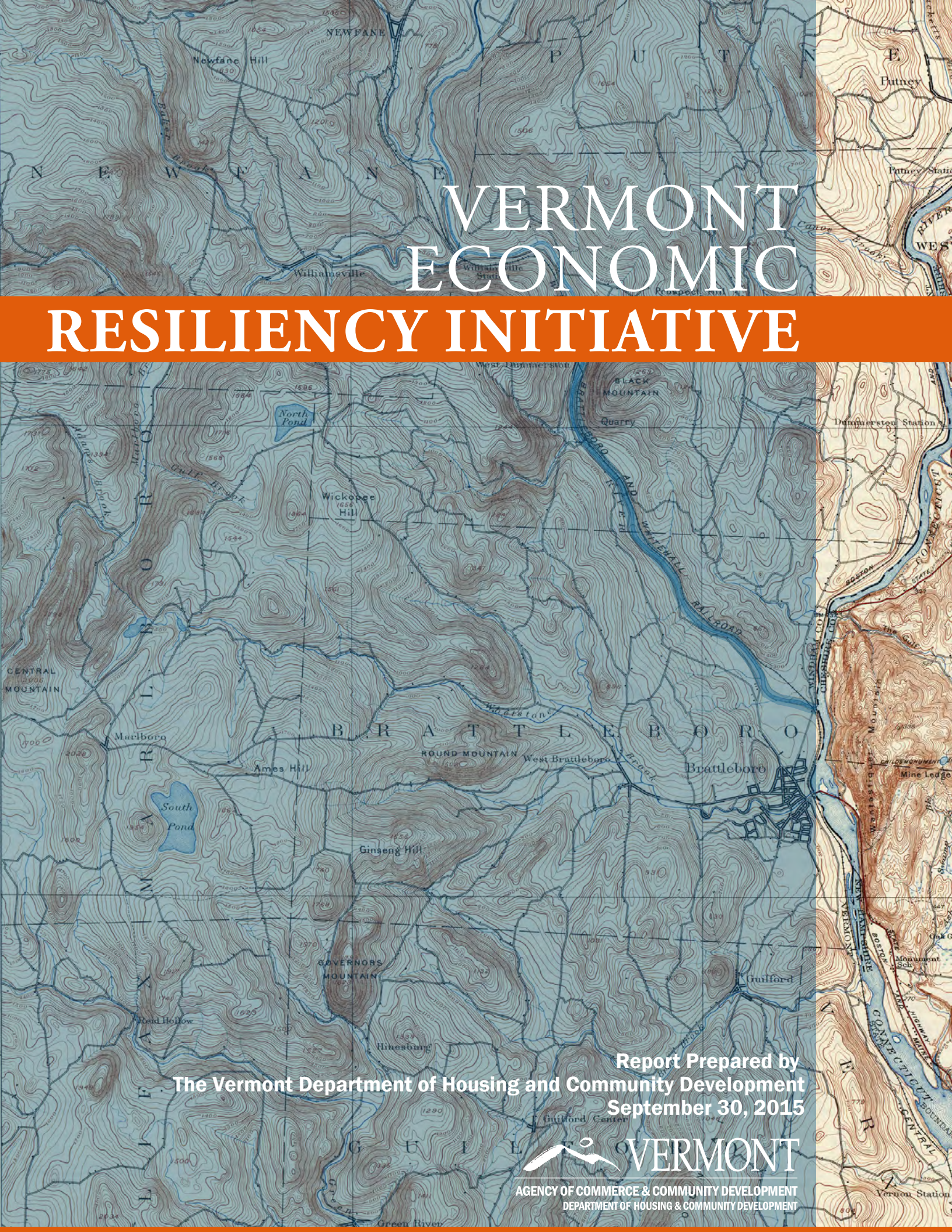

# VERMONT ECONOMIC RESILIENCY INITIATIVE

Report Prepared by
The Vermont Department of Housing and Community Development
September 30, 2015

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

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DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI

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# Table of Contents

## Chapter 1

Overview ..... 1.1

## Chapter 2

Overview ..... 2.1
The Cost of Flooding to Vermont's Economy ..... 2.2
Evaluating Economic Activity ..... 2.4
  Vermont Economy: An Overview ..... 2.4
  Economic Activity: The Methodology ..... 2.6
Understanding Vermont's Flood Risk ..... 2.11
  Mapping Flood Hazard Areas ..... 2.12
  River Corridor Mapping Procedures: The Details ..... 2.15
  Risk Assessment ..... 2.18
  Utilizing the Information ..... 2.23
Infrastructure, Commercial Buildings and River Corridors: A Vulnerability Assessment ..... 2.23
Next Steps: Prioritizing Five Communities ..... 2.28
Resources ..... 2.28
  For more information on FEMA FIRM ..... 2.29
Appendix 2.1 ..... 2.31
Appendix 2.2 ..... 2.33
Appendix 2.3 ..... 2.35

## Chapter 3

Overview ..... 3.1
Step #1: Economic Activity Screen ..... 3.1
  Methodology: Linear Index for Economic Activity ..... 3.2
Step #2: Infrastructure Vulnerability Screen ..... 3.4
Step #3: Commercial Building Vulnerability Screen ..... 3.6
Step #4: Combining Economic, Infrastructure and Building Screens ..... 3.6
The Final Five Regions Chosen: ..... 3.12
Appendix 3.1: ..... 3.17
Appendix 3.2 ..... 3.20
Appendix 3.3 ..... 3.23
Appendix 3.4 ..... 3.26
Appendix 3.5 ..... 3.29
Appendix 3.6 ..... 3.32

## Chapter 4

Overview ..... 4.1
It's All about Partnership ..... 4.1
Fieldwork and Data Review ..... 4.4
  Analysis: Businesses At-Risk ..... 4.7
  Policy and Program Review ..... 4.8
Site Specific Projects ..... 4.11
Community Engagement ..... 4.14
Appendix 4.1 ..... 4.17

Request for Proposals....4.17
List of Consultants Selected....4.29
Appendix 4.2....4.30
Welcome Letter....4.30
VERI Overview....4.33
Overview of the Local Study Area....4.34
Bennington Case Study....4.35
Appendix 4.3....4.37
Sample Notification Letter....4.37
Appendix 4.4....4.38
Community Reports....4.38

## Chapter 5

Overview....5.1
Listening and Documenting Lessons Learned....5.2
Filling the Data Gap....5.4
River Corridor Protocols and Maps....5.4
Identifying Vulnerable Roads Segments....5.5
Identifying Undersized Bridges and Culverts....5.5
Digital Parcel Data....5.6
Provide Tools and Training to Municipalities....5.6
VERI Framework for Targeting Investment to Protect Business and the Economy....5.7
Flood Resilience Checklist....5.8
State Planning Manual Update....5.9
Stormwater and Green Infrastructure Guidelines....5.9
Technical Guidance: Standard River Management Principles and Practices....5.10
Update Standards and Policies....5.10
Town Plan Updates: New Flood Resilience Element Required....5.11
ERAF Updates....5.11
New Rivers, Road and Bridge Standards....5.13
Flood Hazard Area and River Corridor Rule....5.15
Shoreland Protection and Water Quality Protection Acts....5.15
Strengthen Communication and Coordination....5.16
Information Easy to Access: Flood Ready Vermont....5.16
Roads and Rivers Training....5.17
Targeting Rebuilding and Mitigation Investments Together....5.18
Improve Response and Preparedness....5.19
Assisting Businesses Planning....5.20
Updating and Testing Emergency Preparedness Plans....5.20
Integrating Data Gathering with Emergency Management....5.21
Improving Response Time....5.22
Next Steps: Implementing VERI through Partnerships....5.22
Resources....5.24
Appendix 5.1:....5.25

## Chapter 6

Tools You Can Use....6.1

# List of Figures

## Chapter 2

Figure 2.1: River Corridors Designed to Encompass Channel Evolution ..... 2.13
Figure 2.2: Stream Channel Meander Pattern Adjustment over Time ..... 2.14
Figure 2.3: Sample Phase II River Corridor Map ..... 2.16
Figure 2.4: Depiction of Meander Centerline and Belt Width ..... 2.17
Figure 2.5: Impact of Floodplain Access on the River Channel ..... 2.19
Figure 2.6: 1927 Flood in Randolph, Vermont ..... 2.20
Figure 2.7: Bankfull Width ..... 2.24
Figure 2.8: Map of Federal Aid Highway Miles in River Corridors ..... 2.25
Figure 2.9: VTrans Vulnerability Assessment in Woodstock ..... 2.26
Figure 2.10: VTrans Vulnerability Assessment in Barre City ..... 2.27

## Chapter 3

Figure 3.1: 2012 Annual Average Number of Establishments ..... 3.3
Figure 3.2 Miles of Federal Aid Roads in River Corridors ..... 3.5
Figure 3.3: Summary of VERI Screening Process ..... 3.10
Figure 3.4: Map of Barre Study Area ..... 3.12
Figure 3.5: Map of Brandon Study Area ..... 3.13
Figure 3.6: Map of Brattleboro Study Area ..... 3.14
Figure 3.7: Map of Enosburg Study Area ..... 3.15
Figure 3.8: Map of Woodstock Study Area ..... 3.16
Figure 3.9: Annual Average Employment (2012) ..... 3.17
Figure 3.10: Total Town Wages (2012) ..... 3.18
Figure 3.11: Room Taxes (2012) ..... 3.19
Figure 3.12: Bridges Having Spans of Less than Bankfull Width ..... 3.23
Figure 3.13: Federal Aid Road Miles in High River Erosion Areas ..... 3.24
Figure 3.14: Federal Aid Road Miles in High River Deposition Areas ..... 3.25

## Chapter 4

Figure 4.1: 2011 Flood Damage Costs in Woodstock by Category ..... 4.2
Figure 4.2: Woodstock Community Forum Held on October 2, 2014 ..... 4.4
Figure 4.3: Fieldwork Makes the Difference – Measuring Undersized Culvert ..... 4.5
Figure 4.4: River Data Collection ..... 4.6
Figure 4.5: Gunner's Brook in Barre City ..... 4.7
Figure 4.6: 2015 Community Forum in Barre ..... 4.13
Figure 4.7: Future Flooding is Now ..... 4.15

## Chapter 5

Figure 5.1: Map of ERAF participation (July 2015) ..... 5.13
Figure 5.2: VTrans Updated the Orange Book in 2013 ..... 5.14
Figure 5.3: Governor Shumlin Signing the Shoreland Protection Act into Law ..... 5.15
Figure 5.4: Road and Rivers Training Program ..... 5.17
Figure 5.5: Stafford Hill Solar Farm Increases Vermont's Safety and Resilience ..... 5.19

# List of Tables

## Chapter 2

Table 2.1: Hazards Considered from the State Hazard Mitigation Plan ..... 2.1
Table 2.2: Major Industry Sectors that Contribute to State of Vermont Economy ..... 2.5
Table 2.3: Summary of Economic Data Set Review ..... 2.7
Table 2.4: Factors Used to Make River Corridor Delineations in Vermont ..... 2.31
Table 2.5: Vermont River Corridor Geodatabase Design and Development ..... 2.33

## Chapter 3

Table 3.1: 2012 Annual Average Number of Establishments ..... 3.2
Table 3.2: Total Economic Scores and Rank for Vermont Municipalities ..... 3.3
Table 3.3: Miles of Federal Aid Roads in River Corridors ..... 3.4
Table 3.4: Total Infrastructure Vulnerability Scores and Rank for Vermont Municipalities ..... 3.5
Table 3.5: Top 10 Vermont Municipalities for At-risk Businesses ..... 3.6
Table 3.6: VERI Project Team Review For Identification of 32 Priority Communities ..... 3.9
Table 3.7: Annual Average Employment (2012) ..... 3.17
Table 3.8: Total Town Wages (2012) ..... 3.18
Table 3.9: Room Taxes (2012) ..... 3.19
Table 3.10: Total Economic Scores for Top 82 Vermont Municipalities ..... 3.20
Table 3.11: Bridges Having Spans of Less than Bankfull Width ..... 3.23
Table 3.12: Federal Aid Road Miles in High River Erosion Areas ..... 3.24
Table 3.13: Federal Aid Road Miles in High River Deposition Areas ..... 3.25
Table 3.14: Total Infrastructure Vulnerability Score for Top 75 Vermont Municipalities ..... 3.26
Table 3.15: Municipalities with 10 or More Businesses At-risk ..... 3.29
Table 3.16: Thirty Two Vermont Municipalities with High Economic Activity and Flood Risk ..... 3.32

## Chapter 4

Table 4.1: Neshobe River, Brandon, VT Flood Events and Damage ..... 4.5
Table 4.2: Businesses in Flood/ Erosion Hazard Zones in Woodstock Study Area ..... 4.8
Table 4.3: ERAF Review for Barre Town and City ..... 4.10
Table 4.4: Summary of Policy and Program Recommendations ..... 4.10
Table 4.5: Summary of Project Specific Categories ..... 4.11
Table 4.6: Summary of Project Specific Recommendations ..... 4.12

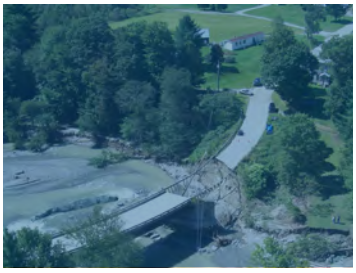
## Chapter 5

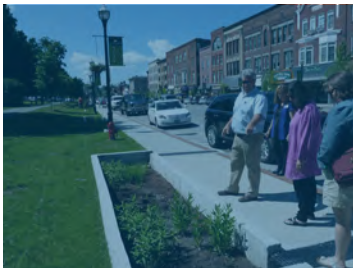
Table 5.1: Vermont Roadways with Unstable River Corridors (URC) ..... 5.5
Table 5.2: ERAF Matching Requirements ..... 5.12
Table 5.3: Municipalities and ERAF Requirements – 2014 Compared with 2015 ..... 5.12

## List of Acronyms

| | |
|---|---|
| **BACH-DA** | Business, Agriculture, Cultural and Historic Damage Assessment |
| **BFE** | Base Flood Elevation |
| **CEDS** | Comprehensive Economic Development Strategy |
| **CIS** | Community Information System |
| **CRS** | Community Rating System |
| **COOP** | Continuity of Operations Plan |
| **DLAN** | Disaster LAN |
| **EMAC** | Emergency Management Assistance Compact |
| **ERAF** | Emergency Relief Assistance Fund |
| **FEH** | Fluvial Erosion Hazard |
| **FEMA** | Federal Emergency Management Agency |
| **FIRM** | Flood Insurance Rate Maps |
| **GIS** | Geographic Information System |
| **GMP** | Green Mountain Power |
| **GSI** | Green Stormwater Infrastructure |
| **IHP** | Individuals and Household Program |
| **ISC** | Institute for Sustainable Communities |
| **LEOP** | Local Emergency Operations Plan |
| **LID** | Low Impact Development |
| **LLIS** | Lessons Learned and Information Shared |
| **NFIP** | National Flood Insurance Program |
| **QCEW** | Quarterly Census of Employment and Wages |
| **RCPA** | River Corridor Protection Area |
| **RDC** | Regional Development Corporation |
| **RPC** | Regional Planning Commission |
| **SEOP** | State Emergency Operations Plan |
| **SFHA** | Special Flood Hazard Area |
| **SGA** | Stream Geomorphic Assessment |
| **SGIA** | Smart Growth Implementation Assistance |

| | |
|---|---|
| **SHMP** | State Hazard Mitigation Plan |
| **S-RAAT** | State Rapid Assessment and Assistance Teams |
| **SRCM** | State River Corridor Maps |
| **URC** | Unstable River Corridor |
| **USDA** | United States Development Agency |
| **US EDA** | United States Economic Development Agency |
| **USEPA** | United States Environmental Protection Agency |
| **V-DAT** | Vermont Downtown Action Team |
| **VERI** | Vermont Economic Resiliency Initiative |
| **VHCB** | Vermont Housing and Conservation Board |
| **VLCT** | Vermont League of Cities and Towns |
| **VLT** | Vermont Land Trust |
| **VT AAFM** | Vermont Agency of Agriculture, Food and Markets |
| **VT ACCD** | Vermont Agency of Commerce and Community Development |
| **VT DHCD** | Vermont Department of Housing and Community Development |
| **VT ANR** | Vermont Agency of Natural Resources |
| **VT DEC** | Vermont Department of Environmental Conservation |
| **VT DEMHS** | Vermont Department of Emergency Management and Homeland Security |
| **VT DOL** | Vermont Department of Labor |
| **VT DOT** | Vermont Department of Taxes |
| **VTrans** | Vermont Agency of Transportation |





# Chapter 1

## Introduction and Overview

## Chapter 1

Overview ..... 1.1

## Overview

Natural disasters represent one of the most significant and costly threats to business today. The effects of damage to businesses, homes, roads and utilities ripple throughout all aspects of the economy of the communities, regions and states affected by natural disaster. For a business, the impacts range from the cost of building repairs, to service disruption, closures, the inability to move goods and services and temporary or permanent unemployment for workers. The broader economic impact can be crippling when you add the infrastructure repair costs borne by taxpayers.

The upheaval from a natural disaster can vary in time and scale. For example, a lack of electricity, water, or wastewater services may mean businesses cannot operate normally and thus remain closed. Damage to roads, bridges and homes may impact the work force who cannot safely commute to work or may be focused on putting their homes and lives back together. Road closures may leave employees stranded, break supply chains and businesses may also be unable to deliver their goods to market. Rising floodwaters may destroy records, equipment or inventory, costing time and money for those impacted businesses. Costly building repairs and high insurance deductibles often exceed the available capital for small businesses to remain open. According to the Federal Emergency Management Agency (FEMA), nearly 40% of businesses do not reopen after a disaster and data from the US Small Business Administration indicates that over 90% of businesses fail within two years after being struck by a disaster.

Even when not directly impacted, many businesses still fail after a disaster due to public perception. Images of floodwaters rushing through a downtown, a rollercoaster sitting off its pier in the ocean, or a covered bridge floating down river, can convey that a community is "closed for business." These impressions can take years to reverse, which may stifle the local economy and stymie the community's ability to recover.

Records from Vermont's Division of Emergency Management and Homeland Security (VT DEMHS) show the state has experienced flooding every year since 2007 and had at least one federally declared disaster in 21 of the past 25 years. While flooding and other natural disasters are not uncommon in Vermont, the scale and impact of the flooding in August 2011 served as a wake-up call and raised awareness of the need for improved strategies to protect areas of key economic importance.

In 2011, Tropical Storm Irene severely damaged Vermont's transportation network, including the closure of 146 state road segments (approximately 531 miles) and 34 state bridges; damage to 2,260 local road segments; the closure of 175 local roads; damage to 289 local bridges of which 90 were closed. Thousands of Vermont's businesses were affected by the flooding and suffered prolonged disruptions to operations.

Given the trend of more extreme and costly weather events over time, disaster preparedness makes good business sense. Understanding and managing risk, is the first step in helping communities and businesses reduce repair costs and remain open after a disaster.

After Tropical Storm Irene, Vermont Governor, Peter Shumlin challenged communities to "build back stronger than Irene found us." The Vermont Economic Resiliency Initiative (VERI) is designed to help meet that challenge. It is modeled after a successful project in Bennington, Vermont that minimized business interruption and saved taxpayers money by substantially reducing flood recovery costs.

With support from the US Department of Commerce, Economic Development Administration (US EDA), the Vermont Agency of Commerce and Community Development (VT ACCD), working with the Agency of Natural Resources (VT ANR), Agency of Transportation (VTrans) and the Regional Planning Commissions (RPCs), launched VERI to better understand Vermont's flood risk and identify and implement projects that protect lives, help businesses remain open and reduce costs to taxpayers for repetitive repair to infrastructure.

VERI built upon the relationships developed and strengthened during Tropical Storm Irene's recovery – and brought together state, regional and local partners to create a new model to help towns identify changes and investments needed to break the cycle of repetitive loss, speed post-disaster economic recovery and reduce the long-term financial burden of disasters on impacted communities, businesses, and individuals. VERI expanded state and local capacity to identify and prioritize risks and take steps to ensure economic viability in the years to come.

This report describes the data, collaborators and the step-by-step process used to pinpoint implementation projects by combining inundation and fluvial erosion flood maps with data on critical infrastructure and key economic assets. It describes the methodology to rank and select communities for detailed analysis as well as how to engage and involve communities in the process to identify policy changes and projects to minimize the economic impact of future floods.

While focused on Vermont, VERI's process, recommendations, conceptual designs and tools create models to help other states and communities analyze and identify flood risk, policy changes and public projects that can reduce threats to their economy. The chapters summarized below may be used as a comprehensive resilience guide book or as stand-alone documents to help communities and states tackle specific issues.

*Chapter 2: Assessing State-Wide Risk, Economic Activity and Associated Infrastructure.* This chapter explains how Vermont evaluated and weighed the many hazards and the steps used to measure and evaluate local economic activity on a statewide basis. It details the state's process to create a statewide flood map that combined FEMA's inundation maps with protocols for a state river corridor map that delineated fluvial erosion hazard areas. It then describes how the statewide flood maps were combined with existing data on road infrastructure and buildings to assess and rank economic vulnerability.

*Chapter 3: Screening Process to Select Communities.* This chapter describes the community selection and prioritization process to select five communities to participate in the project, along with the reasoning and alternatives the team considered to help other states and regions focus their efforts on areas with the greatest need and impact.

*Chapter 4: Partnering with Communities.* This chapter details the on-the-ground project work – the data gathering, field analysis, public input and the process to identify specific projects designed to avoid, mitigate or reduce risk to businesses. A final report was prepared for each community and contains a chart of recommendations along with cost range, the businesses and employees that would benefit and it highlights likely partners and funding sources. The chapter describes how the team worked with each community to prioritize the recommendations and set the stage for implementation. The final five community reports can be found in Appendix 4.4 in Chapter 4.

*Chapter 5: VERI: Part of the Quilt to Rebuild a Stronger Vermont.* This chapter provides a snapshot of lessons learned in Vermont and how projects like VERI and other related initiatives helped advance an integrated, long-term strategy in response to these lessons to protect our people, property, environment and economy from floods and other disasters. Policy, legislation and programs that provide long-term systemic changes are highlighted along with Vermont's collaborative approach.

*Chapter 6: Toolbox for Local Governments and Business.* This chapter provides an 'à la carte' mix of 101 overviews, checklists and more advanced tools that communities and businesses can use to weather the next storm. Documents are grouped into the following categories: floodproofing, managing debris, reducing stormwater with green infrastructure, protecting floodplain river corridors, planning and preparing for disasters and were developed based on the needs identified in the five communities.

Applying the lessons learned from Tropical Storm Irene's recovery and implementing the recommendations resulting from VERI will take time, but work has already begun to bring state agencies, local government, non-profits, philanthropic organizations and others together to determine how best to implement priority projects outlined in this report.

Flooding due to severe storms is certain to happen again in Vermont and other states, but over time, VERI's process, along with data, step-by-step analysis, community outreach, and tools outlined in this report can help communities in Vermont and other states identify and address vulnerabilities to break the cycle of repetitive loss, speed post-disaster economic recovery and reduce the long-term financial burden of disaster.

# Chapter 2

## Statewide Assessment of Risk, Economic Activity and Associated Infrastructure

## Chapter 2


Overview ..... 2.1

The Cost of Flooding to Vermont's Economy ..... 2.2

Evaluating Economic Activity ..... 2.4

- Vermont Economy: An Overview ..... 2.4
- Economic Activity: The Methodology ..... 2.6

Understanding Vermont's Flood Risk ..... 2.11

- Mapping Flood Hazard Areas ..... 2.12
- River Corridor Mapping Procedures: The Details ..... 2.15
- Risk Assessment ..... 2.18
- Utilizing the Information ..... 2.23

Infrastructure, Commercial Buildings and River Corridors: A Vulnerability Assessment ..... 2.23

Next Steps: Prioritizing Five Communities ..... 2.28

Resources ..... 2.28

- For more information on FEMA FIRM ..... 2.29

Appendix 2.1 ..... 2.31

Appendix 2.2 ..... 2.33

Appendix 2.3 ..... 2.35

## Overview

Understanding the type, frequency and level of risk faced by a business, community or state is needed in order to plan, prepare, and respond to those risks. Therefore, one of the first tasks for the Vermont Economic Resiliency Initiative (VERI) project team was to understand the natural and man-made risks faced by Vermont and determine what hazards this project would evaluate on a statewide basis. Knowing and understanding risk is the first step in avoiding economic disruption and loss after a disaster.

The team looked at the State's Hazard Mitigation Plan (SHMP), which is required by the Federal Emergency Management Agency (FEMA) in order for states to receive federal funding for response and recovery (2013 Vermont SHMP: http://vem.vermont.gov/sites/vem/files/VT_SHMP2013%20FINAL%20APPROVED%20ADOPTED%202013%20VT%20SHMP_scrubbed_cleanedMCB.pdf). The SHMP includes an analysis of statewide risk from common man-made and natural disasters such as tornadoes, hurricanes, earthquakes, flooding, winter storms, landslides, wildfires, dam failures, and terrorism. Other less common categories in the plan include: wind, structural fires, transporting hazardous materials, power outages, infectious disease outbreaks, and invasive species. Table 2.1 illustrates the hazards considered from the SHMP which were ranked qualitatively by the State Hazard Mitigation Committee.

**Table 2.1: Hazards Considered from the State Hazard Mitigation Plan**

| Hazard | Frequency of Occurrence | Warning Time | Geographic Extent | Potential Impact |
|---|---|---|---|---|
| Flooding and Fluvial Erosion | Highly Likely | None - Minimal | Region-wide | Major |
| Tornadoes | Occasionally | None- Minimal | Community-wide | Major |
| Severe Thunderstorms | Highly Likely | 6-12 hours | Region-wide | Moderate |
| Landslides/ Rockslides | Likely | None - Minimal | Community-wide | Moderate |
| Wildfires | Occasionally | 6-12 hours | Statewide | Moderate |
| Dam Failure | Unlikely | 3-6 hours | Community-wide | Major |
| Severe Winter Storms | Highly Likely | More than 12 hours | Region-wide | Minor |
| Hail | Likely | 6-12 hours | Region-wide | Minor |
| Ice Jams | Highly Likely | More than 12 hours | Community-wide | Minor |
| Rockcuts | Occasionally | None - Minimal | Community-wide | Minor |
| Extreme Temperatures | Likely | More than 12 hours | Region-Wide | Negligible |

When assembling a team to assess risk in a state or region, it is important to include representatives from emergency management as they have information on repetitive damage, hazard types – key ingredients when developing a risk assessment.

Each hazard poses a different and unique threat to business activity. Depending upon location and context, some are more important than others. For this project, secondary risks were omitted entirely from the VERI analysis, as the likelihood and predictability of these events disrupting economic activity in Vermont is low. This analysis would be different for other states. In California, for example, earthquakes, invasive species or wildfires are a real and present danger to business and/or agriculture.

