considered
  - ❖ Limited width ROW acquisition (less costly than full-width acquisition and eases negotiation)
  - ❖ Less impacts to natural resources, private properties, and existing conservation easements
  - ❖ Maintains existing traffic pattern and public use
  - ❖ Moderate permitting considerations
  - ❖ Recommended through Town review
  - ❖ Reasonably supported by public opinion

Future Steps and Funding Potential

- **Future tasks for implementing design recommendation:**
  - ❖ Additional public engagement and sharing
  - ❖ Site reconnaissance and investigation (survey, wetlands, etc.)
  - ❖ Final engineering and design with capable consulting firm
  - ❖ Boundary surveying, deed research, and ROW acquisition
  - ❖ Abutting property owner negotiations
  - ❖ Environmental and natural resource review
  - ❖ Local, State and Federal regulatory review and permitting (VANR, USACE, FEMA, Town, etc.)
  - ❖ Explore funding through various grant and/or loan programs:
    - ➢ FEMA Hazard and Pre-Disaster Mitigation Grant Programs
    - ➢ Vermont Better Roads
    - ➢ VANR Conservation Ecosystem Restoration Grant Program
    - ➢ USDA Rural Development Grant Program
  - ❖ Secure funding for project design and construction

Conclusion of Study

- **Final Creek Road Erosion Study Report (June 16, 2017):**
  - ❖ Compilation of all work, plans, analysis, and documentation completed during the project
  - ❖ Included separate Executive Summary document for Town
- **Future Project Review (beyond study scope):**
  - ❖ Town has already engaged in planning discussions through Selectboard, Infrastructure and Budget Committees, Public Works, and other Town staff
- **QUESTIONS?**