The project team reviewed each type of risk and considered the probability of occurrence, response and recovery costs, and if the location of occurrence could be predicted. After that analysis, the team decided that this project would focus on the risk from flooding, both inundation and fluvial (river-related) erosion. This is in line with the SHMP and the 1999 Act 137 Report to the Vermont General Assembly, which both identified flooding and fluvial erosion as the number one risk to the state and its economic centers (the report can be found here: http://watershedmanagement.vt.gov/rivers/docs/rv_act137.pdf). Other "highly likely" hazards for Vermont include ice jams, severe thunderstorms, and winter storms, each of which can cause flooding.

High winds, snow storms and ice are all high risk factors in Vermont, but predicting and mitigating their effects is difficult. Nonetheless, several of the tools in Chapter 6, such as local emergency and hazard mitigation plans and continuity of operations plans (COOP) are relevant preparation tools for any disaster.

## The Cost of Flooding to Vermont's Economy

In 2011, thousands of Vermont's small businesses were affected by the flooding associated with both the spring flooding around Lake Champlain and Tropical Strom Irene, and suffered prolonged disruptions to operations. This in turn caused a delay in getting employees back to work and prolonged the recovery of the whole community. Damage to or loss of businesses following a disaster brings multiple hardships to a community including lost job, lost tax revenues for local government, and lost work and sales for local businesses. According to FEMA's Lessons Learned and Information Sharing network, "the private sector employs most of the nation's workforce, owns 85% of critical infrastructure, and

produces goods and services necessary for the day-to-day functioning of society." The recovery of a community is therefore directly related to the recovery of its businesses and workforce.

Damage from a disaster has ripple effects in the lives of individuals, business operations, and community budgets. In April 2012, FEMA issued an Economic Impact Assessment examining the quantitative and qualitative consequences of Tropical Storm Irene (US EDA, 2012) (see resource section). The results of this analysis make it clear that the storm's overall effect was significant:

- By late March 2012, the Small Business Administration had made loans totaling more than $33 million to businesses and individuals;
- The FEMA Individuals and Household Program recorded Real Property Verified Losses as a result of Tropical Storm Irene of almost $25.5 million, representing just over 1,000 homes and businesses;
- By November 2011, the US Department of Agriculture (USDA) had received reports of damage to 463 agricultural producers and it is estimated that 9,348 acres of land damage occurred as a result. Damage ranged from lost crops and infrastructure, land washed away by overflowing rivers and creeks, to wind damage to maple sugar woods; and
- Vermont experienced a sharp spike in initial weekly unemployment claims immediately following Tropical Storm Irene, with an increase in claims of 149% for the week ending September 3rd and the culmination of initial claims from September 3-10th representing a 376% increase.

While flooding and other natural disasters are not uncommon in Vermont, the scale and impact of the events of 2011 (both the spring flooding around Lake Champlain and Tropical Storm Irene) served as a wake-up call and raised awareness of the need for improved strategies to protect areas of key economic importance.

## Evaluating Economic Activity

In the past, when river corridors and their associated watershed have been assessed, recommended management strategies were focused on achieving river stability and floodplain function. The goals were to mitigate hazards, protect public safety, improve water quality, and maintain habitat. However, these strategies did not consider the potential to reduce business closings and loss of income. One key goal of this project was to bring the economic impacts into the prioritization of implementation strategies.

Before conducting a detailed analysis on how best to ensure businesses remain open and economic impacts to communities are reduced at the local level, the VERI project team developed a methodology to assess economic activity across the state. This economic activity data was then ranked along with information on at-risk infrastructure, and commercial buildings within the river corridor to assist in prioritizing five study areas. This chapter outlines the methodology we developed and Chapter 3 summarizes the ranking and prioritization process.

### Vermont Economy: An Overview

Vermont is a place of apparent contrasts. It is a small rural state with more than 7,000 farms and the largest private sector employer is IBM (now GlobalFoundries), the iconic electronics manufacturer. The state is known for cheeses, craft beers and skiing, yet, increasingly, its cutting-edge technology companies (such as Dealer.com, BioTek, Logic Supply and NRG Systems) make INC. magazine's list of fastest-growing companies. Vermont has more than 100 general stores and, at the same time, is home to MyWebGrocer, an Internet-based grocery marketing company with over 300 employees.

In the wake of 2011's Tropical Storm Irene, Vermont set out to not only repair its infrastructure, but to create a stronger and more prosperous state; resilient to both natural and economic impacts. With guidance and support from the US Economic Development Administration (US EDA), the state gathered input from stakeholders to develop a Comprehensive Economic Development Strategy (CEDS). The CEDS lays out goals to strengthen the Vermont economy, and like VERI, focuses on key sectors that could be weakened by climate change – skiing, agriculture, maple and forest products, and tourism, as shown in Table 2.2 (VT ACCD, 2014).

**Table 2.2: Major Industry Sectors that Contribute to State of Vermont Economy**

| Sector Name | 2012 GDP ($ million) | Employees | Number of Businesses | Location Quotient |
|---|---|---|---|---|
| Agriculture, Forestry, Fishing and Hunting | 325 | | 417 | 1.275 |
| Mining, Quarrying, and Oil and Gas Extraction | 52 | 800 | 65 | .10 |
| Utilities | 774 | 1,800 | 48 | 1.451 |
| Construction | 1035 | 14,200 | 2848 | 1.056 |
| Manufacturing | 3150 | 31,800 | 1075 | .962 |
| Wholesale Trade | 1263 | 9200 | 1451 | .802 |
| Retail Trade | 2195 | 37,700 | 3253 | 1.319 |
| Transportation and Warehousing | 542 | 6,800 | 555 | .659 |
| Information | 655 | 4,700 | 488 | .541 |
| Finance and Insurance | 1480 | 9,000 | 972 | .679 |
| Real Estate and Rental and Leasing | 3683 | 3,100 | 708 | 1.09 |
| Professional, Scientific, and Technical Services | 1775 | 14,000 | 2995 | .849 |
| Management of Companies and Enterprises and Administrative and Support and Waste Management and Remediation Services | 793 | 10,100 | 100 | .727 |
| Educational Services (not including preK-12, public schools) | 616 | 12,600 | 405 | 1.953 |
| Health Care and Social Assistance | 2827 | 48,100 | 1878 | 1.384 |
| Arts, Entertainment, and Recreation | 245 | 4,000 | 400 | .912 |
| Accommodation and Food Services | 1335 | 29,500 | 1755 | 1.614 |
| Other Services (except Government) | 697 | 10,100 | 1982 | 1.055 |
| Government (includes preK-12 public schools) | 3803 | 55,000 | n/a | 1.1136 |

(Source VT ACCD, 2014)

## Economic Activity: The Methodology

The project team began with a review of data sets that provided town-level information and were available consistently statewide. Information related to employment, taxes, revenues and profits, and commercial buildings or 'units' were evaluated. The methodology developed takes into account the value of goods produced and services provided, and the labor force that produced them, for each town in which they were produced.

'Economic activity' is a measure of the economic transactions that take place within any community. Those transactions are the result of value-added goods and services production that arise through the combination of labor and the utilization of natural and built capital. Total economic activity is a combination of changes in the value of built capital, changes in the value of natural capital, and income to workers and business owners.

The project team incorporated expert opinions by consulting the staff in the State Auditor's Office and the State's Economist, regarding the methodology for measuring and screening economic activity by town.

Measuring total economic activity can begin with the total dollar value of the transactions that take place in a community. Every sale of goods or services is a reflection of the value of the goods and services produced. For this study, the team reviewed several sets of data that provide a piece of the story with respect to the sales going on in the community. Some are direct measures of the transaction such as sales tax, meals and rooms tax or property transfer tax. However, these are only a subset of value added transactions taking place. Manufactured items are typically sold at a wholesale level and not subject to sales tax. Food and clothing are two large categories of goods not subject to sales tax. Very few services, including the professional services of health care and legal services are subject to sales tax.

The income received by workers is another approach to understanding the value of economic activity in a community and allows a more complete understanding of the range of transactions. However, just as with measuring individual transaction volume, the income for workers is an incomplete measure of total economic activity. One large reason is that the location of a worker's paycheck may not be the same as the location where the value added activity takes place. For example, utility workers are paid from a central office, but their work tends to be distributed over a wide area.

The increasing mobility of labor and knowledge based industries makes it almost impossible to use a limited set of measures to gauge the economic activity in different communities. For this study, the project team used the basic measures and reviewed the results with individuals and organizations with local knowledge about the different character of economic activity in each community.

To assess economic activity at a municipal level, the project team sought data to answer the following questions:

- What is the value of goods and services produced in each municipality?
- What is the value of the labor force that produces goods and services in each municipality?

## The Data Sets

The team reviewed various data sets, identified the key information provided and assessed any limitations. Table 2.3 summarizes the team's data set review. Data limitations are noted. The final primary data sets chosen are discussed in the text that follows.

**Table 2.3: Summary of Economic Data Set Review**

| Data Set | Information Provided | Limitation |
|---|---|---|
| Average annual number of business establishments by town | An establishment is an 'economic unit' (a farm, factory or store) that produces goods or provides services at a single physical worksite and that is engaged, predominantly, in one type of economic activity | The count of business is not a measure of business size, profitability and workforce. |
| Average annual employment by town | The number of jobs in each town. The annual average of the monthly employment figures in each town, as reported by covered employers. | These data exclude self-employed people, most farms, some non-profits, churches, rail workers, elected officials, student workers, and officers and family members of sole proprietorships or partnerships. |
| Annual Total wages, by town | The total of all wages paid by reporting establishments in each town. Includes wage data from businesses that report to the quarterly census. Businesses that report to the QCEW include private, for-profit businesses with one or more employees, government agencies, non-profit organizations with four or more employees, and farms employing ten or more workers. | Self-employed people are not covered, nor are the majority of farms, non-profits such as churches, railroad workers (covered separately), elected officials, sole proprietorships or partnerships, and student workers. This is not total payroll data by town of employment. |

| Data Set | Information Provided | Limitation |
|---|---|---|
| Income Tax withholding data, by town | Income tax withholding is an indirect measure of wages for a business. | Individuals can change the amount of withholding depending on their personal tax situation. For example, workers with a larger household will have lower withholding than a worker in a single-person household. |
| Sales Taxes Received, by town | | Sales taxes are based on a subset of sales. Most transactions are not subject to sales taxation including food, residential energy use, and most services. |
| Meals Receipts, by town | Prepared foods in restaurants is subject to the meals tax | A combined measure of tourist activity and local resident's use of restaurants. Small towns with few tax collecting restaurants do not have their results reported by VT DOT. |
| Rooms Receipts, by town | Overnight accommodations are subject to the rooms tax | Another measure of local tourism activity. This does not include second home ownership and as with the meals tax, small towns may not have enough tax paying businesses to have their receipts reported by VT DOT. |
| Property Valuation | Each town has a Grand List that includes the value of all properties. The total of property value is both a reflection of the potential for development and the value of improvements that have taken place. | |
| Per Capita Income | | Does not incorporate the location in which the income was generated. |
| Vermont Small Business Development Center Client Network | | A limited subset of the small businesses in the state. |
| Internet Fiber/Broadband Mapping | | There is limited data on the extent of coverage by town that is publicly available. |
| American Community Survey (2007-2010) | Provides 5-Year Estimates of Employment | Not as current as other obtainable state data. |
| National Flood Insurance Program Data | The Community Information System (CIS) provides the number of policies for both residential & non-residential properties | While this can easily be done for state & county levels, it would be an onerous task to do this for towns because it would need to be analyzed one town at a time. |

| Data Set | Information Provided | Limitation |
|---|---|---|
| Utility Data [Green Mountain Power (GMP)] | GMP had location data on commercial accounts by town in their service area. | There are many towns not served by GMP and the data from the other utilities is variable in its format and coverage. Reaching out to the other small municipal and private utilities to piece together statewide data set would have been time consuming and the information may not have been consistent. |
| Insurance Companies | The following information was requested:<br>• What percentage of Vermont companies that are insured for floods?<br>• What percentage of Vermont companies are covered for other disaster-related property losses?<br>• How many business claims are filed and for businesses in which towns?<br>• How do insurers target the risk pool? | Proprietary information that is not publicly available |

The project team was assisted by the Vermont Department of Labor (VT DOL) and reviewed information it uses from the Quarterly Census of Employment and Wages (QCEW, from the US Bureau of Labor Statistics). The team also reviewed various data sets provided by the Vermont Department of Taxes (VT DOT) and considered using several other datasets, reported in Table 2.3 along with the VT DOL and DOT information. Ultimately, the additional data sets were not used due to the limitations outlined in the table or because they provided duplicative information. It should be noted that a limitation of the VT DOL information is that big corporations headquartered outside of Vermont will only file under one return for the whole corporation, even if they have operations/buildings in Vermont.

Other states wishing to replicate the VERI model, will find varying degrees of accuracy and relevance for each data set. The availability of municipal level data, the subset of businesses represented, and the comparability of state data and federal data will inform decisions about the usefulness of the data.

After reviewing all the data sets, evaluating the type of information they provide, and their geographic distribution, the project team used the following primary and secondary data sets to rank statewide economic activity in each community.

### Selected Primary Data Sets

The following data sets were used in the evaluation of statewide economic activity:

- ***Annual Number of Establishments***, 2012 (VT DOL data).
- ***Annual Average Employment,*** 2012 (VT DOL data).
- ***Total Wages,*** 2012, (VT DOL data).
- ***Rooms Sales,*** 2012, (VT DOT data). These data were used as a proxy for the tourism sector of the economy.

### Selected Secondary Data Sets

The following information was also used in evaluation and ranking of towns:

- ***Top Five Employers within each Region:*** Critical employers within each town and region were identified. The project team reached out to Vermont's Regional Development Corporations (RDCs) and asked them to provide this economic information.
- ***Towns and Regions Dependent on One Employer:*** The RDCs provided the names and locations of Vermont's top employers in each region, with an indication of which were critical to the health of the local economy, and which were firms on which the local or regional economy was dependent. This information helped to minimize the limitation around big corporations headquartered outside of Vermont only filing one tax return for the whole corporation, even if they have operations/buildings in Vermont.
- ***Agriculture:*** Number of dairy, vegetable and fruit farms per town which was provided by the Vermont Agency of Agriculture, Food and Markets (VT AAFM).

While researching, analyzing, and finalizing the data sets to develop a town-by-town snapshot of economic activity, the VERI project team developed a methodology to evaluate flood risk and understand where it intersects with economic activity and any associated infrastructure.

There are eleven **Regional Development Corporations** (RDCs) throughout Vermont. They provide local technical assistance to the businesses and employers within the communities they serve. This entails, but is not limited to, real estate and site selection assistance, project finance coordination, workforce development programming, and general business advocacy.

## Understanding Vermont's Flood Risk

As noted above, flooding due to inundation and fluvial erosion has caused and will cause widespread damage, property loss, and socio-economic disruption in Vermont. In order to understand the statewide risk of inundation and fluvial erosion, the Vermont Agency of Natural Resources (VT ANR) developed a statewide flood hazard map layer and then applied a river sensitivity assessment to determine where the risk of flooding would likely be greatest. The information below provides an overview of the 'how-to' steps taken in Vermont to perform this statewide assessment, an important step in understanding where this risk intersects with areas of economic activity and associated infrastructure.

## Mapping Flood Hazard Areas

### Inundation

Inundation, or overbank flooding, occurs when a stream channel or waterbody receives a significant amount of rain or snow melt, or when the stream channel is blocked by debris or an ice jam. The excess water spills out onto or 'inundates' the floodplain. Inundation is easiest to visualize if one thinks of a bath tub filling up with water and spilling out over the top.

Inundation risk can be assessed on the most current FEMA-published Flood Insurance Rate Maps (FIRM) on which the National Flood Insurance Program (NFIP) is based. These maps are based on the area of floodplain that would flood during the '100-year flood' or the area with a 1% probability of flooding in any given year (see resource section for more information about FEMA FIRM maps).

1% annual chance of flood = 100-year flood = base flood

### Fluvial Erosion

In Vermont, fluvial erosion results in the greatest flood-related losses. Fluvial erosion is the wearing-away of river channel beds and banks by the action of water. It results when stormwater picks up speed as it moves downhill in river and stream channels, picking up sediment and debris in one reach and depositing it in a slower moving reach of river or piling up behind bridges and culverts. The magnitude or rate of fluvial erosion is highly variable, ranging from a gradual and continual process to an episodic or catastrophic event.

**Fluvial Erosion** refers to the wearing-away of materials off the stream bed and banks by the action of water during a high flow event.

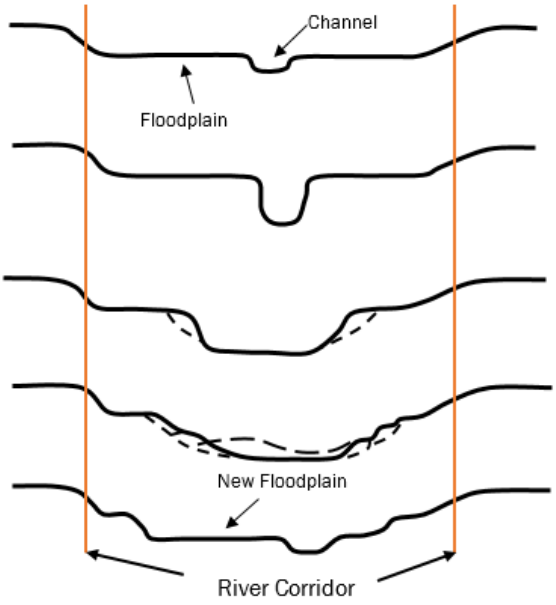
Currently available FEMA FIRM maps only cover 20% of Vermont's rivers and streams and depict inundation flooding. However, due to Vermont's topography of hills and valleys, the areas of greatest risk are fluvial erosion hazard (FEH) zones. FIRM maps are also of limited use in Vermont because they are a static depiction of the floodplain. They map only a small percentage of water bodies, and map updates are infrequent. Thus, as part of this project, VT ANR developed river corridor maps for all perennial streams to indicate the area of greatest risk from fluvial erosion and current or future inundation.

The river corridor maps developed take into account different types of risk and the dynamic nature of flood hazards, and have a broader reach. They can be used strategically to plan growth and development along rivers, and to better protect property and businesses. The river corridor also represents, on average, the minimum amount of floodplain necessary to accomplish vertical stability (Ward et al., 2002, Ward, 2007). It is important to remember that when rivers are vertically stable with enough room to meander and inundate floodplains, they are in their least erosive form.

VT ANR developed a mapping protocol for river corridors to encompass an area around and adjacent to the river channel where the following are most likely to occur:

- ***Fluvial erosion***: the area where flowing water can cause vertical and lateral movement of stream banks and beds (see Figures 2.1 and 2.2);

**Figure 2.1: River Corridors Designed to Encompass Channel Evolution**

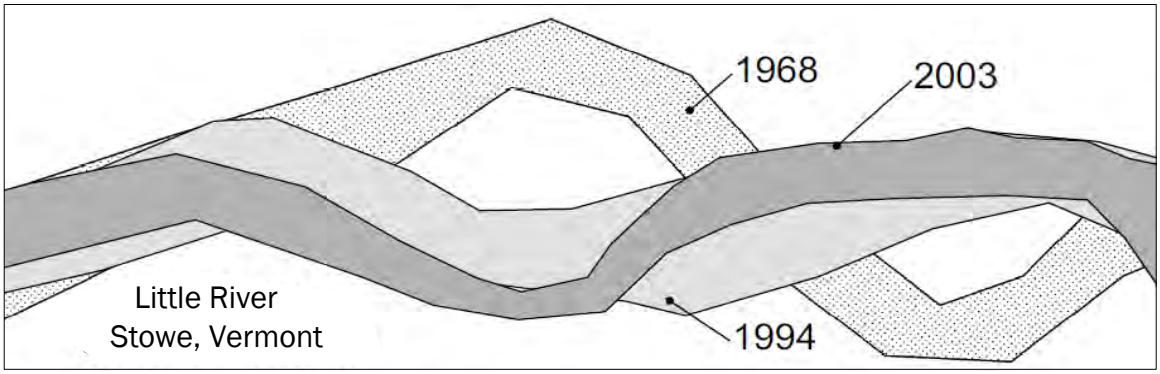



Five stages of channel evolution, starting with a shallow depth to floodplain, followed by channel deepening, widening, filling, and finally, at Stage V, a new floodplain formed at a lower elevation. Approximately 75% of VT stream channels are at Stages II – IV.

The red lines on either side of the channel indicate how the river corridor would be delineated in cross-section to capture all stages of the channel evolution process.

- *Channel evolution*: stream channels continually evolve toward the development of floodplains (i.e., overall channel depth) that more evenly distribute the flows and energy of differing flood events over time. River corridors accommodate these floodplains and where this evolution is most likely to occur (see Figure 2.2);

**Figure 2.2: Stream Channel Meander Pattern Adjustment over Time**




- *Down-valley meander migration*: streams naturally deposit on the inside of channel bends and erode on the outside of bends, all the while maintaining the vertical stability brought about by the channel evolution process described above.

A **stream geomorphic assessment** (SGA) is a physical study of a river's geology, size, shape, movements, and existing conditions which affect river flow patterns and stability.

VT ANR developed its river corridor mapping methodology over the past decade. During this time several peer reviews and studies were conducted to verify the reasoning and methodology for stream geomorphic assessment and river corridor mapping in Vermont. VT ANR worked with the Lake Champlain Basin Program and the US Environmental Protection Agency (US EPA) to conduct an academic peer review. FEMA and the USDA also completed independent quality assurance reviews. Prior to the development of the statewide river corridor layer, staff conducted a study of over a hundred unconstrained river reaches and compared the new Vermont calculated meander belt widths with those produced by the published formulas and found that its adopted methodology was sound and supported by locally-derived data.

Mapping river corridors in this way covers both inundation and erosion hazard areas and shows an area that, if protected, will serve over time to restore floodplains, which are important for storing flood water and minimizing the risks associated with inundation and erosion.

## River Corridor Mapping Procedures: The Details

This section provides the details of the river corridor mapping procedure developed in Vermont. It is designed for the technical staff (river engineers, biologist and Geographic Information System (GIS) professionals) in other communities or states who wish to replicate this work.

River corridor widths were calculated to represent the narrowest band of valley bottom land necessary to accommodate the least erosive river floodplain that would exist naturally within a given valley setting.

VT ANR mapping procedures also recognize that certain rivers are highly managed or constrained by human structures and delineates the river corridor to reflect the existence of certain man-made constraints. (The ANR river corridor mapping procedures are formally adopted in the Vermont Department of Environmental Conservation (VT DEC) Flood Hazard Area and River Corridor Protection Procedures (12-05-2014) http://www.watershedmanagement.vt.gov/rivers/docs/FHARCP_12.5.14.pdf.)

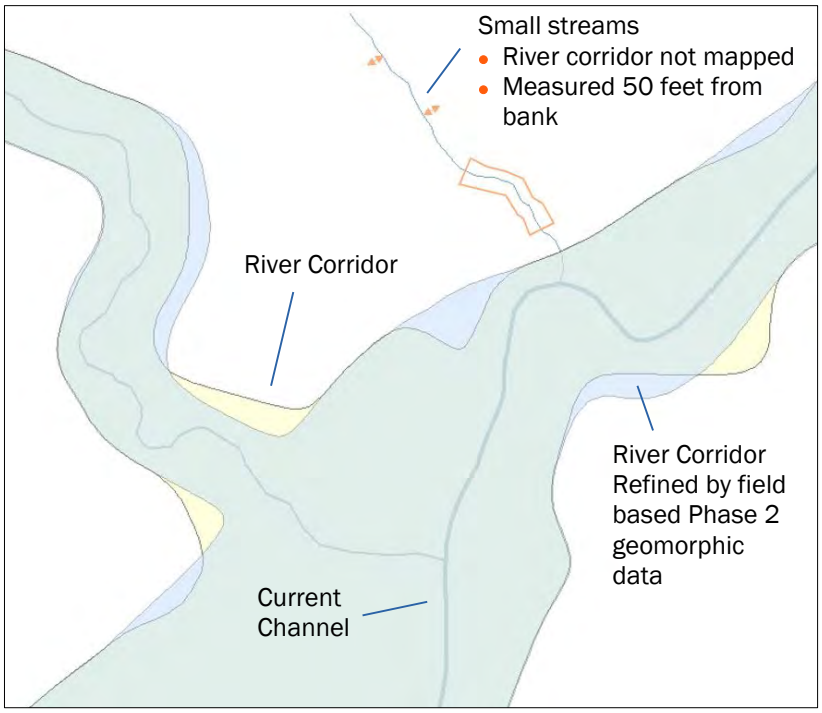
The final product, a Statewide River Corridor Map Layer, was developed to indicate the following map categories:

- ***Drainage Areas of Less than or Equal to Two Square Miles:*** simple top-of-bank 50 foot setbacks for streams draining less than or equal to two square miles;

- ***Drainage Areas Larger than Two Square Miles:*** river corridors were drawn using hydrographic (i.e. river flow) and topographic data and modifying for natural and man-made confining features. Details for how this was developed are below; and

- *Phase II Assessments:* river corridors drawn as updates or administrative revisions to the base layer based on new data, detailed field studies, or municipal planning at the reach-scale or the watershed-scale. Currently, over 2,057 miles of Vermont streams have undergone detailed, field-based study through completed stream geomorphic assessments (SGA).

**Figure 2.3: Sample Phase II River Corridor Map**



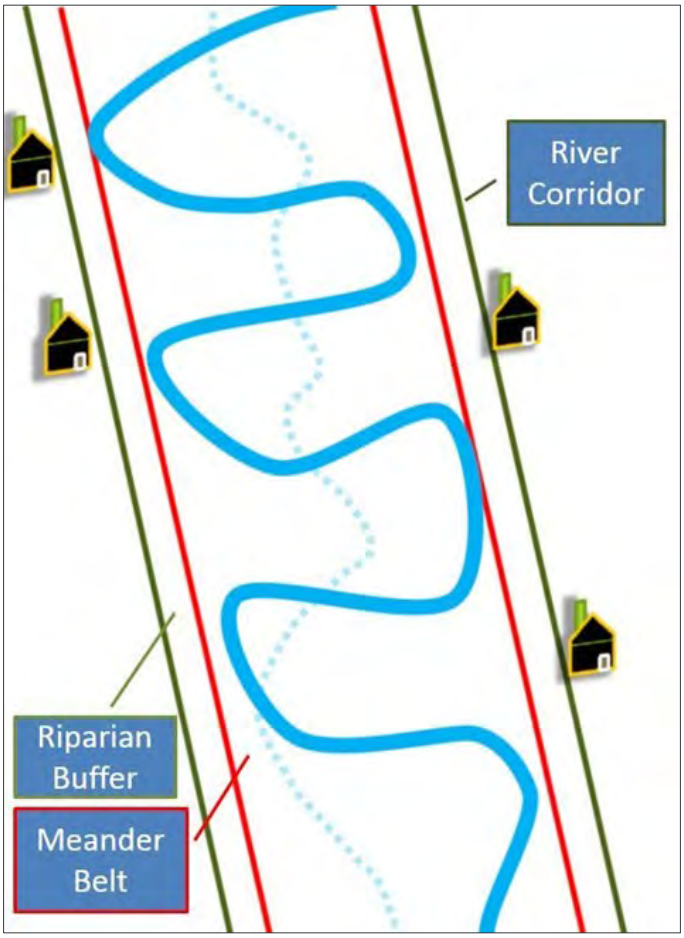

## Base Layer Development

The river corridor base layer is derived from an analysis of digital elevation data to calculate valley geometry (slope and width) and an analysis of drainage data to calculate channel and meander belt widths. Existing structures like state roads and railroads were established as artificial valley walls and used to delineate the location of the meander belt on the base layer. Rivers and streams do not follow the same course, but instead snake, or meander over time. As water flows through a stream channel, it erodes the outer banks, widens its valley, and deposits silt and debris on the flatter areas that have less energy. It is a natural process. The risk occurs when homes, businesses and infrastructure are within the area where a river naturally moves. The area that the river snakes is known as the

meander belt and this area provided the foundation of the base layer for the river corridor maps developed by VT ANR.

For streams in unconfined, low slope alluvial settings (e.g., a flat meadow), the average meander belt width is approximately six channel widths wide (Williams, 1986; Kline and Cahoon, 2010). The meander belt extends laterally across the river valley from outside meander bend to outside meander bend, thereby encompassing the natural variability of the stream channel (Figure 2.4).

**Figure 2.4: Depiction of Meander Centerline and Belt Width**




Protecting this area from development maintains the channel slope and minimizes vertical channel instability over time along the extent of the stream reach (Riley, 1998). Ideally, the meander belt can be achieved by three channel widths either side of a meander centerline.

Vegetative buffers are a least cost, self-maintaining practice to provide natural boundary conditions and stream bank resistance against erosion and moderate lateral channel migration. Providing space for these functions is consistent with the goal of achieving and maintaining least erosive conditions, thereby minimizing the risk of harm to life, property and infrastructure from flooding.

Valley topography or other constraints (e.g., bedrock and exposed ledge) may prohibit channel movement, such that the full six channel widths can only be achieved by providing more width on one side of the stream than the other. (Note: For more discussion of the delineation of the meander centerline and the belt width, refer to Appendix E of the *VT Stream Geomorphic Assessment Handbooks* and other VT *DEC technical guidance* http://www. watershedmanagement.vt.gov/rivers/docs/assessmenthandbooks/rv_apxecorridordef.pdf). Also, note that many of Vermont's streams have been straightened, channelized, or have become incised (deepened), losing access to their historic floodplains. In many cases, these streams are undergoing channel evolution or the processes of erosion and deposition to adjust and re-establish a stable channel slope (Refer to the State Rivers Program's website to examine fluvial geomorphic data stored on the Data Management System or via Map Viewer: http://www.watershedmanagement.vt.gov/rivers.htm)

**Planform** is the meandering shape of the river from a birds eye view.

The table in Appendix 2.1 describes how the meander belt width and other factors were used to develop river corridors in Vermont. Variables include the inherent stability of the stream channel; its sensitivity to erosion hazards; the presence of natural or significant human-created confining features; the evidence or likelihood of valley side slope failure; and the presence of hydrologically-connected features within the river valley.

VT ANR added an additional 50 foot setback on either side of the meander belt on all rivers except for small streams, to allow space for the establishment and maintenance of a vegetated buffer when the stable slope and planform are achieved. This riparian buffer aids in bank stability and slowing flood water velocity. It also serves as a margin of safety ensuring that if new structures placed immediately adjacent to a river corridor there would still be space between a stabilized streambank at the edge of the meander belt and the edge of the structure. For small streams (those draining less than or equal to two square miles), the 50 foot setback from each bank is used to serve both meander and riparian buffer functions.

## Risk Assessment

Statewide river corridor mapping was the first step in conducting a risk assessment. Next, the team used river sensitivity and a vulnerability assessment to determine risk.

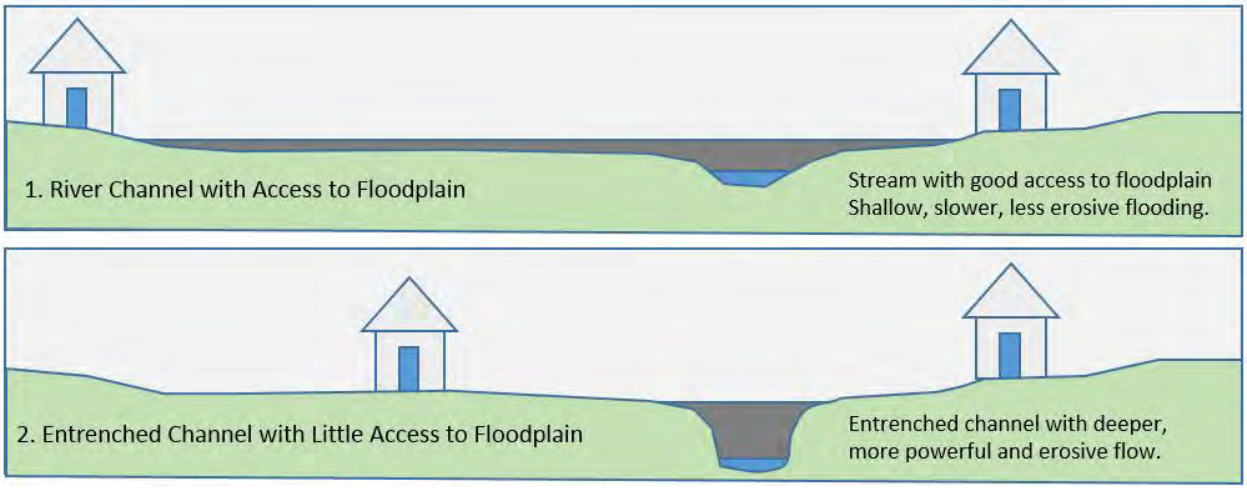
**River Sensitivity:**
A sensitivity assessment shows a river's tendencies to carry and/or deposit sediments or debris throughout the watershed. The river sensitivity data used in the VERI project to assess flood risks statewide included:

- Using the methodology described above, the ***land area in the river corridor*** based on the meander belt widths derived from watershed size, channel slope, and valley confinement. The mapped river corridor indicates an area where risk is higher.

- ***Erosion and deposition risk ratings*** for each segment of river corridor based on changes in stream power and confinement, stream confluence areas, and the number of road crossings.

Functioning floodplains, particularly adjacent to low gradient, unconfined streams are critical to the moderation of stream power and fluvial erosion. Steeper-deeper flows are more erosive due to their higher stream power. Increasing floodwater, upon spilling to an adjacent floodplain, becomes only incrementally more powerful because depth has not grown proportionately with flows. In confined systems, where floodplain is limited, either naturally or by human encroachment, flood water becomes very powerful and erosive because depths are increasing more proportional with volume of flow (see Figure 2.5).

**Figure 2.5: Impact of Floodplain Access on the River Channel**



A River Corridor Flood Sensitivity Coarse Screen was developed to enhance statewide risk assessments with respect to fluvial erosion hazards. In conjunction with developing the Statewide River Corridor Map Layer, VT ANR provided technical support to the Vermont Land Trust (VLT) in the development of the River Corridor Flood Sensitivity Coarse Screen. VLT, using private foundation funding, developed the coarse screen data for each VT ANR delineated river corridor segment. With permission from VLT, staff applied the VLT data to the statewide layer to support the vulnerability assessment of the VERI project.

The Coarse Screen rates both direct and indirect erosion risks. Indirect erosion risk may be defined as the risk of erosion damage resulting from channel avulsions that occur when flood-deposited sediments and debris block a stream channel. When a stream segment becomes "plugged" by deposited sediments and debris, high velocity flows completely leave the channel (i.e., avulse) causing over-land erosion and severe downcutting erosion as the stream cuts a new channel away from the old one (see Figure 2.6 below).

**Figure 2.6: 1927 Flood in Randolph, Vermont**

Aerial picture of the Third Branch of the White River in Randolph, Vermont after the 1927 flood. Evidently, the river flowed along a more sinuous path, through large meanders, prior to the flood.

During the flood these meander bends became plugged with sediment and debris causing the river to rise up and leave the channel, then flow straight down-valley, cutting new channels along the way.

The Course Screens were developed using the following data:

**Erosion Risk Coarse Screen**

- ***Specific stream power*:** which is a function of the channel slope and depth. The deeper and steeper the flow, the more power it has to erode materials on the channel bed and banks.
- ***Natural channel confinement by the valley:*** confinement is calculated by dividing the valley width by the channel width. The higher the ratio, the lower the confinement of the channel by the natural valley walls. Floods tightly confined within a narrow valley are more erosive than unconfined flood flows which spill onto a floodplain.

- ***Percent increase in confinement by existing permanent infrastructur*e:** natural valleys that are bisected by infrastructure may be more prone to erosion. Naturally unconfined stream, with functioning floodplains, are characterized by finer-grained (more erodible) bed and banks. When the confinement is significantly increased in this type of stream, the beds and banks are much more easily eroded during floods.

**Deposition Risk Coarse Screen**

- ***Specific stream power*:** which is a function of the channel slope and depth. Flows that are shallow in depth and of lower gradient have less power it transport sediment and woody debris. During a flood when loads (or inputs) of sediment and debris increase beyond the capacity (or power) to transport them, they deposit within the channel and begin forming a "plug" or blockage to flows.

- ***Reaches with significant decreases in slope*:** Stream reaches that exit a steep, confined valley into a low gradient (or low slope), unconfined setting will switch dramatically from being erosional (i.e., with high sediment transport capacity) to being depositional. Over time these reaches become characterized by alluvial fans, which are domes of sediment that have built up due to this switch from transport to depositional flows.

- ***Confluences with larger tributaries***: Stream confluences are high deposition zones. Typically, a tributary flood will rise faster than that of the main stem stream to which it flows. The main stem will act as a dam to the sediment-laden floodwaters of the tributary stream. The damming effectively flattens the slope of the tributary flood and it loses transport power depositing sediment and debris in the confluence area.

- ***Number of road crossings:*** Bridges, culverts, and their road approaches often impound floodwater behind them (flattening the slope of the flows). Islands form above stream crossings from sediment deposition, especially where the crossing is significantly undersized to the stream.

Each parameter in the erosion and deposition screens were characterized as low, moderate, or high based on a range of values in published studies and VT ANR's stream geomorphic assessment protocols. Each river corridor segment in the Statewide River Corridor Map Layer was rated as presenting a high, medium or low risk of erosion or deposition process by compiling the scores of the three erosion parameters for sensitivity to erosion and the four deposition parameters for sensitivity to deposition.

The Course Screen is a valuable tool because, using remote sensing data, VT ANR can generate a consistent, statewide sensitivity rating for every river corridor segment. However, the Course Screen has limitations in evaluating risks at the site-specific level. For project development, erosion and deposition processes are evaluated based on field data from stream geomorphic assessments.

For a step-by-step process and timeline for the design and development of the Vermont River Corridor Geodatabase, see table in Appendix 2.2.

## Utilizing the Information

The VERI project team used these maps and river sensitivity analysis along with a vulnerability assessment and information on economic activity to help analyze risk in Vermont municipalities and determine the five communities for further analysis (see Chapter 3). There are many other uses for river corridor maps.

River corridor maps serve as a planning and assessment tool for reducing damages to existing structures and property, avoiding new damages, protecting public safety, and avoiding the high cost to install and maintain bank stabilization structures. Minimizing investments within the river corridor will reduce the need for channel maintenance, which, in turn, will avoid the unintended consequences of transferring bank erosion and other damaging effects from upstream (Brookes, 1988; Huggett, 2003; Brierley and Fryirs, 2005).

## Infrastructure, Commercial Buildings and River Corridors: A Vulnerability Assessment

Economic activity – the movement of goods and services, ability of employees to get to work and customers to receive services – depends on infrastructure, especially transportation infrastructure. For example, the Route 9 Bridge over the Whetstone Brook in Brattleboro, Vermont connects more than 16,000 people daily to their jobs and local businesses. If damaged and closed, the impact to the economy is great.

Working with the Agency of Transportation (VTrans) and VT ANR, the VERI team developed a vulnerability assessment for the state's roads, bridges, and non-residential buildings.

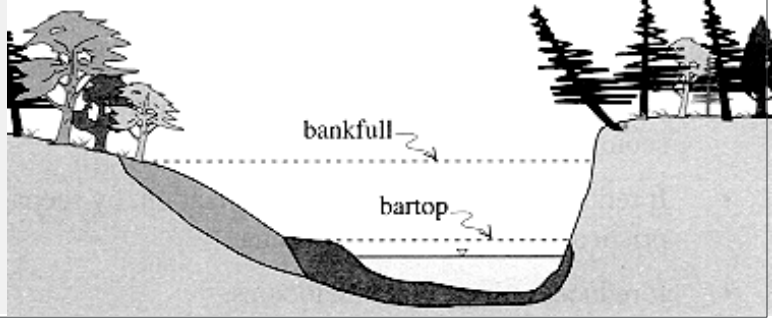
Vulnerability describes the characteristics of a community that make it susceptible to the damaging effects of a hazard. From a physical vulnerability standpoint, the VERI project team looked at the size and location of transportation infrastructure and non-residential buildings to begin assessing vulnerability to economic activity. Common types of transportation infrastructure damage after a flood are washouts, undercuts or sink holes. The damage can occur by the sheer force of water overtopping a road, or by other erosive forces of a river.

VTrans conducted a GIS-level vulnerability assessment of state and town bridges, federal aid highways, and non-residential buildings in river corridors statewide in every municipality. This assessment was aggregated by town and combined with other indicators to develop a short list of municipalities that were considered as candidates for the more detailed VERI case studies.

- ***Bridges having spans of less than bankfull channel width:*** Defined as bridges too narrow in span to pass the annual flood or semi-annual flood event. Such undersized bridges lead to upstream deposition and downstream scour (i.e., erosion) and are more likely to fail from either being undermined from scour or plugging and being out-flanked during a flood event (see Figure 2.7). Information about bridge span was obtained from the VTrans bridge inventory system and compared to the bank-full width of the river it crosses from the Statewide River Corridor GIS data. Only bridges that VTrans inspects were included in the analysis, which are those with spans greater than 20 feet on both the state and town highway system, and those between six and 20 feet on the state system. Because of inconsistent data availability, the assessment did not include bridges with spans less than 20 feet on town highways or any culverts on the state or town highways.

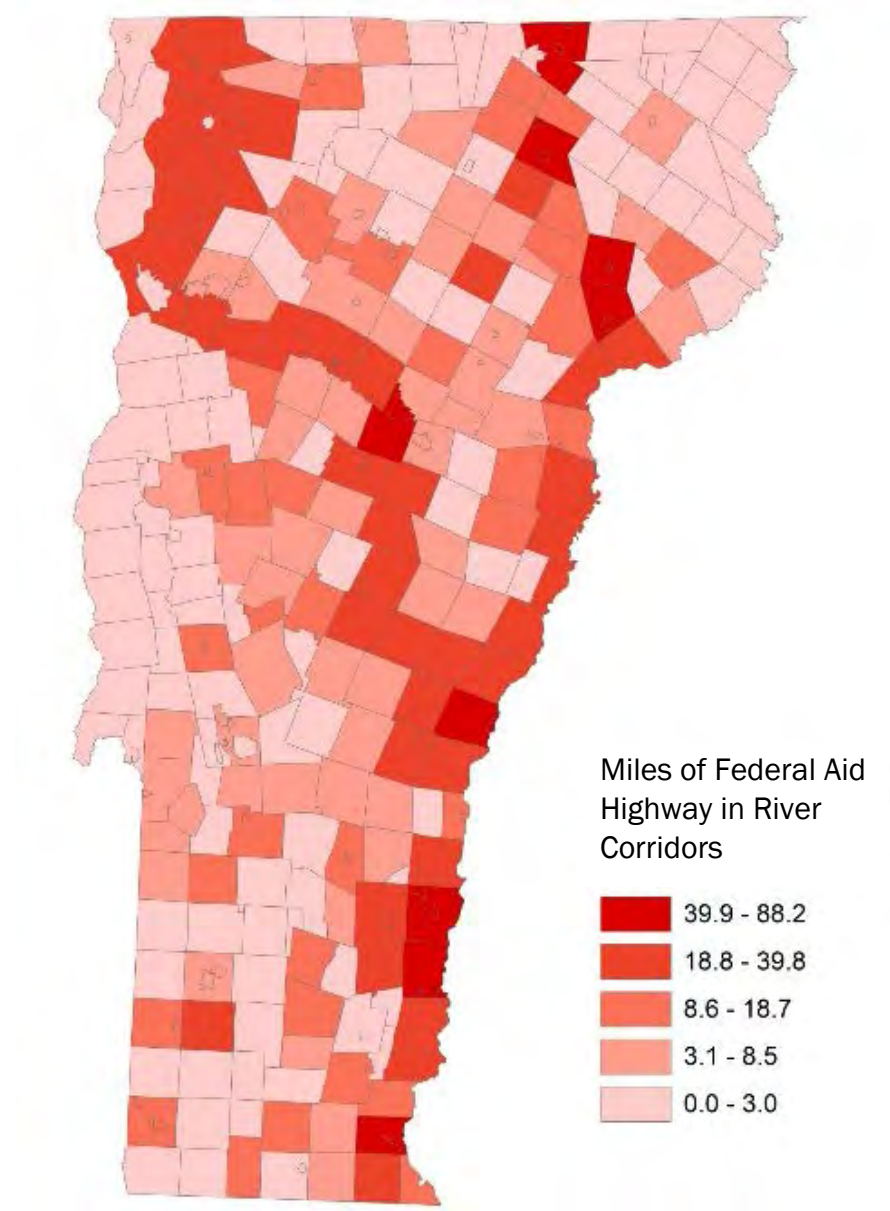
**Figure 2.7: Bankfull Width**

A bridge that provides adequate bankfull width can accommodate water volume and movement of sediment which helps to maintain a river's stability near the structure under normal circumstances and reduces the potential for damage during heavy precipitation events.



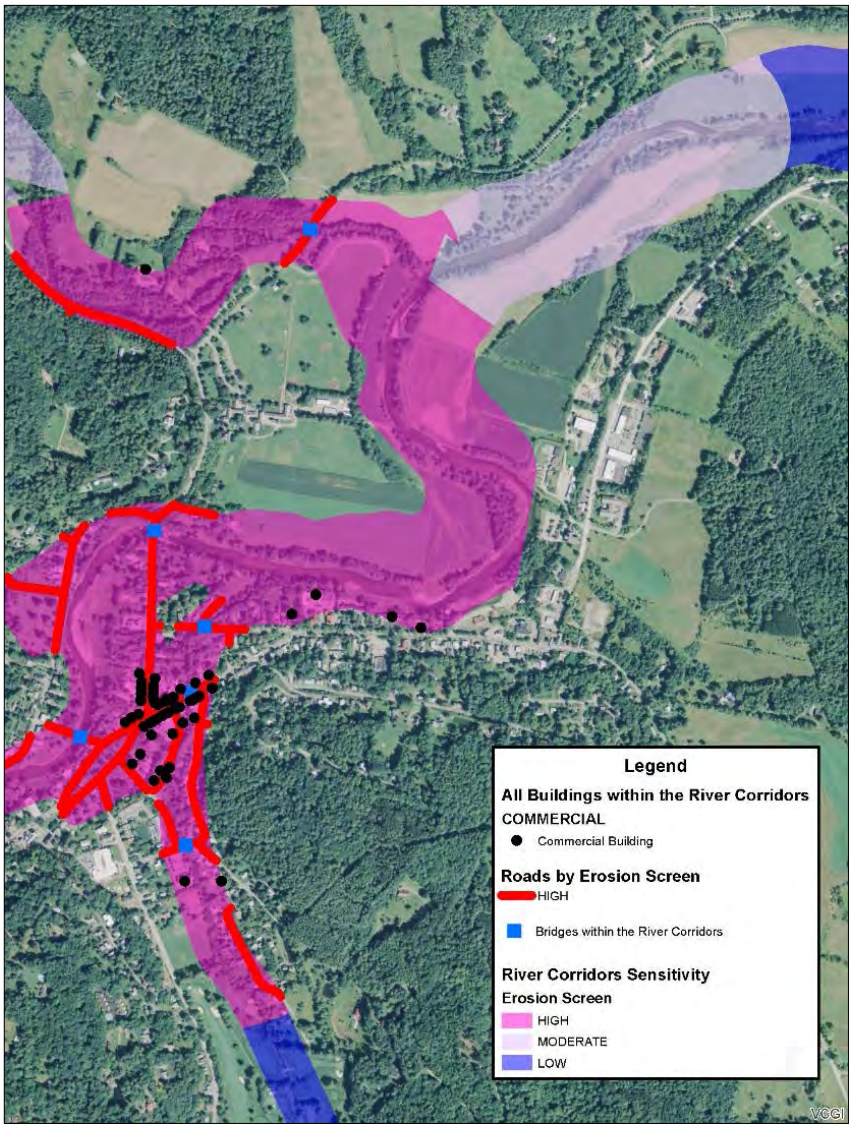
- ***Number of Federal Aid Miles within a Town in River Corridors:*** In general, federal aid roads include the Interstate, major roads that have a US or VT route number, and local roads that connect more than one town. Federal aid roads provide the backbone of the network and are most critical for access to jobs and moving freight. When these roads are within or abutting a river corridor they are vulnerable to loss or damage from fluvial erosion during a flood event (see Figure 2.8).

**Figure 2.8: Map of Federal Aid Highway Miles in River Corridors**



- *Percent of Federal Aid Road Miles within a Town in High Erosion Risk Portion of River Corridors:* This is a subset of the federal aid roads that are in or abutting reaches of a river corridor that and deemed to be at high risk to erosion damage. The coarse screen identifies those road miles, in high gradient settings, that have greatly increased the confinement of the stream within the valley (see Figure 2.9).

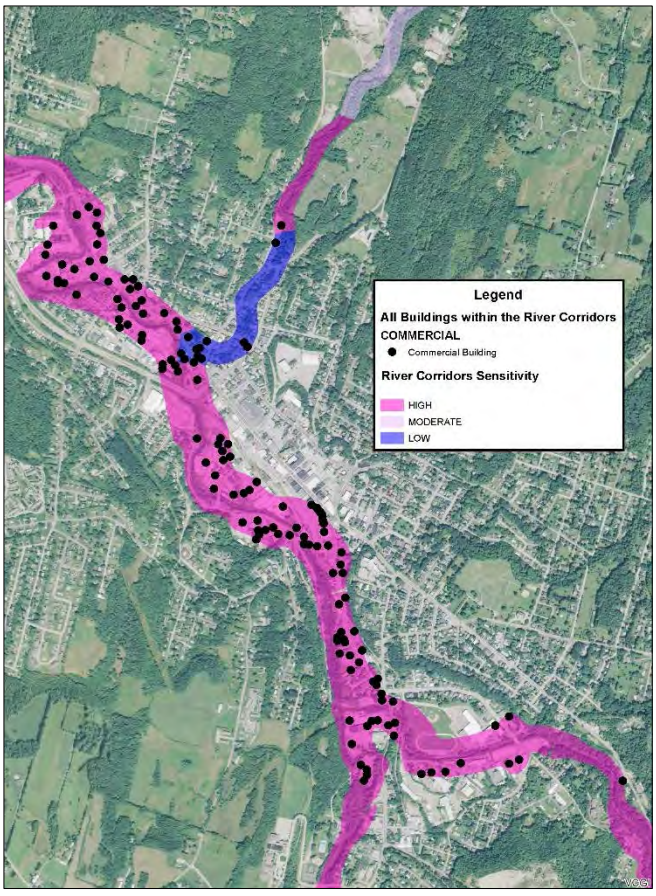
**Figure 2.9: VTrans Vulnerability Assessment in Woodstock**



- *Percent of Federal Aid Road Miles within a Town in High Deposition Risk Portion of River Corridors:* This is a subset of the federal aid roads that are in or abutting reaches of a river corridor that are deemed to be at high risk to damage or disruption due to deposition caused by a flood-related event. The coarse screen identifies those road miles, in lower gradient settings, either directly downstream of a higher gradient stream segment or near stream confluences and/or road crossings (see Figure 2.9).

- *Number of Non-residential Buildings in River Corridors Based on E-911 site data*: Non-residential buildings are most likely some type of business, commercial or industrial use. Where these buildings are within or abutting a river corridor they are vulnerable to loss or damage from flood or fluvial erosion (see Figure 2.10).

**Figure 2.10: VTrans Vulnerability Assessment in Barre City**



VTrans staff also considered using the Network Robustness Index but decided to limit roadway vulnerability assessment to roadways that are part of the federal aid system as this includes major collectors (often town highways that connect two or more towns) through interstates. The team made this decision because these are the roads that have the greatest impact on access to jobs and goods and services movement.

This GIS-level screening provides a reasonable means to compare the relative vulnerability of the roads and bridges to damage from floods in over 250 municipalities in Vermont. However, the probability that specific road segments or bridges identified in the screening will actually fail during a flood cannot be determined without more detailed analysis. For additional information on the analysis, see Appendix 2.3.

The project did not review structures such as wastewater treatment plants, water or electrical utilities, high hazard dams, or culverts in the state vulnerability assessment as this information was not easily accessible for towns across the state. Where available, the team did evaluate the impact of these systems malfunctioning on business recovery in the five target communities. Transportation infrastructure that has been repeatedly damaged, or for which there are no alternative routes, were also considered in the priority areas, as part of the infrastructure hazards analysis.

## Next Steps: Prioritizing Five Communities

The data sets discussed in this chapter were used in the ranking process outlined in the following chapter. The information allowed us to develop a prioritization process so that the VERI team could choose five regions to develop in-depth projects that would reduce, avoid, and mitigate risk in areas of high economic activity.

## Resources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## For more information on FEMA FIRM

FEMA has published extensive information regarding the mapping of flood hazard areas. The FEMA Map Service Center (http://msc.fema.gov) is the primary online repository of flood hazard area data and provides educational information and technical assistance.

A recent flood insurance study titled, *Guidelines and Standards for Flood Risk Analysis and Mapping* provides technical information detailing the engineering, scientific, and mapping specifications (found at: http: //www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping).

Flood insurance studies and flood hazard area maps are on file in the municipal offices of communities participating in the NFIP.

In addition, in VT DEC maintains digital copies of the maps and studies and publishes the maps on VT ANR's Natural Resources Atlas (found at: http://anrmaps.vermont.gov/websites/anra/).

# Appendix 2.1

**Table 2.4: Factors Used to Make River Corridor Delineations in Vermont**

| Type of Stream | How the River Corridor was Determined |
|---|---|
| Streams with a Drainage of Less than or Equal to Two Square Miles | Small streams shall be assigned a simple setback of at least 50 feet on either side of the stream, measured horizontally and perpendicularly from the top of each streambank. A corridor may be delimited for a small stream during a map update, if field data verifies a moderate to high sensitivity |
| Very Low and Low Sensitivity Streams | The meander belt width shall be equal to the existing channel width, if the stream is a bedrock or boulder substrate reference stream type (very low to low sensitivity). For mapping purposes, the meander belt shall be delimited at the top of the stream bank of the existing channel or a minimum of a half channel width on either side of the meander centerline, whichever provides the greater lateral extension on either side of the meander belt |
| Moderately Sensitive Streams (with a drainage > 2 square miles) | The meander belt width shall be equal to a minimum of four channel widths, if the stream (i.e., at the reach scale) is a steep to moderate gradient (greater than 2 percent gradient) reference stream type, and the existing stream type does not represent a stream type departure. The meander belt is delineated with a minimum of two channel widths on either side of the meander centerline |
| Highly and Extremely Sensitive Streams (with a drainage > 2 square miles) | The meander belt width shall be equal to a minimum of six channel widths, if the stream is a gentle gradient or braided reference stream type or if the stream is in a moderate gradient valley setting, but the existing stream type represents a stream type departure.[1] For stream types that are in either very low gradient settings or very high deposition areas, the meander belt width multiplier may be increased up to eight times the channel width. The meander belt is delineated with a minimum of three to four channel widths on either side of the meander centerline. Within zones of extremely high and active deposition (e.g., active alluvial fans), the river corridor shall be delineated to include all recent channels and the entire zone of active depositional process; |
| Natural or Human-Imposed Confining Features | Where the meander belt extends a certain distance beyond the toe of the valley wall (including bedrock outcrops or ledge that limit river movement), the corridor is truncated at the valley toe, and that truncated distance is used to extend the meander belt laterally on the opposite side, to provide a total belt width as described above. This extension may, in some cases, be limited by the valley wall on the opposite side of the stream as well; in which case the meander belt extends from the toe of one valley wall to the toe of the other and will be narrower than the multiple of channel widths prescribed above. If the initial meander belt delineation extends beyond an engineered levee, railroad, or federal aid highway, the full river corridor shall be measured from the embankment toe of that infrastructure and extend laterally on the opposite side. This shift of the river corridor acknowledges the alignment of the road has been structurally maintained over time in those locations. The river corridor is shifted to optimize attainment of naturally stable conditions and the reduction of flood velocities and erosion potential within the stream reach. Adjustment of the river corridor for road infrastructure does not imply that adjacent road infrastructure is outside of an area subject to fluvial erosion hazards; on the contrary, infrastructure or other improvements directly abutting the boundaries of a river meander belt may be as, or more, vulnerable to fluvial erosion as infrastructure within the corridor. |

| Type of Stream | How the River Corridor was Determined |
|---|---|
| Streams Subject to Bank or Slope Failure | Erosion hazards outside the meander belt may also exist. If field evidence indicates bank erosion and/or large, mass wasting failures along the valley wall exist or would exist concurrent with the edge of the calculated meander belt, an additional setback to the top of the immediately adjacent erodible side-slope or slope stability allowance, as determined by a geo-technical analysis, shall be added to the meander belt to accommodate stable bank slopes |
| Natural or Manmade Depressions Adjacent to Streams | If field evidence indicates features such as natural or human-created depressions and old channels adjacent to the stream are deeper than the stage of the annual flood, the meander belt may extend laterally to encompass those features in recognition of their potential to be captured by the river or contribute to a channel avulsion (relocation) during a flood; |

# Appendix 2.2

**Table 2.5: Vermont River Corridor Geodatabase Design and Development**

| | | Details | Timeline | % of Timeline |
|---|---|---|---|---|
| ***Step One*** | Develop lines that identify the toes of Valley Walls (VWs) | Spatial Analyst and ArcGIS software and VT 10-meter Digital Elevation Model, slope, and VT hydrology Dataset (VHD) were used to create a cost-distance raster for streams draining greater than 2 square miles. Raster converted to polygons. River Scientists QC'd valley walls against aerial photos, topographic maps, contour lines, and field visits. | 6/2013 - 11/2013 | 15% |
| ***Step Two*** | Split Vermont Hydrography Dataset (VHD) into Reach segments | River Scientists digitized reach break points along VHD, based on VT's Stream Geomorphic Assessment Tool (SGAT) procedures. ArcGIS used to split VHD into "SGAT reaches." | 6/2013 - 9/2013 | 5% |
| ***Step Three*** | Delineate subbasin catchments for each reach break | ArcHydro Tools and Spatial Analyst software were used to divide watershed basins into stream-reach sized catchments. Cumulative drainage area was assigned from catchments to each VHD reach. | 8/2013 - 9/2013 | 10% |
| ***Step Four*** | Create Meander Centerlines (MCLs) as per the River Corridor Protection Guide (2009) | Digitized for all streams draining greater than 2 square miles by River Scientists and temporary employee. | 8/2013 - 9/2013 | 10% |
| ***Step Five*** | Attribute MCLs with drainage area and slope values | ArcGIS and 3D Analyst software used to assign MCLs with slope, drainage area, and buffer multipliers. | 11/2013 - 12/2013 | 2% |
| ***Step Six*** | Create MCL buffer polygons | Buffers calculated from channel multiplier, slope, bankfull width, and Vermont hydraulic geometry curve. | 11/2013 - 3/2014 | 2% |
| ***Step Seven*** | Bump and clip MCL buffers by VWs | Draft 1 "natural" River Corridor Protection Area produced. | 2/2014 - 3/2014 | 5% |
| ***Step Eight*** | Bump and clip buffers by roads, railroads to create River Corridor Protection Area (RCPA) | Draft 1 River Corridor Protection Area (RCPA) produced. | 2/2014 - 3/2014 | 5% |
| | QA/QC Draft 1 RCPA | River Scientists examined three test basins. | 4/2014 - 5/2014 | 5% |
| | Assign Sensitivity attributes to Draft 1 RCPA | Map-based stream sensitivity developed by Milone & MacBroom, Inc. for Vermont Land Trust and used by ANR by MOA to support Agency of Commerce and Community Development with the Vermont Economic Resiliency Initiative (**VERI**). ArcGIS used to assign attributes to RCPA. | 12/2013 - 1/2014 | 5% |
| | Draft 2 RCPA process refinement and production | Refine Valley Walls, MCLs, channel multipliers, and basin catchments; re-run processes. | 4/2014 - 5/2014 | 5% |

| | | Details | Timeline | % of Timeline |
|---|---|---|---|---|
| | Draft 3 RCPA process refinement and production | Add VHD single channel buffers to RCPA. | 6/2014 - 7/2014 | 5% |
| ***Step Nine*** | Create River Corridors (RC) from RCPA | Add 50 foot buffer to Step Six buffers-- re-run all bump and clip processes to get RC. | 6/2014 - 7/2014 | 10% |
| | Draft 4 RCPA and RC process refinement and production | More refinements to bump and clip process to smooth corridors through stream crossings | 7/2014 - 9/2014 | 5% |
| | Manual refinement of Draft 4 RC | Add/Remove Edit software tool created by IT contractor for River Scientists to use in manually modifying RC. Results in RC_EDITS versions 1, 2, and 3. | 9/2014 - 11/2014 | 8% |
| | Final River Corridors geodatabase | Final River Corridors converted to geodatabase; Federal Geographic Data Consortium compliant metadata developed in ArcGIS. | 12/2014 | 1% |
| | Vermont River Corridors (VRC) geodatabase uploaded to Agency of Natural Resources online Atlas | Website upload handled by ANR GIS. | 1/2/2015 | 1% |
| | VRC attributed with VLT stream sensitivity attributes for VERI project | Shapefile copy VERI deliverable to Agency of Commerce and Community Development (ACCD). | 1/2015 | 1% |
| | | | | 100% |

# Appendix 2.3

## Transportation Vulnerability Assessment

To assist the Vermont Agency of Commerce and Community Development (VT ACCD) with screening municipalities in Vermont relative to economic importance and risk from damage and disruption due to flooding, VTrans conducted a GIS-level vulnerability assessment of all state and town highways. The vulnerability assessment also includes all bridges and other structures on state and town highway within the VTrans bridge inventory. The vulnerability assessment of highways and bridges was aggregated by town and combined with other indicators to develop a short list of municipalities that were considered as candidates for the more detailed VERI case studies.

Additional detail on the highway and bridge vulnerability screening is provided below.

### Highways

- Road centerline data, which is available in a GIS data layer and includes all state, local and private roadways in Vermont, was intersected with the River Corridor Sensitivity data layer. Through this overlay, river corridor sensitivity attributes were applied to the road centerline arcs. The intersect process was run on the full road centerline data layer, so both State Highways and Town Highways could be evaluated and summarized.

- Road segments that were within the bounds of high sensitivity river corridor reaches were identified as high risk road segments.

- Highway mileage summaries were generated by the High, Moderate and Low sensitivity categories for Erosion and Deposition for all State Highways and Class 1, 2, 3 Town Highways. Through this process, identification of risk status for both state and local roads was possible for the high sensitive river corridor reaches.

### Bridges

- In conformance with the National Bridge Inventory (NBI), Vermont maintains an historical record of all bridges subject to the National Bridge Inspection Standards (NBIS). These standards establish requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and both the preparation and maintenance of a state bridge inventory. The NBIS apply to all structures that are longer than 20 feet in length and located on public roads, which include state and town highways. These bridges are commonly referred to as long structures. The NBI also includes long structures that are within federal lands such as national forests and national parks. The vulnerability of these bridges to flood damage will be important to consider in areas of the country where national parks, forests and other federal lands drive the local and regional economies. The NBI is available everywhere in the country because all state departments of transportation are required to maintain an inventory of long structures in their state in order to receive federal transportation funding (The most recent NBI data are available: http://www.fhwa.dot.gov/bridge/nbi/ascii.cfm). The attribute within the bridge inspection data that was used to conduct the preliminary screening of bridges

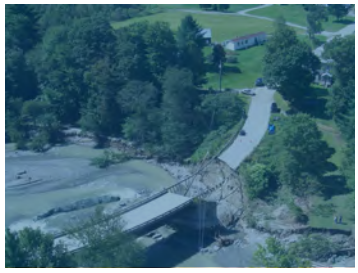
vulnerable to flood damage (i.e., its span is less than the bankfull width of the channel) was the length of maximum span (Item #48 in the NBI data).

- VTrans also has an inventory of state owned "short structures" with spans between 6 and 20 feet that were also included in the VERI analysis. The inventory of short structures is not currently required in order to receive federal transportation funding and therefore may not be available in every state. The analysis does not include town structures with spans less than 6 feet or culverts on the state or town highways.

- In order to compare long and short structure spans to a river channel's bankfull width, the structures must be in a GIS data layer. VTrans works collaboratively with the Vermont Center for GIS to maintain and annually update a GIS data layer that contains all the long structures from Vermont's NBI and all of the short structures not in the NBI. If a GIS data layer for bridges is not available, the NBI also includes latitude and longitude data (NBI items 16 and 17) for each structure which can be used to generate a GIS layer of bridges.

- Using typical GIS spatial analysis tools, the structure data was extracted from the VTrans NBI and short structure inventory and intersected with the River Corridor Sensitivity data layer, which applied the river sensitivity attributes to each structure. A key attribute for assessment is the bank-full width field that exists within the River Corridor Sensitivity data layer.

- Each structure was evaluated to assess the structure's span and the width of the corresponding river. The maximum span of each structure was compared to the bank-full width of the adjacent river reach and those with spans that were less than bank-full width were then identified as vulnerable.



# Chapter 3

## Screening Process: 251 to 5

## Chapter 3

Overview ..... 3.1
Step #1: Economic Activity Screen ..... 3.1
Methodology: Linear Index for Economic Activity ..... 3.2
Step #2: Infrastructure Vulnerability Screen ..... 3.4
Step #3: Commercial Building Vulnerability Screen ..... 3.6
Step #4: Combining Economic, Infrastructure and Building Screens ..... 3.6
The Final Five Regions Chosen: ..... 3.12
Appendix 3.1: ..... 3.17
Appendix 3.2 ..... 3.20
Appendix 3.3 ..... 3.23
Appendix 3.4 ..... 3.26
Appendix 3.5 ..... 3.29
Appendix 3.6 ..... 3.32

## Overview

Once the data sets were collected and maps developed to illustrate flood risk and economic activity, the project team developed a screening process to select five communities for further analysis. The next step was to conduct a more detailed, on-the-ground analysis and the development of specific recommendations to protect economic activity and associated infrastructure in those communities. This chapter provides an overview of the screening process, along with the reasoning and alternatives considered to help other states and regions focus on areas with the greatest need and impact. See Figure 3.3 for a step-by-step summary of the screening process.

## Step #1: Economic Activity Screen

As discussed in the previous chapter, along with secondary information, the primary data sets used to evaluate state-wide economic activity included:

- ***Number of Establishments,*** 2012 (VT DOL data). The number of work sites (e.g., farms, factories, or stores) per town that produce goods or provide services through one type of economic activity.

- ***Annual Average Employment***, 2012 (VT DOL data). The number of jobs in each town. The annual average of the monthly employment figures in each town, as reported by covered employers. These data exclude self-employed people, most farms, some non-profits, churches, rail workers, elected officials, student workers, and officers and family members of sole proprietorships or partnerships.

- ***Total Wages***, 2012, (VT DOL data). The total of all wages paid by reporting establishments in each town.

- ***Rooms Sales Tax***, 2012, (VT DOT data). This was used as a proxy for the tourism sector of the economy.

The project team identified three options for an economic activity screening methodology for the towns in Vermont. The three options were as follows:

- *Create a linear index:* Assign a town score for each of the primary economic measures on a scale of 1 to 10 and then add together the scores for each town, resulting in a score between 1 and 40.

- *Assign a dollar value to each town's economic activity:* Take the total wages per town (which would incorporate measures 1 through 3 above), add the dollar value of sales & use taxes and meals & rooms taxes, and use the combined dollar amount to rank-order each town from high to low.

- *Use a hybrid method:* Utilize a combination of the above options.

To determine the pros and cons of each approach, the project team consulted with Susan Mesner, an economist and the Vermont Deputy State Auditor, and Jeff Carr, the Vermont State Economist, and incorporated their comments into the ranking methodology. In their expert opinions, both agreed that the linear index methodology would work best and meet the needs of this project. The screen was then used to rank the relative economic activity level for the towns in Vermont.

## Methodology: Linear Index for Economic Activity

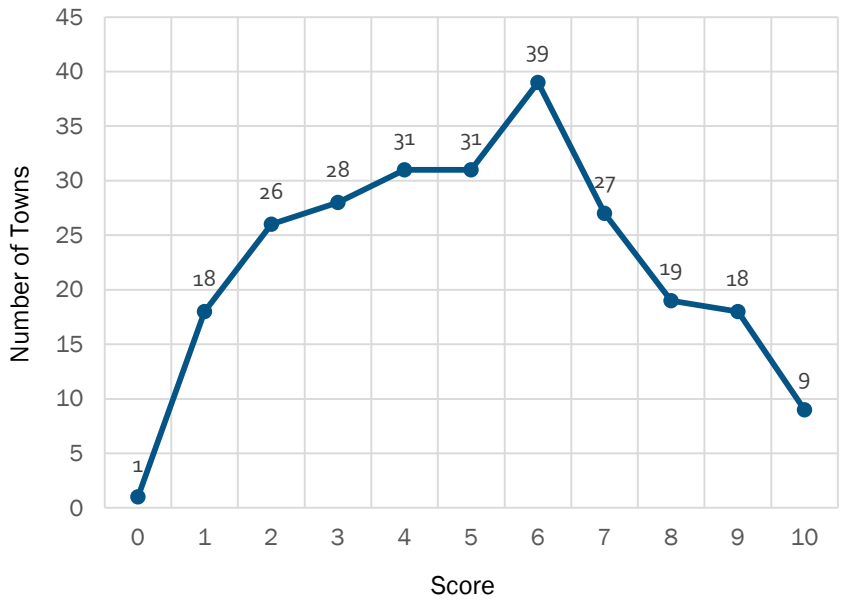
For each of the four data sets, towns were grouped into 'bell shaped' tranches to review the distribution and simplify the next steps. A score between 0 and 10 was assigned to each range.

**Table 3.1: 2012 Annual Average Number of Establishments**

| Range | Score | Number of Towns with Rank |
|---|---|---|
| 600-1,519 | 10 | 9 |
| 200-599 | 9 | 18 |
| 125-199 | 8 | 19 |
| 80-124 | 7 | 27 |
| 40-79 | 6 | 39 |
| 28-39 | 5 | 31 |
| 21-27 | 4 | 31 |
| 13-20 | 3 | 28 |
| 6-12 | 2 | 26 |
| 1-5 | 1 | 18 |
| 0 | 0 | 1 |

The table and associated graph for the annual average establishments is illustrated in Table 3.1 and Figure 3.1 and the corresponding tables and graphs for the other three economic data sets can be found in Appendix 3.1.

**Figure 3.1: 2012 Annual Average Number of Establishments**




Each town was then assigned a score in each of the economic measures on a scale of 0 to 10 depending on where they were in the range. Table 3.2 illustrates the results for the first eight towns in alphabetical order. Then the four scores were added together for a score of between 1 and 40 for each town. The team developed a list of the top 82 towns (as shown in Appendix 3.2).

**Table 3.2: Total Economic Scores and Rank for Vermont Municipalities**

| Town | Establishment Score | Employment Score | Total Wages Score | Rooms Sales Score | Total Score | Ranking |
|---|---|---|---|---|---|---|
| Addison | 6 | 5 | 5 | 2 | 18 | 99 |
| Albany | 3 | 3 | 2 | 0 | 8 | 192 |
| Alburgh | 6 | 5 | 5 | 4 | 20 | 82 |
| Andover | 3 | 2 | 2 | 0 | 7 | 198 |
| Arlington | 7 | 7 | 7 | 6 | 27 | 31 |
| Athens | 1 | 0 | 0 | 0 | 1 | 238 |
| Averill | 1 | 1 | 1 | 0 | 3 | 232 |
| Bakersfield | 2 | 3 | 2 | 0 | 7 | 199 |

## Step #2: Infrastructure Vulnerability Screen

To identify towns that have the most infrastructure that is vulnerable to hazards, the VERI project team combined river corridor data with the following four transportation infrastructure data sets discussed in Chapter 2:

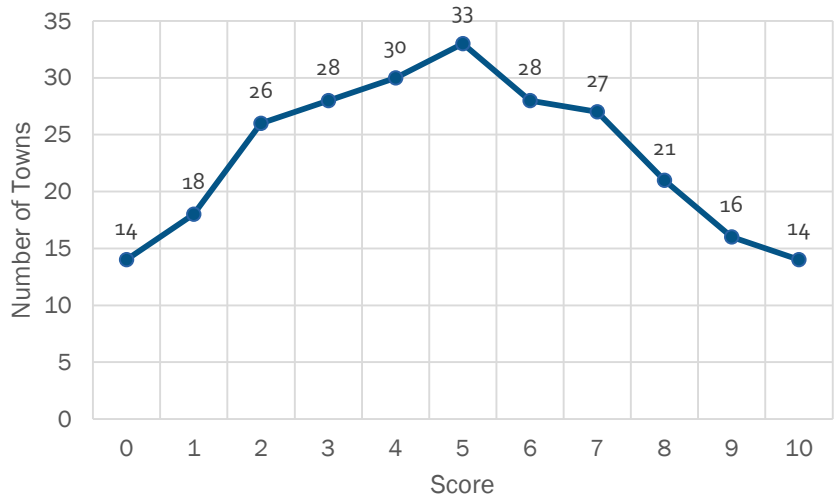
- Number of bridges having spans of less than bankfull width. These data show bridges that are too narrow to pass the flow of water from an annual or semi-annual flood event.
- Number of federal aid road miles (federal roads, state Class 1 roads and many state Class 2 roads) in river corridors. Federal aid roads are those that are most likely to be used to transport goods and services.
- Number of federal aid road miles in high river erosion areas. High erosion and deposition areas are more likely to experience flooding that destroys a road, rather than temporarily making it impassable.
- Number of federal aid road miles in high river deposition areas.

As with the economic activity rankings, the project team assigned a town score for each of the four infrastructure vulnerability data sets on a scale of 0 to 10. The table and figure (Table 3.3 and Figure 3.2) show results for number of federal aid road miles in river corridors and the other three can be found in Appendix 3.3. To do this, the values in each data set were sorted from high to low, and sub-groups were created based on a bell curve distribution as with the economic activity data sets.

**Table 3.3: Miles of Federal Aid Roads in River Corridors**

| Range | Score | Number of Towns Having This Rank |
|---|---|---|
| 34-88 | 10 | 14 |
| 26-33 | 9 | 16 |
| 21-25 | 8 | 21 |
| 10-20 | 7 | 27 |
| 5-9 | 6 | 28 |
| 3-4 | 5 | 33 |
| 1.75-2 | 4 | 30 |
| .75-1.74 | 3 | 28 |
| .4-.74 | 2 | 26 |
| .01-.3 | 1 | 18 |
| 0 | 0 | 14 |

**Figure 3.2 Miles of Federal Aid Roads in River Corridors**




Scores for each town were then added together for each town, resulting in a total score between 1 and 40, with 1 representing towns will the least vulnerable infrastructure, 40 with the most vulnerable infrastructure. From this, a list of the top 75 towns with the most vulnerable infrastructure was developed and can be found in Appendix 3.4. Table 3.4 shows the first eight towns on that list.

**Table 3.4: Total Infrastructure Vulnerability Scores and Rank for Vermont Municipalities**

| Town | Federal Aid Roads in River Corridor Score | Bridges with Spans Less Than Bankfull Width Score | Highway in High Erosion Score | Highway in High Deposition Score | Total Score | Rank |
|---|---|---|---|---|---|---|
| Bethel | 10 | 10 | 10 | 9 | 39 | 1 |
| Barnet | 9 | 10 | 9 | 9 | 37 | 2 |
| Barton | 10 | 10 | 8 | 9 | 37 | 3 |
| Bennington | 7 | 10 | 9 | 9 | 35 | 4 |
| Bradford | 9 | 8 | 9 | 9 | 35 | 5 |
| Brattleboro | 10 | 8 | 9 | 8 | 35 | 6 |
| Hartford | 10 | 10 | 10 | 5 | 35 | 7 |
| Arlington | 7 | 8 | 9 | 10 | 34 | 8 |

## Step #3: Commercial Building Vulnerability Screen

The project team also wanted to evaluate a direct risk to businesses and used the number of non-residential buildings in river corridors, based on E-911 site data as an indicator of this risk.

Eighty-five towns were found to have 10 or more non-residential buildings located in the river corridor. Montpelier has the most with 300, followed by Barre City with 169 and Springfield with 154. The top ten can be found in Table 3.5, with a complete list of all 85 towns and a map of commercial site density found in Appendix 3.5.

**Table 3.5: Top 10 Vermont Municipalities for At-risk Businesses**

| Town | Number of Non-Residential Buildings in the River Corridor |
|---|---|
| Montpelier | 300 |
| Barre City | 169 |
| Springfield | 154 |
| Woodstock | 140 |
| St. Johnsbury | 126 |
| Ludlow | 84 |
| Bennington | 80 |
| Brattleboro | 73 |
| Manchester | 69 |
| Wilmington | 69 |

## Step #4: Combining Economic, Infrastructure and Building Screens

Based on the above screening, the project team had three lists for the top municipalities in Vermont ranked from highest to lowest for:

- Economic Activity
- Infrastructure At-risk
- Non-residential Buildings At-risk

Reviewing each list, it was determined that 34 Vermont towns appeared on all three list. They were centers of economic activity that had infrastructure and non-residential buildings vulnerable to flood hazards. Next, the list of 34 communities needed to be reduced to five.

Two towns were eliminated - Bennington and Waterbury - as they had or were in the process of conducting a similar analysis, resulting in flood hazard mitigation activities that are planned or completed. This reduced duplication of efforts and allowed more towns in Vermont to benefit. A table of the 32 towns that were candidates for VERI's Priority Area Designation is included in Appendix 3.6.

The project team applied secondary criteria to determine the final list. The following criteria were noted in the review table:

- ***The size of the community*:** to ensure communities of different (small, medium and large) sizes based on population were represented in the five priority communities.

- ***Geographic distribution*:** to ensure various areas of the state were represented.

- ***The key economic activity:*** in Vermont, tourism and agriculture are key areas of economic activity and it was important to include communities representing these sectors.

- ***Home to a key employer (i.e. hospital, higher education, large plant, etc.):*** based on the information received from the RDCs.

- ***Presence of a state designated downtown or village center:*** Vermont has established a framework of state "designations" to provide incentives to encourage communities to maintain Vermont's historic settlement pattern of compact centers surrounded by working lands. These programs are also designed to help align our environmental, housing, and transportation policies, programs, regulations, and public investments to maintain and enhance the landscape cherished by Vermonters and visitors alike. Designated communities receive priority funding consideration for various grants and implementation programs. These communities were noted as they have greater likelihood of receiving funding for implementation.

- ***Location of other critical infrastructure at risk*:** If the information was available, it was noted if the community had critical infrastructure (wastewater treatment plant or pipes, water treatment facility or pipes, high hazard dams, electric utility infrastructure, etc.) in river corridors or other hazard areas.

- ***Towns with digital parcel maps*:** This information could help with subsequent analysis for the community phase of the project and was noted if available.

- ***Towns where we have Phase 2 Stream Geomorphic Assessment (SGA) data or LiDAR data*:** As above, this information could help with the local watershed analysis and was noted in communities where available.

Table 3.6 captures the review process conducted for 10 communities. To review all 32, see Appendix 3.6.

**Table 3.6: VERI Project Team Review For Identification of 32 Priority Communities**

| Town | Economic Activity Ranking | County | 2011 Pop. Estimate | Infra-structure Vulnera-bility Ranking | Number of Vulnerable Commer-cial Buildings Ranking | Designated Downtown or Village Center | Critical Employer | Critical System Risk | SGA | Parcel Map | LiDAR | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barre City | 14 | Washington | 9,066 | 12 | 169 | Downtown | | | Yes | 2007 | Yes | |
| Brattleboro | 4 | Windham | 11,978 | 6 | 73 | Downtown | Yes | Yes | Yes | 2014 | Yes | |
| Cambridge | 20 | Lamoille | 3,695 | 26 | 35 | Village | | | Yes | 2006 | No | Tourism |
| Enosburg | 57 | Franklin | 2,800 | 65 | 10 | Village | | | Yes | 2014 | Yes | Ag. |
| Hardwick | 65 | Caledonia | 3,003 | 22 | 55 | Village | | | Yes | 2000 | No | Ag. |
| Hartford | 10 | Windsor | 9,952 | 7 | 45 | Downtown | | | Yes | 2014 | Yes | |
| Ludlow | 16 | Windsor | 1,963 | 43 | 84 | Village | | | Yes | 2014 | No | Tourism |
| Montpelier | 7 | Washington | 7,868 | 11 | 300 | Downtown | Yes | | Yes | 2014 | Yes | |
| Morristown | 33 | Lamoille | 5,277 | 51 | 46 | Downtown | Yes | | Yes | 2012 | No | |
| Woodstock | 19 | Windsor | 3,047 | 24 | 140 | Village | | Yes | Yes | 2010 | Yes | Tourism |

Finally, the project team reviewed the list to identify communities that would be 'interested and enthusiastic' partners in this initiative. The team's thinking on this criteria was centered on its past experience with the community – would there be community buy-in, was there past support for flood resilience, and what was the history of success in implementing projects? These were all important considerations for the final five communities chosen. The team also relied on VT ANR's knowledge of the river reaches, flood history and any potential concerns or opportunities.

Project team members next reached out to the top five communities to explain the project, provide an overview of the expected deliverables, the time commitment and resources required from the community and invite them to participate.

**Figure 3.3: Summary of VERI Screening Process**

*Step One: Create a linear index for economic activity*

- For each economic data source, sort each town from high to low and break into ranges based on a bell curve. For Vermont, the project team broke it into ten ranges, each with an assigned score from 1 to 10.
- Assign each town a score of 1 to 10 for each of the data measured used. For Vermont, there were four (number of annual average establishments; average annual employment; total town wages; and room taxes).
- Add up the scores for each town.

*Step Two: Create an index for transportation vulnerability*

- For each transportation vulnerability data source, sort each town from high to low and break into ranges based on a bell curve. For Vermont, the project team broke it into ten ranges, each with an assigned score from 1 to 10.
- Assign each town a score of 1 to 10 for each of the data measured used. For Vermont, there were four (number of bridges having spans of less than bankfull width; number of federal aid road miles in river corridors; number of federal aid road miles in high erosion areas; number of federal aid road miles in high river deposition areas)
- Add up the scores for each town.

**Step Three: Determine number of vulnerable non-residential buildings**

- Determine the number of non-residential buildings at risk based on E-911 data of these buildings overlaid with ANR's river corridor map.
- Rank from highest to lowest

**Step Four: Identify the communities on all three lists.**

**Step Five: Eliminate any communities that have completed or have funding for similar projects.**

**Step Six: Screen the list for other factors.**

- The screen included size of the community; home of key employer; presence of a community center; other infrastructure such as sewer, water or power at risk; parcel mapping, and LiDAR. Also considered was if the community would be interested partners and had a track record of implementing projects.

**Step Seven: Pick top communities to study.**

## The Final Five Regions Chosen:

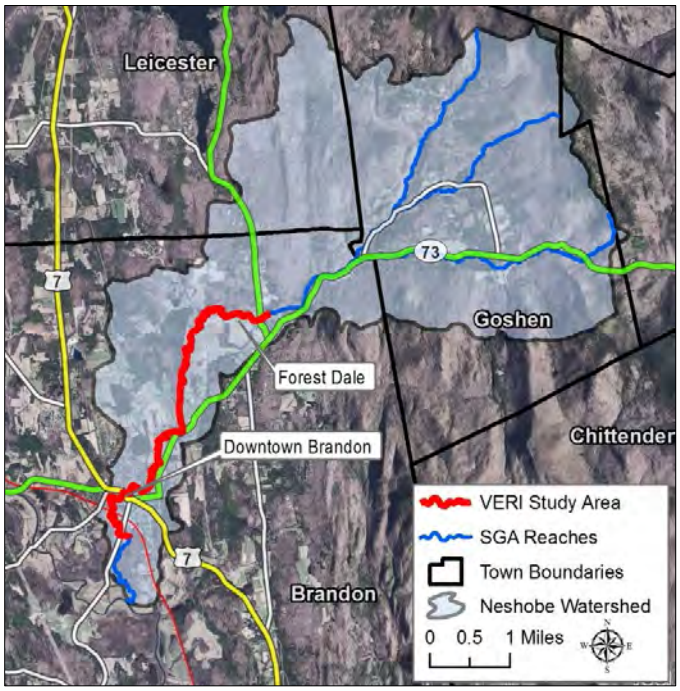
Based on the scoring, in depth review and discussion of secondary factors, the following five areas within seven municipalities were chosen:

*Gunners Brook in Barre City and Barre Town:* Approximately 3.0 river miles of Gunners Brook from the Barre town line to Stevens Branch in Barre City. This area was selected because it is a designated downtown, has an unusually high level of development adjacent to the channel, significant economic activity, and history of repeated flooding and flood damages. The communities have worked to identify and manage flood risks through adoption of floodplain regulations and hazard mitigation plans.

**Figure 3.4: Map of Barre Study Area**

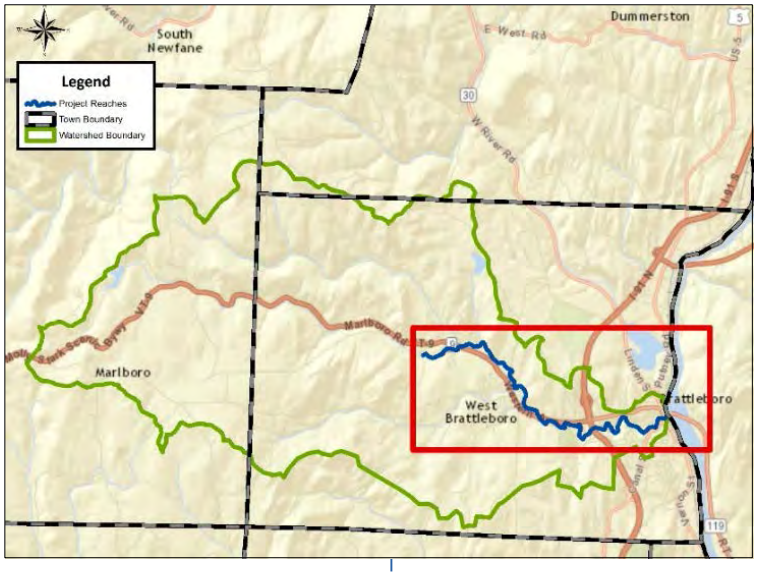
***The Neshobe River in Brandon:*** Approximately 5.0 river miles from the confluence of Leicester Hollow Brook through Brandon Village. Brandon was selected because it has a densely developed designated downtown area with significant economic activity and critical transportation infrastructure and commercial buildings at risk of flooding. Brandon also has a history of strong local support of initiatives to reduce flood risks, including past efforts to identify and prevent flood risks throughout the town. For example, Brandon is one of a handful of towns in Vermont that have adopted flood hazard regulations above and beyond the minimum National Flood Insurance Program (NFIP) requirement. As a result of its proactive regulations, Brandon qualifies for the highest level for federal and state reimbursement (75% federal and an additional 17.5% state) of federally-declared disasters through the Emergency Relief Assistance Fund (ERAF). The town has also encouraged the permanent conservation of key floodplains upstream of the downtown to help protect downstream properties and infrastructure during future floods by allowing flood waters to spread out over a large area and slow down the energy and speed of flood waters.

**Figure 3.5: Map of Brandon Study Area**



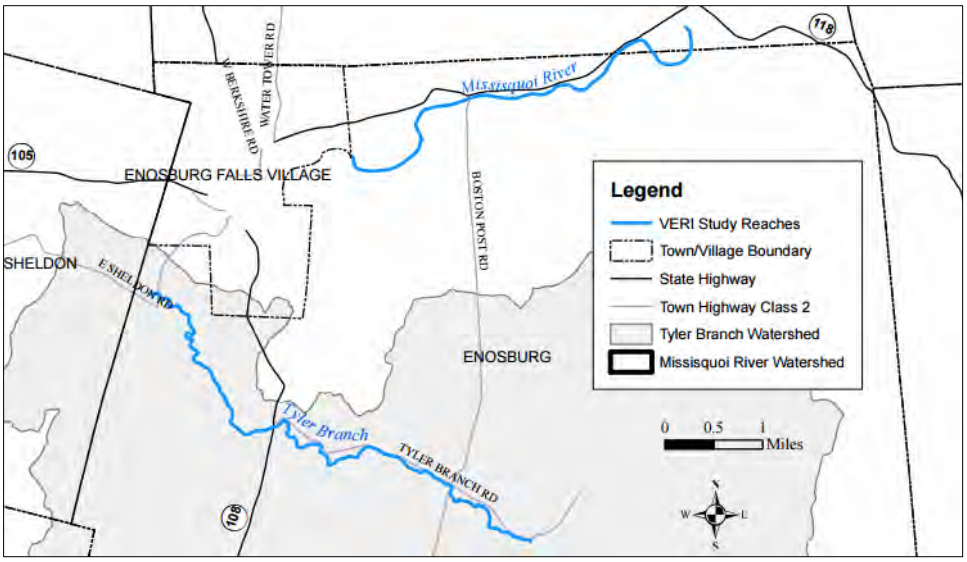
***The Whetstone Brook in Brattleboro:*** Approximately 5.5 river miles from West Brattleboro to the confluence with the Connecticut River. Brattleboro was selected for the VERI project because of its role as a regional economic center – it has the fourth highest economic activity in the State (tied with Rutland). It is also located on Routes 5 and 9, critical north-south and east-west travel corridors that are particularly vulnerable to floods. Finally, Brattleboro has completed a number of flood protection projects identified in the 2008 River Corridor Plan and is working to floodproof many downtown buildings.

**Figure 3.6: Map of Brattleboro Study Area**



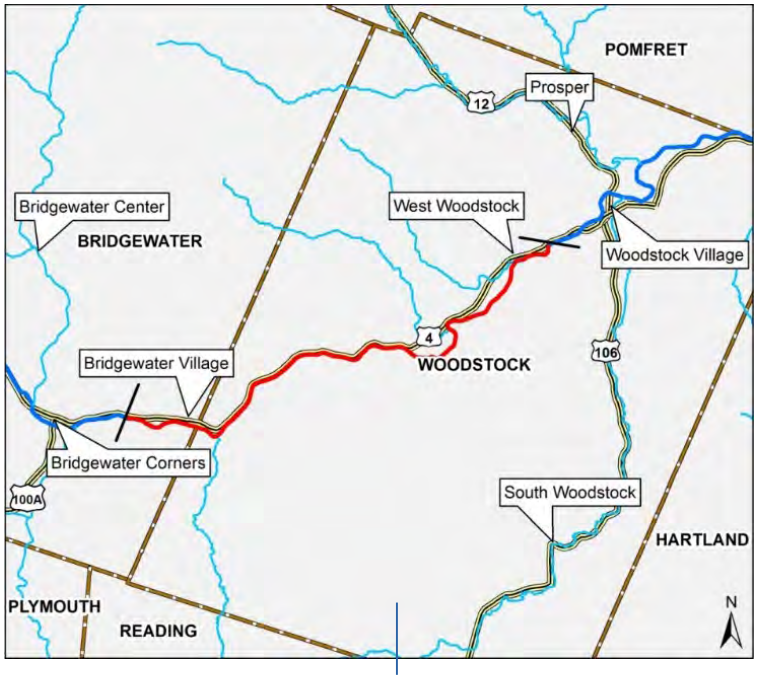
***Tyler Branch in Enosburgh Town and Enosburgh Falls Village:*** Approximately 5.25 river miles from the confluence of Beaver Meadow Brook and Cold Hollow Brook to the town line. The Enosburgh Town and Enosburg Falls Village were selected as they represent an agricultural-based economy that is impacted by flooding and erosion. The community has worked to identify flood and erosion risks and projects are regularly implemented to strengthen the transportation network that is essential to access local farms and move agricultural products to market.

**Figure 3.7: Map of Enosburg Study Area**



***The Ottauquechee River in Woodstock:*** Approximately 6.4 river miles of the main stem from Bridgewater Village to West Woodstock outside of Woodstock Village. Woodstock was selected as it has a densely developed downtown area with significant economic activity, critical transportation infrastructure and commercial buildings at risk of flooding and a history of community engagement, including past efforts to identify flood risks throughout the town. For example, the Town of Woodstock has adopted strategies for protecting new development and substantially improved buildings from flood hazards through regulations that offer greater protection to the community than the minimum National Flood Insurance Program (NFIP) guidelines. With its completion of a town hazard mitigation plan in 2015, the town and village now qualify for the intermediate level of state ERAF reimbursement (12.5%) for costs related to federally-declared disasters.

**Figure 3.8: Map of Woodstock Study Area**




Chapter 4 provides an overview of the in-depth work in each of these regions.

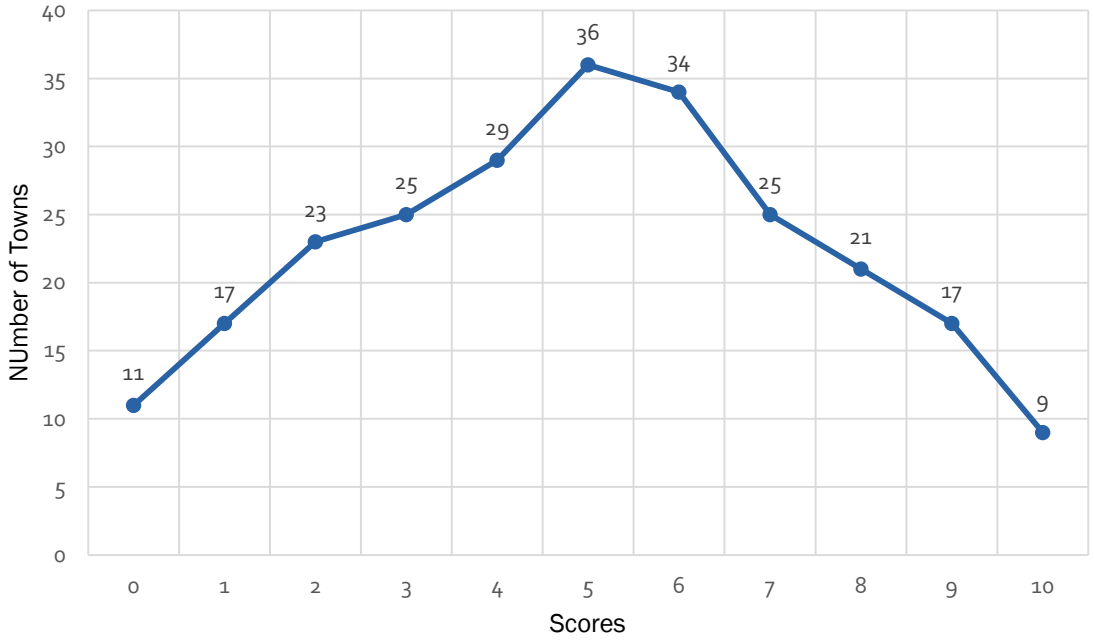
## Appendix 3.1:

***Annual Average Employment***, 2012 (VT DOL data). The number of jobs in each town. The annual average of the monthly employment figures in each town, as reported by covered employers. These data exclude self-employed people, most farms, some non-profits, churches, rail workers, elected officials, student workers, and officers and family members of sole proprietorships or partnerships.

**Table 3.7: Annual Average Employment (2012)**

| Range | Score | Number of Towns With Rank |
|---|---|---|
| 8,000-33,177 | 10 | 9 |
| 2,500-7,999 | 9 | 17 |
| 1,260-2,499 | 8 | 21 |
| 700-1,259 | 7 | 25 |
| 300-699 | 6 | 34 |
| 170-299 | 5 | 36 |
| 100-169 | 4 | 29 |
| 60-99 | 3 | 25 |
| 31-59 | 2 | 23 |
| 12-30 | 1 | 17 |
| 0 | 0 | 11 |

**Figure 3.9: Annual Average Employment (2012)**

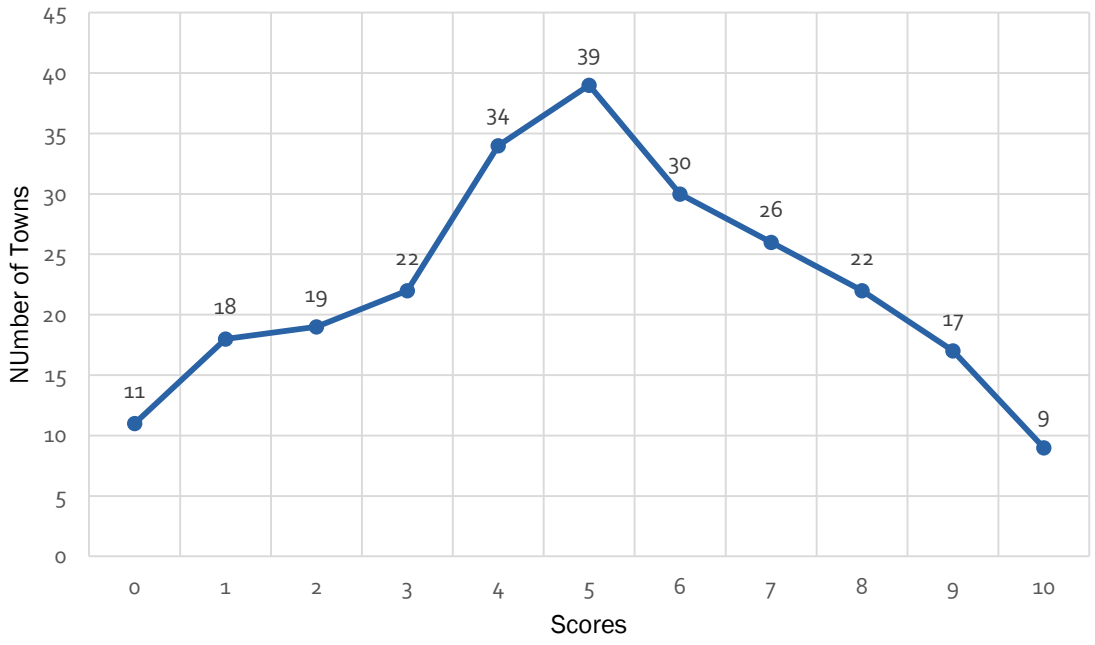


*Total wages*, 2012, (VT DOL data). The total of all wages paid by reporting establishments in each town.

**Table 3.8: Total Town Wages (2012)**

| Range | Score | Number of Towns With Rank |
|---|---|---|
| $300 m - $1.7 b | 10 | 9 |
| $100 m - $299 m | 9 | 17 |
| $40 m - $ 99 m | 8 | 22 |
| $25 m - $39 m | 7 | 26 |
| $11 m - $24 m | 6 | 30 |
| $5.5 m - $10 m | 5 | 39 |
| $3.0 m - $5.4 m | 4 | 34 |
| $1.7 m - $2.9 m | 3 | 22 |
| $1.0 m - $1.6 m | 2 | 19 |
| $100,000 - $999,000 | 1 | 18 |
| 0 | 0 | 11 |

**Figure 3.10: Total Town Wages (2012)**

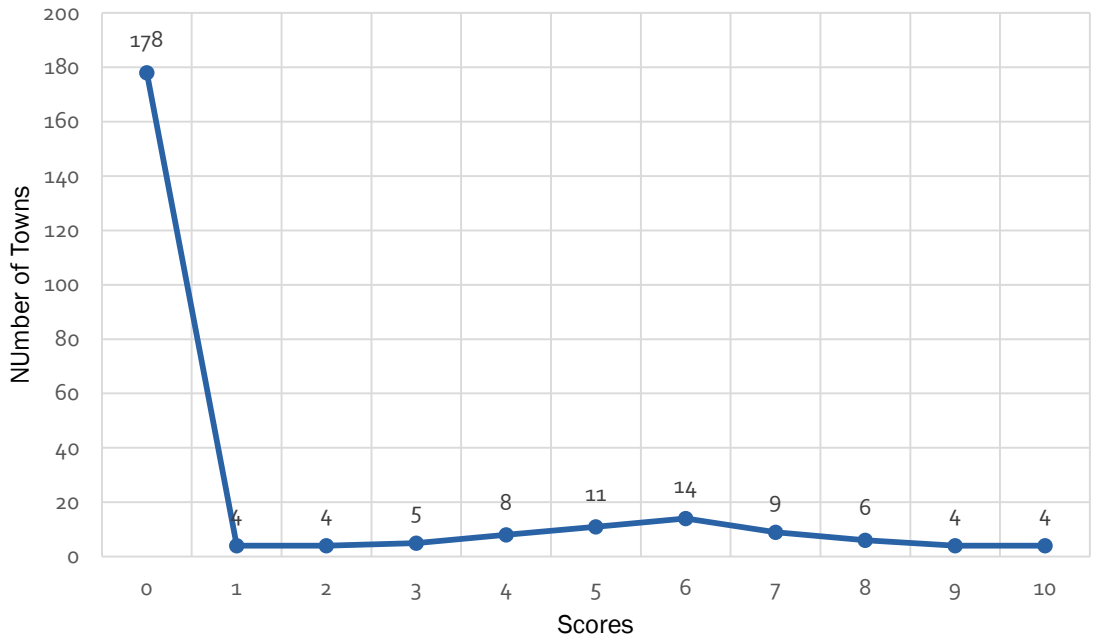


***Rooms Sales***, 2012, (VT DOT data). This was used as a proxy for the tourism sector of the economy.

**Table 3.9: Room Taxes (2012)**

| Range | Score | Number of Towns With Rank |
|---|---|---|
| $20 m - $53 m | 10 | 4 |
| $12 m - $19 m | 9 | 4 |
| $7 m - $11 m | 8 | 6 |
| $3 m - $6 m | 7 | 9 |
| $1 m - $2.9 m | 6 | 14 |
| $600 k - $999 k | 5 | 11 |
| $300 k - $599 k | 4 | 8 |
| $200 k - $299 k | 3 | 5 |
| $150 k - $199 m | 2 | 4 |
| $100 k - $149 k | 1 | 4 |
| 0 | 0 | 178 |

**Figure 3.11: Room Taxes (2012)**



# Appendix 3.2

**Table 3.10: Total Economic Scores for Top 82 Vermont Municipalities**

| Town | Annual Average Establish-ments Score | Annual Average Employ-ment Score | Total Wages Score | Rooms Tax Receipts Score | Total Score | Rank |
|---|---|---|---|---|---|---|
| Burlington | 10 | 10 | 10 | 10 | 40 | 1 |
| South Burlington | 10 | 10 | 10 | 10 | 40 | 2 |
| Colchester | 10 | 10 | 10 | 9 | 39 | 3 |
| Brattleboro | 10 | 10 | 10 | 8 | 38 | 4 |
| Rutland | 8 | 9 | 8 | 0 | 25 | 5 |
| Bennington | 10 | 10 | 10 | 7 | 37 | 6 |
| Montpelier | 10 | 10 | 10 | 7 | 37 | 7 |
| Stowe | 9 | 9 | 9 | 10 | 37 | 8 |
| Manchester | 9 | 9 | 9 | 9 | 36 | 9 |
| Hartford | 9 | 9 | 9 | 8 | 35 | 10 |
| Middlebury | 9 | 9 | 9 | 7 | 34 | 11 |
| Shelburne | 9 | 9 | 9 | 7 | 34 | 12 |
| Waterbury | 9 | 9 | 9 | 7 | 34 | 13 |
| Barre City | 9 | 9 | 9 | 6 | 33 | 14 |
| Killington | 8 | 8 | 7 | 10 | 33 | 15 |
| Ludlow | 8 | 8 | 8 | 9 | 33 | 16 |
| Morristown | 9 | 9 | 9 | 6 | 33 | 17 |
| Newport City | 9 | 9 | 9 | 6 | 33 | 18 |
| Woodstock | 9 | 8 | 8 | 8 | 33 | 19 |
| Cambridge | 8 | 8 | 7 | 8 | 31 | 20 |
| Waitsfield | 9 | 8 | 8 | 6 | 31 | 21 |
| Essex | 10 | 10 | 10 | 0 | 30 | 22 |
| Williston | 10 | 10 | 10 | 0 | 30 | 23 |
| Brandon | 7 | 8 | 8 | 6 | 29 | 24 |
| Derby | 8 | 8 | 8 | 5 | 29 | 25 |
| Dover | 7 | 7 | 7 | 8 | 29 | 26 |
| Castleton | 8 | 8 | 8 | 4 | 28 | 27 |
| Rockingham | 8 | 8 | 8 | 4 | 28 | 28 |
| Swanton | 8 | 8 | 8 | 4 | 28 | 29 |
| Wilmington | 8 | 7 | 7 | 6 | 28 | 30 |
| Arlington | 7 | 7 | 7 | 6 | 27 | 31 |
| Barton | 7 | 8 | 8 | 4 | 27 | 32 |
| Berlin | 9 | 9 | 9 | 0 | 27 | 33 |

| Town | Annual Average Establish-ments Score | Annual Average Employ-ment Score | Total Wages Score | Rooms Tax Receipts Score | Total Score | Rank |
|---|---|---|---|---|---|---|
| Chester | 7 | 7 | 7 | 6 | 27 | 34 |
| Milton | 9 | 9 | 9 | 0 | 27 | 35 |
| Randolph | 9 | 9 | 9 | 0 | 27 | 36 |
| Springfield | 9 | 9 | 9 | 0 | 27 | 37 |
| St. Albans City | 9 | 9 | 9 | 0 | 27 | 38 |
| St. Johnsbury | 9 | 9 | 9 | 0 | 27 | 39 |
| Warren | 7 | 7 | 6 | 7 | 27 | 40 |
| Dorset | 7 | 6 | 7 | 6 | 26 | 41 |
| Ferrisburg | 7 | 6 | 6 | 7 | 26 | 42 |
| Jay | 4 | 7 | 6 | 9 | 26 | 43 |
| Lyndon | 9 | 9 | 8 | 0 | 26 | 44 |
| Rutland City | 10 | 10 | 10 | 8 | 38 | 45 |
| Vergennes | 8 | 8 | 9 | 0 | 25 | 46 |
| Winooski | 8 | 8 | 9 | 0 | 25 | 47 |
| Barre town | 8 | 8 | 8 | 0 | 24 | 48 |
| Charlotte | 8 | 6 | 6 | 4 | 24 | 49 |
| Londonderry | 7 | 6 | 6 | 5 | 24 | 50 |
| Richmond | 8 | 8 | 8 | 0 | 24 | 51 |
| Stratton | 4 | 7 | 6 | 7 | 24 | 52 |
| Windsor | 8 | 8 | 8 | 0 | 24 | 53 |
| Bradford | 7 | 8 | 8 | 0 | 23 | 54 |
| Cavendish | 6 | 6 | 5 | 6 | 23 | 55 |
| Clarendon | 7 | 8 | 8 | 0 | 23 | 56 |
| Enosburg | 7 | 8 | 8 | 0 | 23 | 57 |
| Hinesburg | 8 | 7 | 8 | 0 | 23 | 58 |
| Northfield | 7 | 8 | 8 | 0 | 23 | 59 |
| Poultney | 7 | 7 | 7 | 2 | 23 | 60 |
| St. Albans Town | 7 | 8 | 8 | 0 | 23 | 61 |
| Bristol | 8 | 7 | 7 | 0 | 22 | 62 |
| Burke | 6 | 6 | 5 | 5 | 22 | 63 |
| Grand Isle | 6 | 6 | 6 | 4 | 22 | 64 |
| Hardwick | 8 | 7 | 7 | 0 | 22 | 65 |
| Newfane | 6 | 6 | 5 | 5 | 22 | 66 |
| Norwich | 8 | 7 | 7 | 0 | 22 | 67 |
| South Hero | 6 | 6 | 5 | 5 | 22 | 68 |
| Winhall | 6 | 5 | 5 | 6 | 22 | 69 |

| Town | Annual Average Establish-ments Score | Annual Average Employ-ment Score | Total Wages Score | Rooms Tax Receipts Score | Total Score | Rank |
|---|---|---|---|---|---|---|
| Bethel | 7 | 7 | 7 | 0 | 21 | 70 |
| Fairfax | 7 | 7 | 7 | 0 | 21 | 71 |
| Greensboro | 6 | 6 | 5 | 4 | 21 | 72 |
| Jericho | 7 | 7 | 7 | 0 | 21 | 73 |
| Johnson | 7 | 7 | 7 | 0 | 21 | 74 |
| Mendon | 5 | 5 | 5 | 6 | 21 | 75 |
| North Hero | 5 | 5 | 5 | 6 | 21 | 76 |
| Pittsford | 7 | 7 | 7 | 0 | 21 | 77 |
| Putney | 7 | 7 | 7 | 0 | 21 | 78 |
| Royalton | 6 | 7 | 8 | 0 | 21 | 79 |
| Vernon | 6 | 7 | 8 | 0 | 21 | 80 |
| Westminster | 7 | 7 | 7 | 0 | 21 | 81 |
| North Hero | 5 | 5 | 5 | 6 | 21 | 82 |

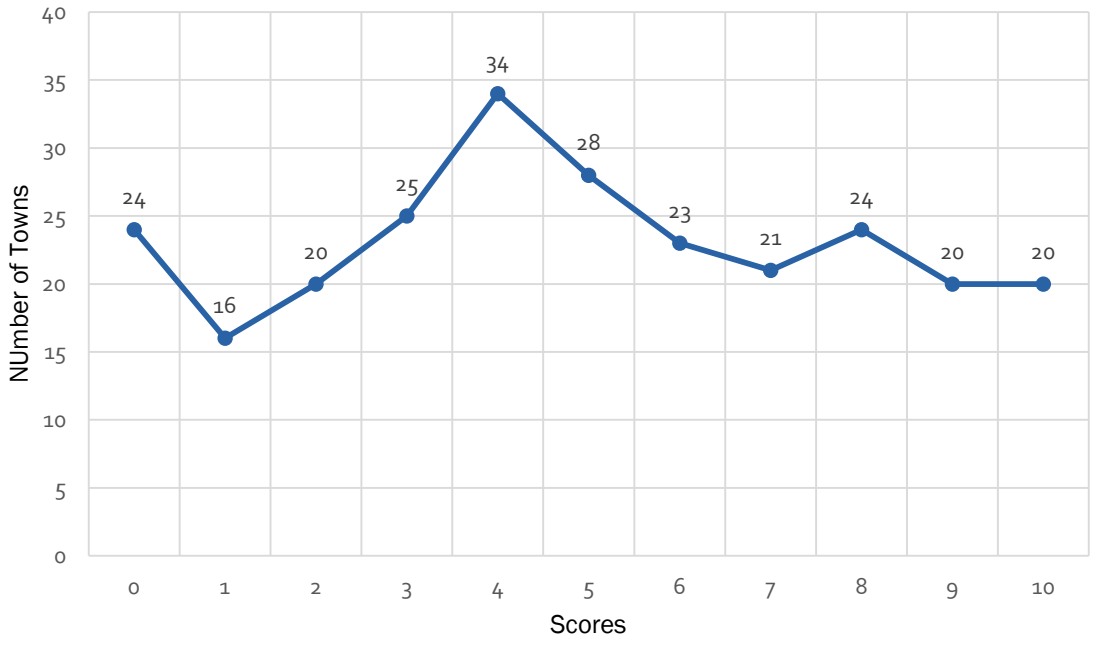
# Appendix 3.3

***Number of bridges having spans of less than bankfull width.*** These data show bridges that are too narrow to pass the flow of water from an annual or semi-annual flood event.

**Table 3.11: Bridges Having Spans of Less than Bankfull Width**

| Range | Score | Number Of Towns Having This Rank |
|---|---|---|
| 20-35 | 10 | 20 |
| 15-19 | 9 | 20 |
| 12-14 | 8 | 24 |
| 10-11 | 7 | 21 |
| 8-9 | 6 | 23 |
| 6-7 | 5 | 28 |
| 4-5 | 4 | 34 |
| 3 | 3 | 25 |
| 2 | 2 | 20 |
| 1 | 1 | 16 |
| 0 | 0 | 24 |

**Figure 3.12: Bridges Having Spans of Less than Bankfull Width**

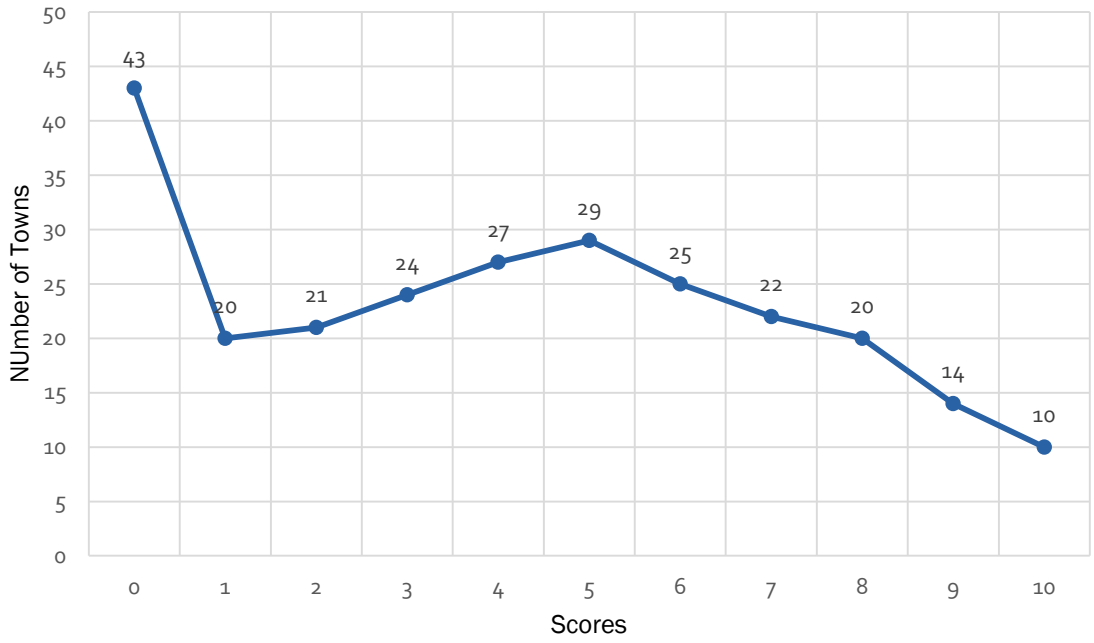


***Number of federal aid road miles in high river erosion areas.*** High erosion and deposition areas are more likely to experience flooding that destroys a road, rather than temporarily making it impassable.

**Table 3.12: Federal Aid Road Miles in High River Erosion Areas**

| Range | Score | Number of Towns Having This Rank |
|---|---|---|
| > 10 | 10 | 10 |
| 6.5-9 | 9 | 14 |
| 4.8-6.5 | 8 | 20 |
| 3.2-4.7 | 7 | 22 |
| 2.1-3.2 | 6 | 25 |
| 1.3-2.1 | 5 | 29 |
| 0.9-1.3 | 4 | 27 |
| 0.55-0.9 | 3 | 24 |
| 0.25-0.54 | 2 | 21 |
| 0.01-0.24 | 1 | 20 |
| 0 | 0 | 43 |

**Figure 3.13: Federal Aid Road Miles in High River Erosion Areas**

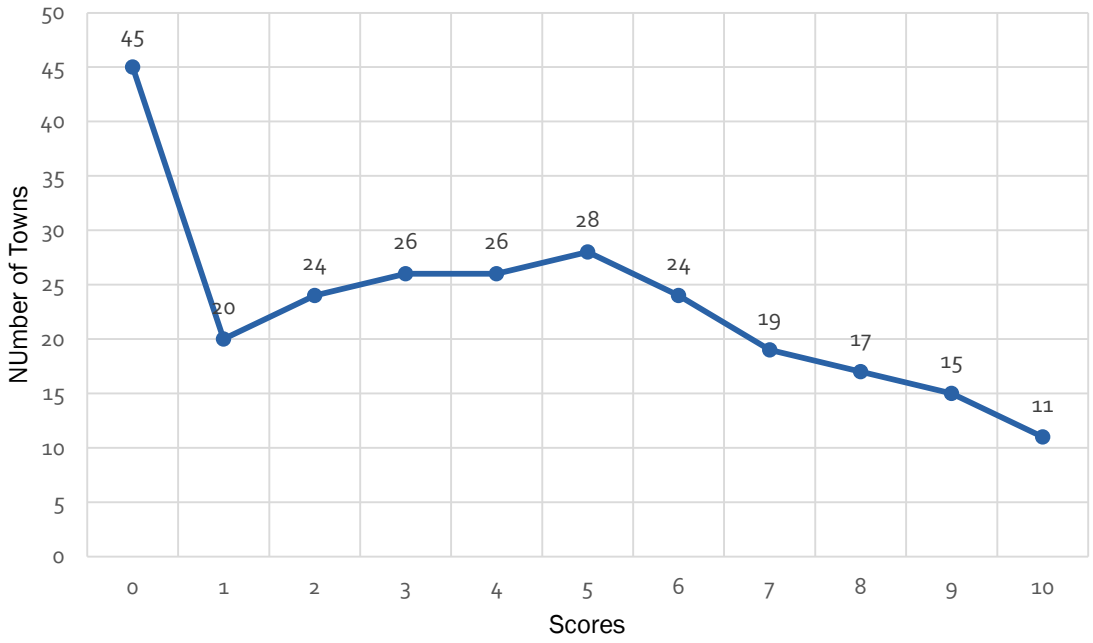


*Number of federal aid road miles in high river deposition areas.*

**Table 3.13: Federal Aid Road Miles in High River Deposition Areas**

| Range | Score | Number of Towns Having This Rank |
|---|---|---|
| > 7.8 | 10 | 11 |
| 5.6-7.8 | 9 | 15 |
| 4.0-5.5 | 8 | 17 |
| 3.0-3.9 | 7 | 19 |
| 2.0-2.9 | 6 | 24 |
| 1.3-1.9 | 5 | 28 |
| 0.9-1.3 | 4 | 26 |
| 0.55-0.9 | 3 | 26 |
| 0.26-0.54 | 2 | 24 |
| 0.01-0.25 | 1 | 20 |
| 0 | 0 | 45 |

**Figure 3.14: Federal Aid Road Miles in High River Deposition Areas**



# Appendix 3.4

**Table 3.14: Total Infrastructure Vulnerability Score for Top 75 Vermont Municipalities**

| Town | Federal Aid Roads in River Corridor Score | Bridges with Spans Less than Bankfull Width Score | Highway in High Erosion Score | Highway in High Deposition Score | Total Score | Rank |
|---|---|---|---|---|---|---|
| Bethel | 10 | 10 | 10 | 9 | 39 | 1 |
| Barnet | 9 | 10 | 9 | 9 | 37 | 2 |
| Barton | 10 | 10 | 8 | 9 | 37 | 3 |
| Bennington | 7 | 10 | 9 | 9 | 35 | 4 |
| Bradford | 9 | 8 | 9 | 9 | 35 | 5 |
| Brattleboro | 10 | 8 | 9 | 8 | 35 | 6 |
| Hartford | 10 | 10 | 10 | 5 | 35 | 7 |
| Arlington | 7 | 8 | 9 | 10 | 34 | 8 |
| Berlin | 10 | 9 | 6 | 9 | 34 | 9 |
| Bridgewater | 6 | 10 | 10 | 8 | 34 | 10 |
| Montpelier | 10 | 10 | 10 | 4 | 34 | 11 |
| Barre City | 6 | 9 | 9 | 9 | 33 | 12 |
| Bolton | 9 | 9 | 5 | 9 | 32 | 13 |
| Cavendish | 6 | 9 | 10 | 7 | 32 | 14 |
| Chelsea | 6 | 10 | 9 | 7 | 32 | 15 |
| Chester | 8 | 9 | 8 | 7 | 32 | 16 |
| Fairfax | 9 | 9 | 8 | 6 | 32 | 17 |
| Sharon | 10 | 10 | 10 | 2 | 32 | 18 |
| Springfield | 10 | 10 | 10 | 2 | 32 | 19 |
| Barnard | 5 | 8 | 8 | 10 | 31 | 20 |
| Lyndon | 10 | 10 | 7 | 4 | 31 | 21 |
| Hardwick | 8 | 10 | 7 | 5 | 30 | 22 |
| St. Johnsbury | 10 | 10 | 9 | 1 | 30 | 23 |
| Woodstock | 10 | 10 | 10 | 0 | 30 | 24 |
| Brookfield | 9 | 6 | 6 | 8 | 29 | 25 |
| Cambridge | 6 | 9 | 6 | 8 | 29 | 26 |
| Dummerston | 7 | 6 | 9 | 7 | 29 | 27 |
| Northfield | 8 | 10 | 8 | 3 | 29 | 28 |
| Royalton | 9 | 9 | 9 | 2 | 29 | 29 |
| Brandon | 7 | 8 | 4 | 9 | 28 | 30 |
| Concord | 6 | 8 | 7 | 7 | 28 | 31 |
| Corinth | 7 | 7 | 7 | 7 | 28 | 32 |
| Danville | 7 | 7 | 7 | 7 | 28 | 33 |

| Town | Federal Aid Roads in River Corridor Score | Bridges with Spans Less than Bankfull Width Score | Highway in High Erosion Score | Highway in High Deposition Score | Total Score | Rank |
|---|---|---|---|---|---|---|
| Jamaica | 7 | 6 | 10 | 5 | 28 | 34 |
| Newbury | 9 | 10 | 5 | 4 | 28 | 35 |
| Randolph | 9 | 10 | 6 | 3 | 28 | 36 |
| Bristol | 6 | 5 | 8 | 8 | 27 | 37 |
| Coventry | 7 | 8 | 5 | 7 | 27 | 38 |
| Craftsbury | 6 | 9 | 5 | 7 | 27 | 39 |
| Granville | 5 | 9 | 7 | 6 | 27 | 40 |
| Johnson | 5 | 9 | 8 | 5 | 27 | 41 |
| Londonderry | 6 | 8 | 9 | 4 | 27 | 42 |
| Ludlow | 7 | 8 | 8 | 4 | 27 | 43 |
| Marshfield | 6 | 10 | 7 | 4 | 27 | 44 |
| Middlesex | 9 | 8 | 6 | 4 | 27 | 45 |
| Plymouth | 6 | 9 | 9 | 3 | 27 | 46 |
| Waterbury | 9 | 10 | 8 | 0 | 27 | 47 |
| Burke | 5 | 8 | 5 | 8 | 26 | 48 |
| Georgia | 8 | 7 | 5 | 6 | 26 | 49 |
| Halifax | 6 | 7 | 8 | 5 | 26 | 50 |
| Morristown | 6 | 9 | 7 | 4 | 26 | 51 |
| Richmond | 9 | 10 | 5 | 2 | 26 | 52 |
| Rochester | 6 | 9 | 9 | 2 | 26 | 53 |
| Rockingham | 10 | 6 | 8 | 2 | 26 | 54 |
| Danby | 7 | 5 | 6 | 7 | 25 | 55 |
| Derby | 10 | 5 | 3 | 7 | 25 | 56 |
| Fairfield | 8 | 8 | 3 | 6 | 25 | 57 |
| Glover | 9 | 6 | 4 | 6 | 25 | 58 |
| Grafton | 9 | 3 | 7 | 6 | 25 | 59 |
| Moretown | 6 | 8 | 7 | 4 | 25 | 60 |
| Barre Town | 5 | 4 | 6 | 9 | 24 | 61 |
| Calais | 7 | 5 | 4 | 8 | 24 | 62 |
| Castleton | 6 | 8 | 2 | 8 | 24 | 63 |
| Clarendon | 6 | 7 | 4 | 7 | 24 | 64 |
| Enosburg | 7 | 8 | 3 | 6 | 24 | 65 |
| Essex | 6 | 9 | 3 | 6 | 24 | 66 |
| Guilford | 9 | 3 | 7 | 5 | 24 | 67 |
| Hartland | 9 | 8 | 2 | 5 | 24 | 68 |
| Newfane | 7 | 5 | 9 | 3 | 24 | 69 |
| Norwich | 8 | 7 | 6 | 3 | 24 | 70 |

| Town | Federal Aid Roads in River Corridor Score | Bridges with Spans Less than Bankfull Width Score | Highway in High Erosion Score | Highway in High Deposition Score | Total Score | Rank |
|---|---|---|---|---|---|---|
| Richford | 6 | 8 | 7 | 3 | 24 | 71 |
| Stockbridge | 5 | 8 | 10 | 1 | 24 | 72 |
| Topsham | 7 | 9 | 7 | 1 | 24 | 73 |
| Berkshire | 4 | 4 | 6 | 9 | 23 | 74 |
| Chittenden | 5 | 5 | 6 | 7 | 23 | 75 |

# Appendix 3.5

**Table 3.15: Municipalities with 10 or More Businesses At-risk**

| Ranking | Town | Non Residential Buildings In Corridors |
|---|---|---|
| 1 | Montpelier | 300 |
| 2 | Barre City | 169 |
| 3 | Springfield | 154 |
| 4 | Woodstock | 140 |
| 5 | St. Johnsbury | 126 |
| 6 | Ludlow | 84 |
| 7 | Bennington | 80 |
| 8 | Brattleboro | 73 |
| 9 | Manchester | 69 |
| 10 | Wilmington | 69 |
| 11 | Barton | 68 |
| 12 | Waterbury | 67 |
| 13 | Berlin | 61 |
| 14 | Johnson | 57 |
| 15 | Hardwick | 55 |
| 16 | Middlebury | 51 |
| 17 | Morristown | 46 |
| 18 | Hartford | 45 |
| 19 | Stowe | 43 |
| 20 | Rutland City | 43 |
| 21 | Northfield | 40 |
| 22 | Lyndon | 39 |
| 23 | Bethel | 38 |
| 24 | Cambridge | 35 |
| 25 | Londonderry | 31 |
| 26 | Chelsea | 30 |
| 27 | Dover | 30 |
| 28 | Waitsfield | 30 |
| 29 | Barre Town | 29 |
| 30 | Moretown | 29 |
| 31 | Newbury | 29 |
| 32 | Warren | 27 |
| 33 | Brandon | 26 |
| 34 | Bridgewater | 25 |
| 35 | Chester | 24 |
| 36 | Rutland Town | 24 |
| 37 | Barnet | 23 |
| 38 | Burke | 22 |
| 39 | Randolph | 22 |

| Ranking | Town | Non Residential Buildings In Corridors |
|---|---|---|
| 40 | Castleton | 21 |
| 41 | Charleston | 21 |
| 42 | Richmond | 21 |
| 43 | Richford | 20 |
| 44 | Wolcott | 19 |
| 45 | Sharon | 19 |
| 46 | Rochester | 18 |
| 47 | Pawlet | 17 |
| 48 | Putney | 17 |
| 49 | Bradford | 16 |
| 50 | Wallingford | 16 |
| 51 | Whitingham | 16 |
| 52 | Arlington | 15 |
| 53 | Concord | 15 |
| 54 | Middlesex | 15 |
| 55 | Weybridge | 15 |
| 56 | Royalton | 15 |
| 57 | Corinth | 14 |
| 58 | Winhall | 14 |
| 59 | Proctor | 14 |
| 60 | Rockingham | 14 |
| 61 | Hancock | 13 |
| 62 | Hartland | 13 |
| 63 | Williamstown | 13 |
| 64 | Ryegate | 13 |
| 65 | Sheldon | 13 |
| 66 | East Montpelier | 12 |
| 67 | Essex | 12 |
| 68 | Fairfax | 12 |
| 69 | Marshfield | 12 |
| 70 | Weston | 12 |
| 71 | Cavendish | 11 |
| 72 | Danby | 11 |
| 73 | Fair Haven | 11 |
| 74 | Newport City | 11 |
| 75 | Glover | 11 |
| 76 | Grafton | 11 |
| 77 | Jamaica | 11 |
| 78 | Lincoln | 11 |
| 79 | Plainfield | 11 |
| 80 | Enosburg | 10 |
| 81 | Montgomery | 10 |

| Ranking | Town | Non Residential Buildings In Corridors |
|---|---|---|
| 82 | Stockbridge | 10 |
| 83 | Townshend | 10 |
| 84 | West Windsor | 10 |
| 85 | Plymouth | 10 |

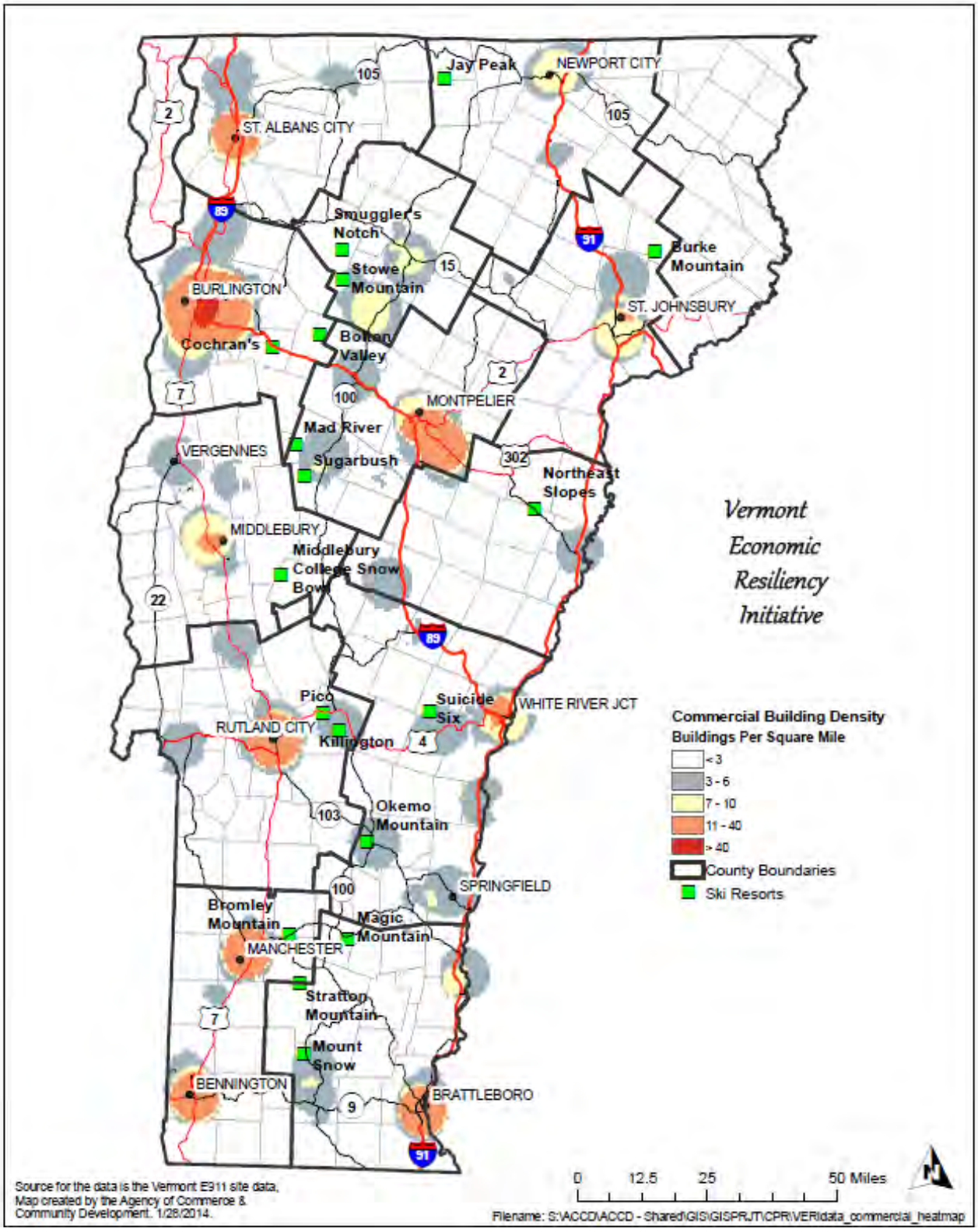
# Appendix 3.6

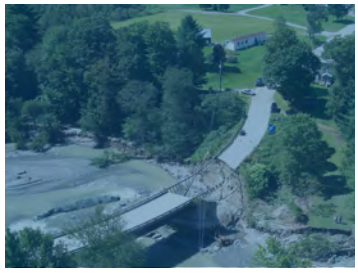
**Table 3.16: Thirty Two Vermont Municipalities with High Economic Activity and Flood Risk**

| Town | Economic Activity Ranking | County | 2011 Pop. Estimate | Infra-structure Vulnerability Ranking | Number of Vulnerable Commercial Buildings Ranking | Designated Downtown or Village Center | Critical Employer | Critical System Risk | SGA | Parcel Map | LiDAR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Arlington | 31 | Bennington | 2,308 | 8 | 15 | | Yes | | Yes | 2009 | Yes |
| Barre City | 14 | Washington | 9,066 | 12 | 169 | Downtown | | | Yes | 2007 | Yes |
| Barre Town | 24 | Washington | 7,937 | 61 | 29 | | | | Yes | 2007 | Yes |
| Barton | 32 | Orleans | 2,805 | 3 | 68 | Village | | | Yes | 2011 | No |
| Berlin | 33 | Washington | 2,886 | 9 | 61 | | Yes | | Yes | 2005 | Yes |
| Bethel | 70 | Windsor | 2,022 | 1 | 38 | Village | Yes | | Yes | 2009 | Yes |
| Bradford | 54 | Orange | 2,804 | 5 | 16 | Downtown | | | Yes | 2013 | No |
| Brandon | 24 | Rutland | 3,943 | 30 | 26 | Downtown | | | Yes | 2011 | No |
| Brattleboro | 4 | Windham | 11,978 | 6 | 73 | Downtown | Yes | Yes | Yes | 2014 | Yes |
| Burke | 22 | Caledonia | 1,751 | 48 | 22 | Village | | | Yes | 2014 | Yes |
| Cambridge | 20 | Lamoille | 3,695 | 26 | 35 | Village | | | Yes | 2006 | No |
| Castleton | 28 | Rutland | 4,695 | 63 | 21 | Village | | | Yes | 2007 | No |
| Cavendish | 55 | Windsor | 1,367 | 14 | 11 | Village | | | Yes | 2009 | No |
| Chester | 34 | Windsor | 3,153 | 16 | 24 | Village | Yes | | Yes | 2014 | Yes |
| Enosburg | 57 | Franklin | 2,800 | 65 | 10 | Village | | | Yes | 2014 | Yes |
| Essex | 30 | Chittenden | 19,713 | 66 | 12 | | Yes | | Yes | 2014 | Yes |
| Fairfax | 71 | Franklin | 4,319 | 17 | 12 | Village | | | Yes | 2012 | Yes |
| Hardwick | 65 | Caledonia | 3,003 | 22 | 55 | Village | | | Yes | 2000 | No |
| Hartford | 10 | Windsor | 9,952 | 7 | 45 | Downtown | | | Yes | 2014 | Yes |
| Johnson | 74 | Lamoille | 3,472 | 41 | 57 | Village | Yes | | Yes | 2012 | No |
| Londonderry | 50 | Windham | 1,758 | 42 | 31 | Village | | | No | 2013 | No |
| Ludlow | 16 | Windsor | 1,963 | 43 | 84 | Village | | | Yes | 2014 | No |
| Lyndon | 44 | Caledonia | 5,971 | 21 | 39 | Village | Yes | | Yes | 2006 | No |
| Montpelier | 7 | Washington | 7,868 | 11 | 300 | Downtown | Yes | | Yes | 2014 | Yes |
| Morristown | 33 | Lamoille | 5,277 | 51 | 46 | Downtown | Yes | | Yes | 2012 | No |
| Northfield | 59 | Washington | 6,221 | 28 | 40 | Village | Yes | | Yes | 2011 | Yes |

| Town | Economic Activity Ranking | County | 2011 Pop. Estimate | Infra-structure Vulnerability Ranking | Number of Vulnerable Commercial Buildings Ranking | Designated Downtown or Village Center | Critical Employer | Critical System Risk | SGA | Parcel Map | LiDAR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Randolph | 36 | Orange | 4,788 | 36 | 22 | Downtown | | | Yes | 2010 | Yes |
| Richmond | 51 | Chittenden | 4,108 | 52 | 21 | Village | | | Yes | 2013 | Yes |
| Rockingham | 28 | Windham | 5,255 | 54 | 14 | Downtown | | | No | 2012 | No |
| Springfield | 37 | Windsor | 9,373 | 19 | 154 | Downtown | Yes | | Yes | 2013 | No |
| St. Johnsbury | 39 | Caledonia | 7,594 | 23 | 126 | Downtown | Yes | | Yes | 2007 | No |
| Woodstock | 19 | Windsor | 3,047 | 24 | 140 | Village | | Yes | Yes | 2010 | Yes |

## Map of Vermont Commercial Site Density





# Chapter 4

## Partnering with Communities

## Chapter 4


Overview ..... 4.1

It's All about Partnership ..... 4.1

Fieldwork and Data Review ..... 4.4

- Analysis: Businesses At-Risk ..... 4.7
- Policy and Program Review ..... 4.8

Site Specific Projects ..... 4.11

Community Engagement ..... 4.14

Appendix 4.1 ..... 4.17

- Request for Proposals ..... 4.17
- List of Consultants Selected ..... 4.29

Appendix 4.2 ..... 4.30

- Welcome Letter ..... 4.30
- VERI Overview ..... 4.33
- Overview of the Local Study Area ..... 4.34
- Bennington Case Study ..... 4.35

Appendix 4.3 ..... 4.37

- Sample Notification Letter ..... 4.37

Appendix 4.4 ..... 4.38

- Community Reports ..... 4.38

## Overview

Funding from the US Department of Commerce, Economic Development Administration (US EDA) allowed the project team to partner with seven communities in five study areas to develop detailed analyses of flood risk and identify specific projects to reduce impacts on local businesses and critical infrastructure. The work outlined in the previous chapters helped narrow and focus the list of potential communities. The next phase of the project was where the on-the-ground work really began – field analysis, public input and outlining specific projects designed to mitigate or reduce risk to businesses with costs, and potential funding sources highlighted. Key to the work in these five areas was the partnership, participation and dedication of elected and volunteer officials, business leaders, homeowners and other interested stakeholders.

Once the top five study areas were identified, the team contacted leaders in the seven communities to explain the project, provide an overview of the expected deliverables, the time commitment and resources required from the community and invite them to participate. These calls took place with either the town manager, Selectboard chair, town planner or a combination of local representatives.

After the seven communities agreed to participate, a consulting team of river scientists and engineers were hired to assist in the detailed analysis of the river corridor, review of past reports and develop specific project recommendations (the Request for Proposals can be found in Appendix 4.1 along with a list of the consultants selected). This consultant team also met with the town representatives and invited interested members of the steering committee to walk the river with them. They also participated in public forums.

If a community raises reasons why it might not be able to implement projects or suggests limiting stakeholder participation in the steering committee, consider this reluctance in your screening process. Try and determine the reason for the reluctance to participate and decide if there is a need to work with a different community.

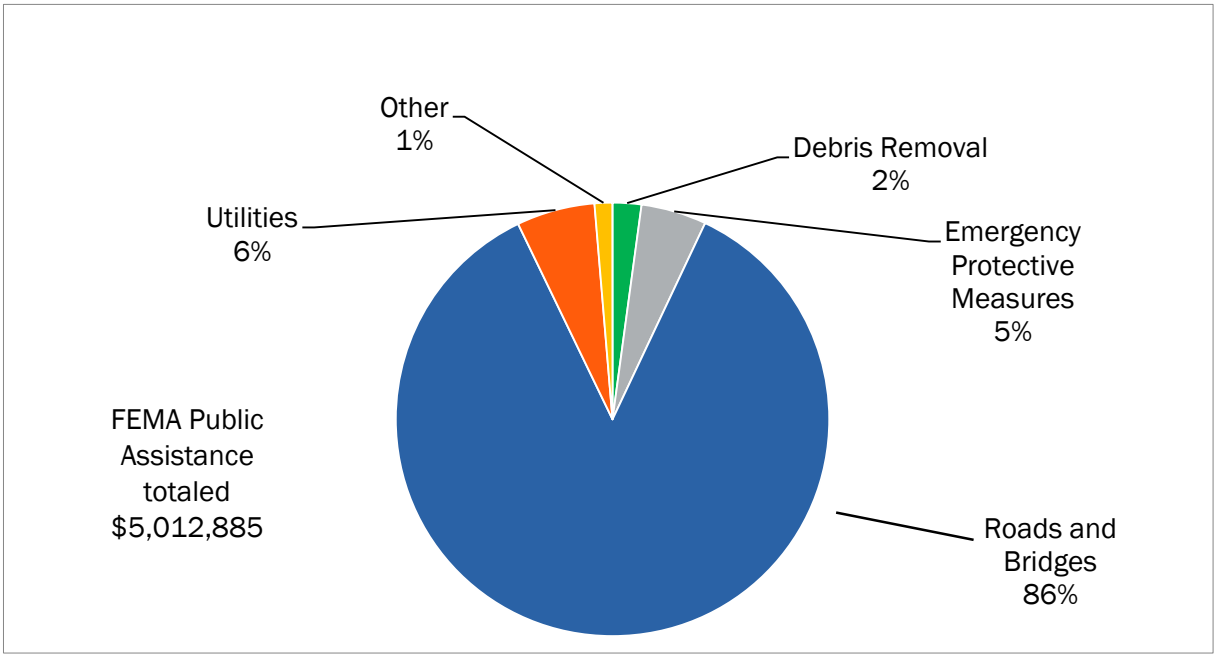
## It's All about Partnership

The project team hosted an orientation meeting with the steering committee in each community to explain the project to a larger group, describe the local commitment and answer questions. In preparation, it sent a welcome letter and information packet containing a project overview, a case study from Bennington, Vermont on which this project was based, an overview of the local study area and roles and responsibilities (see Appendix 4.2 for the welcome packet materials). Steering committee members, five-to-seven in number, were pulled together by the town and included the

town manager, members of the Selectboard and planning commission. Some communities included state legislators, conservation commissioners, managers of the downtown organization, leaders in local sustainability groups and business groups. The project team asked the town to include diverse viewpoints to ensure that a mix of community perspectives were included in the early planning. It also asked for members with a good track record of implementing projects. The goal was to ensure that the steering committee had the ability to win broader community support to implement the project team's recommendations with support from various partners and state agencies.

At the meeting, the project team and consultants provided background on the project, then took questions from the group and outlined the team's commitment to coordination and collaboration. The local steering committee shared information on past flooding damage, past plans and projects, river and watershed studies and pertinent bylaws with the consultants (see Figure 4.1). The team wanted to be sure to build upon or reinforce past work, not re-invent the wheel or start from scratch.

**Figure 4.1: 2011 Flood Damage Costs in Woodstock by Category**



The group also discussed the schedule for upcoming field observation and how best to involve and notify property owners along the river. It was decided that property owners should be notified via mailed postcard that provided an overview of the project, explained that the team would be surveying the river and included a project website and phone number to find additional information or ask questions. Property owners were asked to notify the team if they did not want people in the river near their property. (see Appendix 4.3 for sample notification letter to landowners).

The consultant team then reviewed existing information about each of the five study areas [which was an area smaller than the entire town(s)]. This included a review of available stream geomorphic data provided by VT ANR as well as town plans, local hazard mitigation plans, and any river corridor plans or past projects in the area.

Working with the steering committee in each community, a public forum was held. Before the forum, the Regional Planning Commissions (RPCs) presented at local Rotary, and Chamber of Commerce meetings. Flyers, emails and calls were made inviting the public to the meeting. Op-Eds were drafted for the local papers sharing information on the projects. At these forums, a summary of the project was outlined, recent flood resiliency efforts initiated by the town were highlighted and potential risks identified. The bulk of the forum time was devoted to gathering information from community participants (see Figure 4.2). To help guide the discussion, four questions were asked:

1. What are the hazards and risk areas in the town?
2. What worked and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?
3. What still needs to be addressed in the interests of long-term resilience and sustainability?
4. What information should the final report include and how should this information be presented?

### Vermont's Regional Planning Commissions

Most Vermont communities are led by part time volunteers, many of whom do not have the time and expertise to plan and implement changes to reduce local flood risk. Vermont's 11 RPCs provide professional staff to help towns with a range of services from local transportation, land use and emergency planning to GIS mapping and analysis. RPCs can help communities understand how their decisions about development, floodplain management and conservation affect downstream communities. The new regional resiliency plan requirements, along with efforts to link transportation and watershed planning, play an important role in helping communities beyond their borders to reduce flood risks.

**Figure 4.2: Woodstock Community Forum Held on October 2, 2014**

Meeting notes were drafted and shared with the steering committee and those that attended the meeting. Their comments and edits were included before the notes were finalized and shared on town-specific webpages developed by the project team. The meetings were taped for public access television, where it was possible, to expand participation and awareness.

## Fieldwork and Data Review

Reviewing maps and previous reports, and analyzing input gathered at the forum along with historic flood data provided a foundation of understanding for the consultant team (see Table 4.1 of historic flood damage data in Brandon). Such information helped them understand the goals of the community, past work conducted and recommendations suggested. Nevertheless, walking the river, making observations, taking measurements and noting post Irene changes in the channel conditions were key to developing the project specific recommendations for each community (see Figure 4.3).

**Table 4.1: Neshobe River, Brandon, VT Flood Events and Damage**

| Flood Date | Damage Description | Estimated Recovery Cost |
|---|---|---|
| November, 1927 | Major flooding damage to downtown | Unknown |
| September, 1938 | Major flooding damage to downtown | Unknown |
| April, 1996 | Flooding affects Brandon | $10,000 |
| June, 1996 | Flash flooding | $10,000 |
| July, 2003 | Flash flooding in Brandon and Forest Dale | $25,000 |
| February, 2008 | Flash flooding affects Forest Dale | $100,000 |
| August, 2011 | Major damage throughout Town | >$800,000 |

**Figure 4.3: Fieldwork Makes the Difference – Measuring Undersized Culvert**

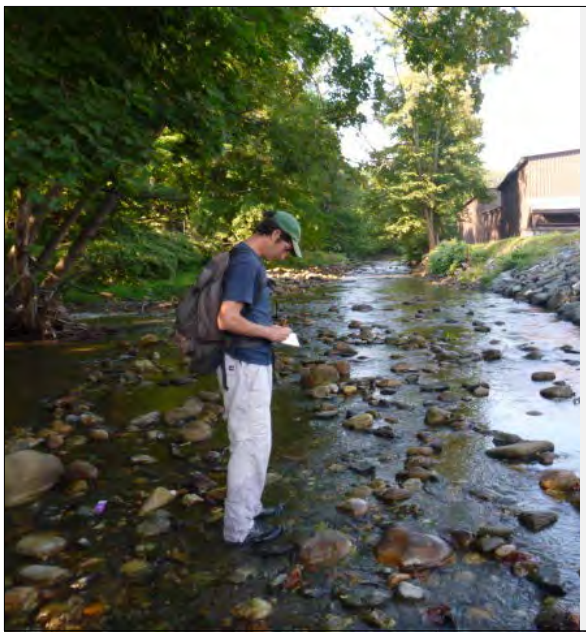
## River Data Collection

After the first public forum, the river scientists on the team walked the river in the study area to observe the current conditions of the river and floodplain and to note the proximity of river features to economic assets (see Figure 4.4). The fieldwork objectives were to:

- observe the current conditions of the river and floodplain compared to previous geomorphic data;
- make note of any changes since 2011's spring flooding or Tropical Storm Irene;
- note the proximity of river features to economic assets;

- make a field determination of flood and erosion risk;
- photo-document field conditions; and
- identify locations where additional data collection is needed.

**Figure 4.4: River Data Collection**



While walking the river, the consultant team made note of the following:

- Locations and dimensions of river bank erosion and rock reinforcement;
- Areas with significant accumulation of sediment in the channel;
- Potential areas of conflict where tributaries join;
- Bridge and culvert dimensions and conditions;
- Riparian buffer conditions;
- Floodplain access; and
- Proximity of buildings and other infrastructure (roads, sewer, water, utility, etc.) to flood hazard areas.

The consultants also conducted Phase II stream geomorphic assessments (SGA) which is a physical study of a river's geology, size, shape, movements, and existing conditions which affect river flow patterns and stability. This was also a field check of VT ANR's river corridor maps. Any differences between the results of VT ANR's modeling and the field work were noted and forwarded to VT ANR. Cross sections of the rivers were also taken via laser level or comparable instrumentation to understand variables such as bankfull width and depth of the channel in relation to elevation of floodplain which indicates how easily the river can access its floodplain. In select areas, limited survey was conducted to provide a base map for conceptual design alternatives. Along with a list of project specific recommendations, each community report included conceptual

design alternatives for two or more of those project recommendations. These conceptual designs provide detailed information to be used for funding applications, request for proposals, grants, and provide design solutions that other communities could use. The survey and design for each conceptual project was preliminary and required future phases to develop detailed project designs, costs, construction plans and permitting.

**Figure 4.5: Gunner's Brook in Barre City**

## Analysis: Businesses At-Risk

The team conducted a GIS mapping analysis to identify at-risk businesses and facilities in the flood hazard zones using FEMA FIRM maps and VT ANR's State River Corridor maps. These map layers and E-911 non-residential buildings were overlaid to identify commercial buildings at-risk. The businesses at highest risk have at least a portion of their buildings in the designated FEMA floodway. During a flood event, the floodway typically conveys the highest velocity waters and is one of the areas of greatest erosion risk. Also of importance is identifying businesses and important facilities and utilities in the 100-year floodplain (also known as the Special Flood Hazard Area) and the State River Corridor. The team developed a table that provided a breakdown of the number of businesses and employees that work in these buildings within these three flood hazard zones. These data only show if buildings are within the flood zone and do not show the elevation of the building relative to the flood zone elevation. This information was reviewed by the RPC partner for each of the five communities. This analysis for Woodstock is shown in Table 4.2.

**Table 4.2: Businesses in Flood/ Erosion Hazard Zones in Woodstock Study Area**

| | Floodway | 100-year Flood Zone | State River Corridor |
|---|---|---|---|
| Number of businesses | 3 | 19 | 26 |
| Number of employees | 61 | 169 | 366 |

## Policy and Program Review

Reducing the impacts of floods involves an ongoing process of evaluating and adjusting policies to minimize risks through protection, prevention and education. Accordingly, the VERI team first reviewed the municipal plan, hazard mitigation plans and land use regulations in each of the five communities to identify the policies they contain and those that are absent. Where available the team also reviewed related plans for capital improvements, conservation, emergency preparedness and continuity of operations. These documents were reviewed with the goal of identifying gaps and opportunities to improve the flood preparedness, safety and resilience of residents, visitors, businesses and local government.

The team then used the US EPA's flood resiliency checklist that was developed from a study in the Mad River Valley in Vermont (Checklist can be found: http://www2.epa.gov/sites/production/files/2014-07/documents/flood-resilience-checklist.pdf). This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

The checklist review for each of the five study areas found (full checklist review can be found in each of the community reports):

- Barre City currently employs 10 of 56 items on the checklist including the discussion of strategies to determine whether to relocate structures that have been repeatedly flooded. Barre Town employs 17 of 56 items on the checklist including the implementation of non-regulatory strategies to conserve land in river corridors through easements, buyouts, and the transfer of development rights.

- Brandon currently employs 28 of 56 items on the checklist including buyouts for frequently flooded property, regulatory measures to limit development in flood prone areas, and utilizing steep slope development regulations.

- Brattleboro employs 33 of 56 items on the checklist, including participating in the National Flood Insurance Program Community Rating System, 15 adopting floodplain development limits that go beyond FEMA's minimum standards for SFHAs, and promoting better management of stormwater runoff (including through regulation).

- Enosburgh currently employs 28 of 56 items on the checklist including regulatory measures to limit development in areas subject to flooding, and utilizing steep slope development regulations.

- Woodstock currently employs 33 of 56 items on the checklist including promoting better management of stormwater runoff, utilizing steep slope development regulations, and encouraging new development in safer areas.

The team also noted each community's rating for the Emergency Relief Assistance Fund (ERAF). In 2014, the state of Vermont updated ERAF requirements to provide matching funding for federal assistance after federally-declared disasters. This program allows towns in Vermont to increase the amount of state aid they could receive as a match to federal aid for post-disaster recovery. Certain damage costs from federally-declared disasters are reimbursed 75% by federal money. The state of Vermont contributes an additional 7.5% of the total cost, but will increase that up to 17.5% if municipalities adopt certain plans, policies, and programs to reduce the risk of floods. The ERAF review for Barre City and Town can be seen in Table 4.3

**Table 4.3: ERAF Review for Barre Town and City**

| Steps to increase state aid to 12.5% | Barre Town | Barre City |
|---|---|---|
| Participation in the National Flood Insurance Program | X | X |
| Adoption of 2013 State Road & Bridge Standards | X | -- |
| Adoption of Local Emergency Operations Plan | X | X |
| Adoption of Local Hazard Mitigation Plan | X | X |
| **Step to increase state aid to 17.5%** | | |
| Adopt no new development in a River Corridor | -- | -- |
| Adoption of a River Corridor or Flood Hazard Protection areas and Participation in the Federal Community Rating System Program | -- | -- |
| ERAF Match | 12.5% | 7.5% |

The results of both reviews identified planning or policy opportunities that were then organized into four groups: Regulations, Community Planning, Emergency Planning, and Education and Outreach. The distribution of opportunities to improve policy and programs were incorporated into each community report. A summary of the number of recommendations in each group across all five study areas can be found in Table 4.4.

**Table 4.4: Summary of Policy and Program Recommendations**

| VERI Totals Policies/Programs | |
|---|---|
| Land Use Regulations | 29 |
| Community Planning | 25 |
| Emergency Planning | 32 |
| Education and Outreach | 18 |

The results of the plan and policy reviews were then combined and scored with either a 1 (ineffective), 3 (limited) or 5 (effective) using the following three objectives:

1. Reduces flood risk (proposed project lowers the flood level);

2. Reduces erosion risk (proposed project lessens the vulnerability to erosion); and

3. Protects businesses, infrastructure and property.

The three scores were added to provide a total score. Cost and ease of implementation, political realities and limitations as well as input from the community were also considered. To assist the town with implementation, potential partners and funding sources were identified. Each recommendation was further explained and next steps were identified. This information was compiled into easy to read charts. (Full checklists for each community can be found in the appendix for each community report in Appendix 4.4.)

## Site Specific Projects

Existing river data and stakeholder knowledge were used to develop specific flood protection projects in each of the five VERI study areas. This information, in conjunction with field work, documenting economic assets and further discussions with stakeholders helped set the stage for these recommendations.

Across all five communities, the recommended projects fall into four primary categories as summarized in Table 4.5.

**Table 4.5: Summary of Project Specific Categories**

| Category | Description |
|---|---|
| Building and Site Improvements | Lowers the risk of flooding and/or erosion to specific properties through improvements to the building and/or surroundings, e.g., sealing off buildings to prevent water infiltration. |
| Channel and Floodplain Management | Lowers the risk of flooding and/or erosion to properties along the river through the improvement of natural river and floodplain functions, e.g., tree plantings along unstable river banks. |
| Infrastructure Improvements | Lowers the risk of flooding and/or erosion to roadways and other municipal or state-owned infrastructure, e.g., increasing the size of bridges and culverts to pass more flood waters. |
| Public Safety Improvements | Lowers the risk of flooding and/or erosion to properties through the avoidance of future flood risks, e.g., FEMA buyouts of improved properties highly vulnerable to flooding. |

### User-Friendly Tables

When deciding how best to communicate recommendations for project-specific, as well as plan and policy updates, the project team decided on a table format. Every effort was made to reduce technical jargon so that anyone in the community could easily understand where the project was located, what the project was, how it would help local businesses or protect infrastructure, estimated costs and timeline as well as potential funding sources. The team used icons similar to 'consumer reports' to indicate how each recommendation met the goals set by the team (reduces flood risk, reduces erosion risk, protects businesses, infrastructure, property). The tables were designed to be a road map that the community could use to solicit input, gather support or prioritize funding.

A table summarizing recommended projects to protect businesses and infrastructure from flooding, along with maps showing the location of each project site, were developed for each of the communities, along with the relevant economic asset and flood hazard information.

To begin, the team screened and prioritized each project. Each project received a score of 1 (ineffective), 3 (limited) or 5 (effective) for the three objectives:

1. Reduces flood risk (proposed project lowers the flood level);

2. Reduces erosion risk (proposed project lessens the vulnerability to erosion); and

3. Protects businesses, infrastructure and property.

The three scores were added to provide a total score, which was then weighted based on the importance of the project in the region. Projects that would result in a regional economic boost and help keep businesses open were given the highest weighting, while projects that would offer minimal economic benefit to the business economy were assigned a lower weighting. Many of the high priority projects are from the 'Infrastructure Improvements' category, as those at-risk areas potentially affect the greatest number of community members and businesses.

The project-specific recommendations for each community can be found in the appendices within each community report. A summary of the number of recommendations in each group across all five study areas can be found in Table 4.6.

**Table 4.6: Summary of Project Specific Recommendations**

| VERI Total Projects | |
|---|---|
| Building and Site Improvements | 14 |
| Channel and Floodplain Management | 25 |
| Infrastructure Improvements | 31 |
| Public Safety Improvements | 10 |

Project partners and stakeholders, including representatives from VT DHCD, VT ANR, VTrans, RPCs and the steering committee in each community, provided feedback on a draft list of mitigation strategies before the draft was released for public comments. The feedback was incorporated into the final prioritization of projects.

After incorporating edits from the community steering committee, the project team hosted a second community forum to share the list of policy and project recommendations to decrease flood risk and ensure businesses remain open (see Figure 4.5). At the forum, community members asked questions, provided input and helped rank the proposed list of priority recommendations. These comments, requests for additions and prioritization were incorporated into the final report for each community (community reports can be found at http:// accd. vermont.gov/strong_ communities/opportunities/planning/resiliency/VERI ).

**Figure 4.6: 2015 Community Forum in Barre**


The project team provided the following recommendations for next steps for the communities to ensure that the project recommendation move forward to implementation:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization.
- Prioritize one to two projects to pursue each year with assistance from partners, and funders identified in the recommendation tables.

- Apply for one to two grants each year to advance project development and/or designs.
- Implement projects as funding allows.
- Monitor project success.

The project team provided information on organizations and programs that can assist town officials. Implementing these projects and updating related flood policies will, over time, help these five areas become safer and more resilient to future floods.

## Community Engagement

A key part of this initiative was to create interest and participation in the overall project, as well as support for the recommendations. Communities should not underestimate the outreach required, especially if the latest flood or disaster is not fresh in the minds of the townspeople. The project team used the RPC's local relationships in each of the five communities to lead this charge. Creating this interest is critical as it is needed for successful implementation of the various recommendations. The report and recommendations were designed as a five year road map that, if implemented, would avoid, reduce and mitigate risk to local businesses, infrastructures, homes and local economy.

The following tools were used to create awareness, communicate, gather input and share results:

- ***Website:*** A webpage was built for each community to provide a general overview of the project, share information on upcoming meetings, meeting notes, and report drafts as well as case studies and funding opportunities.
- ***Media Outreach:*** Newspaper ads, online community forums and calendar postings, flyers and posters on town bulletin boards/related events, town official email blasts, community forum letters and postcards.
- ***Landowner and Business Mailings:*** Field work notification postcards, community forum letters and postcards were developed. Chamber of Commerce email blasts provided updates and feedback opportunities for the local business community.

- ***Op-Eds:*** The project team drafted and distributed two local and state-wide op-eds to media outlets before each of the public forums to raise awareness and let community members know about the upcoming meetings.

- ***Going to Local Businesses:*** The RPC partner in each community set up coffee chats with local businesses and property owners to let them know about the project, how they can participate and gather concerns and suggestions in a smaller setting. They also went to meetings of business groups such as the Chamber of Commerce and Rotary, recognizing that getting business owners to evening meetings can be challenging.

- ***Local Access TV:*** Where available, we partnered with local access TV to tape the public meetings to run on local stations to reach a wider community audience.

**Figure 4.7: Future Flooding is Now**

Before the community and project reports were finalized, torrential rainfall caused flash flooding in the study area in one of our project communities in July of 2015– Gunners Brook in Barre City and Town. Debris from upstream rushed towards downtown Barre and gathered behind the Harrington Avenue Bridge. Logs 2-3 feet in diameter mixed with tree limbs, rocks and other debris. With no natural channel available, the river jumped the banks and flooded the nearby neighborhood and carried thick mud into neighborhood homes, along downtown streets and local businesses. The next day sunny weather turned the mud into a fine dust, creating a dustbowl in the central business district. Barre's community report had recommended removing the bridge – a choke point where debris dams the brook and floods nearby homes. It also recommended buying out 25-30 homes in that neighborhood and creating a public park that could also act as a floodplain to collect debris and allow floodwater to slow and spread – reducing damage to downtown businesses and roadways and protecting local homes. While this is an expensive and long-term project, the same area suffered a similar flood in 2011. Consequently, the VERI recommendations are receiving greater scrutiny and interest because of this recent flood event.

## Funding Recommended Projects

VERI supported, in part, the development of VT ANR's statewide River Corridor GIS analysis and maps that provided the foundation for developing a risk assessment protocol in communities in Vermont. It also supported all the field work, community outreach and development of project recommendations, conceptual designs and final reports in the five study areas. At the end, each community had a suite of options to eliminate, reduce or avoid risks to businesses and local infrastructure and ensure businesses remained opened, repetitive damage and repair costs to roads and bridges reduced and local economies remain strong. However, each of these recommendations requires funding to implement.

This EDA grant did not fund implementation of any of the recommendations. The VERI project team realized that funding these recommendations was critical if the project goals are to be realized. Thus, the team has reached out to potential partners such as the Vermont Land Trust, and the Vermont Housing and Conservation Board, potential funders such as the Vermont Community Foundation and the Vermont Economic Development Authority as well as state agency partners to help identify ways to fund priority projects in each community. VT DHCD, as the project lead, will continue to partner with others to fund projects, update plans and bylaws, and track results.

The State and its partners are committed to supporting VERI communities implementing local programs as part of a comprehensive strategy to reduce the state's flood risks. However, ultimate responsibility to implement the recommendations rests with the communities.

## Appendix 4.1

Request for Proposals
to conduct a Flood Hazard Mitigation Analysis
for the
Vermont Department of Housing and Community Development

May 27, 2014 (revised)

## Table of Contents


I. GENERAL TERMS AND CONDITIONS FOR SERVICES ..... 4.19

A. Introduction ..... 4.19

B. Nature of Proposal ..... 4.20

C. Submission Requirements ..... 4.21

D. Specifications ..... 4.21

E. Award ..... 4.22

F. Term of Engagement ..... 4.22

II. NATURE OF SERVICES REQUIRED ..... 4.22

A. Scope of Work ..... 4.22

B. Work Product ..... 4.24

C. Schedule for Deliverables ..... 4.24

D. Required Deliverables ..... 4.24

III. PROPOSAL REQUIREMENTS ..... 4.25

A. Description of Proposal ..... 4.25

B. Cost of Proposal ..... 4.26

IV. EVALUATION OF PROPOSALS ..... 4.27

A. Review Personnel ..... 4.27

B. Review Criteria ..... 4.27

C. Selection Process ..... 4.28

D. Interview Framework ..... 4.28

V. ACKNOWLEDGEMENT OF ATTACHMENT C - STANDARD STATE CONTRACT PROVISIONS ..... 4.28

# State of Vermont
# Department of Housing and Community Development
# Request for Proposals
# Flood Hazard Mitigation Analysis for the
# Vermont Economic Resiliency Initiative (VERI)

## I. General Terms and Conditions for Services

### A. INTRODUCTION

The Vermont Department of Housing and Community Development (DHCD) is requesting proposals from qualified bidders to conduct flood hazard mitigation analysis in five Vermont towns and to develop location-specific strategies to mitigate flood risks and avoid future flood losses. These strategies will be used in the Department's report to the US Economic Development Administration (EDA) for the Vermont Economic Resiliency Initiative (VERI).

In May 2013, the Vermont Agency of Commerce and Community Development received disaster recovery funding from the EDA to implement the VERI. The goals of VERI are to:

1. Help the state analyze threats to Vermont's areas of economic activity,
2. Develop plans to reduce impacts and avoid future losses, and
3. Help our communities and businesses make the changes needed to bounce back quickly when disaster strikes.

Led by the DHCD, in partnership with the Agency of Natural Resources (ANR), Agency of Transportation (AOT), and Vermont's Regional Planning Commissions (RPCs), VERI has mapped places where natural hazard risks - primarily flooding - intersect with areas of economic activity and associated infrastructure. Five Priority Areas have been selected (see page 22) for a detailed assessment of location-specific hazards. A series of two workshops for town officials, businesses and community members will be held in each town during the summer, 2014 and winter, 2015, led by DHCD and the RPCs. The community-specific strategies developed in these workshops, together with the deliverables of this project, will be included in plans to help those communities prepare for, manage and decrease risk, and avoid future losses. The overall completion date for VERI is May 1, 2015.

Other objectives of this project are to assist these towns as they separately prepare Local Hazard Mitigation Plans and address Flood Resiliency planning requirements for their Town Plans. The deliverables of this flood hazard mitigation analysis will assist towns in identifying flood risks and specific projects for reducing the vulnerability of infrastructure and businesses vital to the local economy. It is understood that further study will be required, outside this Scope of Work, to develop detailed project designs, costs, construction plans, and permitting.

For the purposes of this RFP, "bidder" refers to an individual, a firm, or a team of individuals and/or firms that may respond to this RFP to provide comprehensive services as outlined in this RFP or some portion or division of same.

## B. Nature of Proposal

The proposal submitted shall represent a firm and binding offer. The determination of whether a proposal may be withdrawn is solely at the discretion of the Commissioner of the DHCD or the Commissioner's designee. However, in no event shall a proposal be withdrawn unless the request for withdrawal is filed within five days after the date of submission, and the bidder establishes that the proposal contains a material mistake, and that the mistake occurred despite the exercise of reasonable care.

There is no expressed or implied obligation for the DHCD to reimburse bidders for any expenses incurred in preparing proposals in response to this request. The DHCD reserves the right to retain all proposals submitted. All information submitted becomes the property of DHCD. DHCD reserves the right to issue supplemental information or guidelines relating to this RFP, to make modifications to, or withdraw the RFP. Once a proposal is submitted, the bidder (including specific staff assigned to the project) may not be changed without written notice to and consent of DHCD. All costs incurred in the preparation of the submittal and participation in the selection process are the sole responsibility of the bidder.

All federal requirements of EDA, as stated in "Financial Assistance Standard Terms and Conditions," and all applicable State requirements must be adhered to and will be part of a contract for services. Bidders are subject to 2 C.F.R. Part 1326, Subpart C "Governmentwide Debarment and Suspension (Nonprocurement)" as well as 15 C.F.R. Part 28, "New Restrictions on Lobbying." Bidders should familiarize themselves with these provisions, including the certification requirement. Bidders must include a Form CD-512, "Certification Regarding Lobbying–Lower Tier Covered Transactions," completed without modification. Small businesses, Minority Business Enterprises and Women's Business Enterprises are encouraged to submit proposals.

The bidder selected will be invited to negotiate a contract, and a contract will be executed between the bidder and the DHCD using the State of Vermont's Standard Contract forms and provisions. All contracts are subject to review by State of Vermont legal counsel, and a project will be awarded upon signing of an agreement or contract, which outlines terms, scope, budget, performance measures, and other necessary items.

In negotiating the contract, the bidder and DHCD will agree on the project schedule (including project status meetings), and overall management plan for the completion of draft documents according to the Schedule for Deliverables outlined in Section II of this document. The schedule will provide the DHCD sufficient time for review and

comment on all drafts, and time for the bidder to incorporate any recommended changes into the final drafts.

## C. Submission Requirements

Respondents must submit one (1) digital copy (PDF) and three (3) printed copies of the proposal **by 4:30 p.m., Friday, June 13, 2014** to the Vermont Department of Housing and Community Development, 1 National Life Drive, Davis Building, 6th Floor, Montpelier, VT 05620-0501. Proposals that are not received by this deadline or that are not complete or signed will not be considered. **Proposals arriving via facsimile or e-mail will not be accepted.**

Any questions regarding this RFP should be directed to:

Vermont Department of Housing and Community Development
Attn: Sally Hull, Planning Coordinator
1 National Life Drive
Davis Building, Sixth Floor
Montpelier, Vermont 05620-0501
Phone (802) 828-1365
Email sally.hull@state.vt.us

Bidders are encouraged to submit notice of their Intent to Bid by Wednesday, May 28, 2014. Intent to Bid must be submitted in writing and include the bidder(s) name, lead contact person, address, phone, email, and that the bidder(s) intends to submit a proposal re: Vermont DHCD Request for Proposal, Flood Hazard Mitigation Analysis for the Vermont Economic Resiliency Initiative.

All questions regarding this RFP must be submitted **in writing** to Sally Hull at the address or email listed above, with a copy to Mike Kline, ANR Rivers Program, at the address above or email to mike.kline@state.vt.us. All RFP questions must be received at DHCD by **Wednesday, May 28, 2014**, by letter or email only. DHCD will post responses to written questions by **Friday, May 30, 2014**, on the RFP website at http://vermontbusinessregistry.com/Default.aspx and distribute via email to all bidders who submitted an Intent to Bid. The DHCD reserves the right to select which questions it will answer.

## D. Specifications

Proposals must address all specifications in the RFP. Bidders who have submitted notice of Intent to Bid will be notified in writing if the DHCD makes any changes to proposal specifications. Verbal agreements or instructions from any source are not authorized.

### E. AWARD

The selection will be made based on an evaluation of the cost and content of the proposals and the qualifications and references of the bidder. The DHCD reserves the right to reject any or all proposals or any part thereof, to waive technicalities, correct errors, and to make a selection solely as it deems to be in the best interest of DHCD.

### F. TERM OF ENGAGEMENT

The term of the contract to be negotiated shall be from the date of Contract Signature by DHCD to April 15, 2015, unless extended by approval of both parties. The final report must be completed and transmitted via email for digital copies and via US Mail for hard copies to Sally Hull at DHCD by February 27, 2015.

## II. Nature of Services Required

### A. SCOPE OF WORK

The DHCD is seeking proposals from contractors to conduct analyses of VERI's five Priority Areas, listed below, and to develop location-specific strategies to mitigate flood risks and avoid future flood losses.

The Priority Areas and some of the pertinent beneficial data for these areas are shown below. Bidders should note that Flood Mitigation Analyses in each town will focus on a limited geographic area within each town.

Note that because agreement to participate by the communities listed is pending, this document is subject to modification.

1. Barre City and Barre Town – Gunners Brook, approximately 3.0 river miles from the Barre town line to Stevens Branch in Barre City. In view of existing encroachments, identify areas that could be enhanced for floodplain access, as well as corridor protection measures in Barre Town that might benefit the City. Critical infrastructure includes Route 14 and other major collectors that serve the designated downtown and places of business there. Barre City has done Phase 1 and limited Phase 2 Stream Geomorphic Assessments and a River Corridor Plan. LIDAR and a HEC model are available.

2. Brandon – The Neshobe River, approximately 5.0 river miles from the confluence of Leicester Hollow Brook through Brandon Village. Critical infrastructure includes Route 7, Route 73, and Route 53, plus other major collectors. Brandon has done Phase 1 and 2 Stream Geomorphic Assessments and a River Corridor Plan.

3. Brattleboro – Whetstone Brook, approximately 5.5 river miles from West Brattleboro to the confluence with the Connecticut River. Analysis should focus primarily on mitigation opportunities relating to the river corridor and its intersection with Route 9 and other major collectors that serve the designated downtown, major employers such as Brattleboro Memorial, and local economic driver the Brattleboro Farmer's Market. Brattleboro has done Phase 1 and 2 Stream Geomorphic Assessments and a River Corridor Plan.

4. Enosburg – Tyler Branch, approximately 5.25 river miles from the confluence of Beaver Meadow Brook and Cold Hollow Brook to the town line. Analysis should focus on flooding issues related to Tyler Branch Road and other major collectors that serve the agricultural producers and land in town. Enosburg has done Phase 1 and 2 Stream Geomorphic Assessments and a River Corridor Plan. Some LIDAR data are available.

5. Woodstock – The Ottauquechee River mainstem, approximately 6.4 river miles from Bridgewater village to West Woodstock outside of Woodstock Village. Opportunities should be identified for floodplain restoration projects. The river runs along US Route 4, a key asset that is critical to moving goods and services on an east-west axis in Vermont, from Hartford, through Woodstock, to Killington and Rutland. Opportunities exist for active restoration related to post-TS Irene stream alterations. Woodstock has done Phase 1 and 2 Stream Geomorphic Assessments, and some LIDAR data are available, as well as a new HEC model produced by USGS in 2013.

The towns and RPCs will provide for the consultant's use all data sets available from tax maps, aerial photos, and previous flood information. It is anticipated that some field data (e.g., measured cross-sections of the riverbed and floodplains) within the study area may be needed, and this contingency should be addressed in the response to this RFP. Existing Hydraulics Engineering Center - River Analysis System (HEC-RAS) and geomorphic assessment data will be provided by the ANR Rivers Program.

The State of Vermont, RPCs, and Priority Area municipalities are seeking these plans to answer the following questions specific to the economic assets listed above:

1. What avoidance strategies will mitigate hazards to existing or future economic assets by protecting and restoring upstream and adjacent river corridor and floodplain functions?
2. What retrofits, removals, relocations or other forms of remediation would reduce the vulnerability of existing infrastructure and businesses?
3. What river, river corridor, and floodplain restorations would reduce vulnerability by increasing flood attenuation and achieving least erosive, equilibrium conditions?
4. What wet/dry floodproofing practices would be necessary to address residual risks?

## B. Work Product

During the term of the contract, the consultant shall report progress and review a preliminary inventory of mitigation strategies with DHCD and ANR, and to consider adjustments to the work product, if necessary. DHCD acknowledges that the amount of data available will drive the form and type of recommended mitigative measures in the final report; a semi-quantitative report is anticipated, not full-scale modeling.

## C. Schedule for Deliverables

(Note this schedule is subject to change)

| | |
|---|---|
| October 31, 2014 | Progress review meeting with DHCD and ANR to present preliminary inventory of mitigation strategies. |
| January 1, 2015 | Draft report due with detailed data modeling of location-specific hazards for five Priority Areas, showing the impact of hazard events at a community level, based on sensitivity assessment. |
| January 1-30, 2015 | Participation in second round of five DHCD community workshops in each town to present mitigation strategies. |
| February 27, 2015 | Final report due. |

## D. Required Deliverables

- A preliminary inventory of mitigation strategies.
- A draft report including any data models produced for location-specific hazards in the five Priority Areas.
- A Final Report summarizing findings and recommended strategies for each of the five Priority Areas.
- Supporting maps and field data produced for this study
- HEC-RAS model and outputs, if produced for this study
- One or more conceptual designs for mitigation projects in each of the five Priority Areas

Unless otherwise negotiated to the satisfaction of DHCD, the consultant retained shall submit a written final report to DHCD no later than February 27, 2015. The required deliverables shall be presented in both hardcopy and electronic formats. The electronic version shall be in PDF format. The bidder must provide 10 (ten) bound paper copies of the final report and associated deliverables, one digital copy (PDF) and the native editable file format of the final report and required deliverables.

The bidder shall provide the native editable files (.docs, .xls, etc.) for any and all tables, databases, reports, and maps. All GIS mapping and databases produced for this project will be provided to DHCD at the completion of this project including all metadata (this includes the description, projection and attribution definitions) and

versions of geodatabases used when applicable.

DHCD shall be the proprietor and owner of all contract work product, including the final report and all data purchased or provided therein.

## III. Proposal Requirements

### A. Description of Proposal

1. **Title Page** - showing the proposal's topic, the bidder's name, lead contact person, address, telephone number, email address, and the date of the proposal.

2. **Transmittal Letter** - signed by a person authorized to legally bind the bidder, and containing a brief statement of the bidder's understanding of the work to be done, a commitment to perform the work within the time period, a statement of why the firm or individual believes itself to be best qualified to perform this service, and a statement that the proposal is a firm and irrevocable offer.

3. **Description of Services to be Rendered** - describing the proposed approach and process that will be used to accomplish the services and produce the work products outlined in Section II of this RFP, including:

   a) A statement and discussion of the bidder's analysis of this RFP's requirements, including:

      - any proposed modifications to the Scope of Work with an explanation of the reason for the modification, and a detailed outline of the proposed program for executing the objectives of this RFP;
      - a description of the number of direct hours of activity by each principal and program staff who will work on the project, broken out by major activity; and
      - statements and discussion of anticipated major difficulties and problem areas, together with potential or recommended approaches for their solution.

   b) A description or rationale for the proposal, including;

      - an explanation of why the number of direct hours proposed will be sufficient to the task; and
      - a statement of the extent to which the proposed approach and program can be expected to meet or exceed requirements and specifications of the Scope of Work.

4. **A work plan and schedule for the engagement** - including the appropriate starting and ending dates of specific activities, the issuance date of any first draft of the assessment and the issuance date of the final report.

5. **Description of Bidder** - proposal must provide a description of the bidder's enterprise including number of employees and number of years experience doing work comparable or relevant to this RFP. If any sub-contractors are to be used, then the bidder must provide similar information for the sub-contractors. The proposal must indicated lead bidder and the role of each consultant (and sub-consultant) on the team with a project organization chart.

6. **Qualifications** - proposal must identify the individual(s) that would work on this project including Principal-In-Charge and Project Engineer, show title and company name, qualifications, experience, and any other pertinent information to show knowledge and experience relative to regional and/or local economic forecasting and housing needs assessments, particularly in Vermont.

7. **Resumes** - proposal must include detailed qualifications and levels of competence of individuals to be assigned to the project. This should include the total number of such individuals at each level and the estimated number of hours to be spent by each person.

8. **References** - provide names of at least three references for whom a similar project has been completed within the last five years, including a description of services performed, with a contact person, address, and telephone number for each.

## B. Cost of Proposal

Bidders should be mindful that DHCD has allocated a maximum amount of $150,000 for this study.

Included with each proposal shall be a section addressing cost. This section shall contain all pricing information relative to performing the services described in this RFP and shall include:

1. A total, all-inclusive maximum proposal price to contain all direct and indirect costs including all out of pocket expenses and detail of each. The DHCD will not be responsible for expenses incurred in preparing this proposal and such costs should not be included. The detailed budget should be broken down by task and team member, and include the maximum direct and indirect hourly rates for all individuals involved. In addition, the budget should provide an estimated budget for completing each task of the proposed Scope of Work, including an estimate of all projected staff hours.

2. A page titled **ALL-INCLUSIVE MAXIMUM PRICE** detailing all professional fees and associated expenses presented in a format that supports the total all-inclusive maximum proposal that is being tendered.

3. Proposed Manner of Payment and/or Payment Terms.

# IV. Evaluation of Proposals

## A. Review Personnel

Proposals will be evaluated by a selection committee including DHCD staff and key partners including the ANR Rivers Program. The DHCD will make the final decision regarding which bidder(s) to retain for this study, and will be solely responsible for the execution of any contractual arrangements with that bidder(s).

## B. Review Criteria

1. Initial screening of proposals will determine if each proposal includes the work tasks presented in the Scope of Work.

1. Following the initial screening, the review will focus on:
   a. The responsiveness of the proposal,
   b. The ability to complete the project within the required timeframe,
   c. The qualifications of the consultant and the personnel to be assigned to the project,
   d. The overall strategy and design of the proposal in addressing the proposed services and work tasks, and
   e. Cost.

The selection committee will review the proposals and evaluate each based on the following criteria:

| | CRITERIA | MAX. POINTS |
|---|---|---|
| A) | Prior experience and demonstrated knowledge of: | |
| i. | Flood hydrology, hydraulics, and river morphology, and | 15 |
| ii. | Demonstrated history of effective schedule and budget management for projects of similar scale and budget. | 10 |
| B) | Organization size and structure of bidder's firm or partnership, as related to ability of the firm to complete the work to be performed | 10 |
| | i. Qualifications of staff to be assigned | 10 |
| | ii. Supervision to be exercised over staff by firm's management. Education, position in firm, years and types of experience will be considered for all personnel. | 5 |

| | | | |
|---|---|---|---|
| C) | Bidder understands of work to be performed. This will be determined by the approach to the work and the time estimates to perform each activity. | | |
| i. | | Quality of understanding of work | 10 |
| ii. | | Adequate staff to meet deadline | 10 |
| iii. | | Realistic time estimates for each activity | 10 |
| iv. | | Realistic budgets for each activity | 10 |
| D) | Total cost. | | 10 |
| | **MAXIMUM POINTS** | | 100 |

### C. Selection Process

DHCD reserves the right to reject any and all proposals and to negotiate with more than one firm at the same time. Bidders whose submissions are not selected will be notified in writing or email.

Each proposal will be independently evaluated by the selection committee on Factors A through D above.

### D. Interview Framework

The top evaluated bidder(s) may be invited to discuss their proposal(s) and qualifications with the selection committee prior to awarding the contract. The purpose of this phase is to evaluate the capabilities and qualifications of the bidder. The interview will allow the bidder to demonstrate their experience and qualifications, their proposal offering and approach, and allow the selection committee to ask targeted questions to the bidder.

The final Scope of Work with specified deliverables may be modified through negotiation of the final contract. The final project team may also be modified through negotiation of the final contract. Any expenses resulting from the interview will be the sole responsibility of the bidder.

## V. Acknowledgement of Attachment C - Standard State Contract Provisions

The selected bidder will be expected to execute a contract that contains the most recent Attachment C - Standard State Contract Provisions in effect, which is attached for signature by the bidder and submittal with the proposal.

## List of Consultants Selected

- Bear Creek Environmental, LLC: Mary Nealon
- DuBois & King, Inc.: Matt Murawski
- Fitzgerald Environmental Associates, LLC: Evan Fitzgerald
- Landslide Natural Resource Planning, Inc.: Amy Sheldon
- Milone & MacBroom, Inc.: Roy Schiff

# Appendix 4.2

## Welcome Letter

August 4, 2014

Steven Mackenzie
City Manager
City of Barre
6 North Main Street, Suite 7
Barre VT 05641

Dear Mr. Mackenzie:

We are delighted Barre City has agreed to partner with the state and regional agencies on the Vermont Economic Resiliency Initiative (VERI), a program designed to help municipalities analyze their flood risks and identify steps to minimize rebuilding and recovery costs -- and ensure businesses stay open.

VERI is modeled on the success of a similar project in Bennington (case study enclosed) that reduced the flood impacts of Tropical Storm Irene and saved the town and businesses millions of dollars in economic damages. The project is funded by the US Economic Development Administration (EDA), and led by the Vermont Department of Housing & Community Development (DHCD), in partnership with the Agency of Natural Resources, Agency of Transportation, and Vermont's Regional Planning Commissions.

Barre City is one of seven Vermont communities participating in this initiative. The communities were selected via a thorough state-wide assessment process that identified areas with significant amounts of businesses and infrastructure susceptible to flooding and river erosion. Barre City was chosen because it has a relatively high level of economic activity; is a large city with a designated downtown; has a significant amount of vulnerable infrastructure; and has 169 vulnerable commercial buildings. In addition, Barre City's situation in central Vermont was an important factor, as well as the location of a state office building there and many commercial utility customers. The Agency of Natural Resources also recommended that Barre Town and Barre City be studied together because the watershed study area crosses both boundaries.

VERI will offer community leaders and stakeholders guidance to reduce threats to life, property, and employers that can result from flooding and severe weather. Specifically, we will produce an action plan with strategies to minimize losses and help businesses and communities recover quickly in the event of a flood. We will also provide tailored checklists to reduce risks to specific activities such as farming, municipal operations, or tourism.

The program will begin by helping your town understand how Gunners Brook moves through developed areas. To do this, we have hired river scientists to study approximately 3.0 river miles of Gunners Brook, from the Barre town line to the Stevens Branch in Barre City. Through this analysis, we will identify the locations in town that may be threatened by future flooding. Other activities include a river study project kick off meeting with the river scientist, DHCD, and Central Vermont Regional Planning Commission in **early August 2014,** as well as community education workshops in **September 2014** and **January 2015**.

By participating in this program, your community will learn more about the options available to reduce future costs from loss of businesses, or road, culvert and bridge repair. These options may include methods to better manage storm water, protect existing capital investments, and maintain the local transportation network. The work in Barre City (and the other communities in the program) will also serve as a model to help other Vermont towns take the necessary steps to reduce the economic impacts of floods.

Enclosed are the following additional materials that explain the project and its outcomes:

- a summary of the Vermont Economic Resiliency Initiative,
- a map of the key river segments in Barre City where river scientists will focus their study, and
- a case study of cost savings achieved in Bennington through a similar project.

<u>Your Role</u>

This is an exciting opportunity for Barre City and we appreciate your support. Here is what we need from you to assure a successful outcome:

- River scientists will be walking the Gunners Brook and it is important that property owners receive advance information about the project and the purpose of the scientists' work. Dan Currier of Central Vermont Regional Planning Commission will need your help creating a list of property owners along the brook for him to notify.
- Please share the enclosed materials with landowners, community groups and businesses via the town's website, Front Porch Forum, and other appropriate means. Dan will contact you shortly to coordinate and support these outreach efforts.
- Please attend an informal project kickoff meeting with DHCD, the Regional Planning Commission, and our river science consultants from Bear Creek Environmental. We aim to have this meeting in early August. Dan will be in touch with you to schedule the date.
- Dan will also need your assistance to identifying local data -- tax maps, aerial photos, and information on previous floods and history of damages. He will also need your help creating lists of local economic assets, infrastructure and systems, as well as identifying business establishments that may be vulnerable to flooding.
- Last, Dan will need your help identifying stakeholders to invite to the community forums in September 2014 and January 2015. We also request that municipal leadership support and attend both meetings too.

Project Contacts

Following is a roster of the key people working on this project in Barre City. To assure good communications, we ask that you include both the RPC and DHCD in all emails and other correspondence on activity related to the project:

- DHCD - Chris Cochran, 1 National Life Drive, Montpelier, VT, chris.cochran@state.vt.us, (802) 828-5212.
- Central Vermont Regional Planning Commission – Dan Currier, 29 Main Street, Suite 4, Montpelier, VT, currier@cvregion.com, (802) 229-0389.

Many thanks again for your participation. We look forward to meeting you in person at the kickoff meeting. If you have any questions in the meantime, please do not hesitate to contact us.

Sincerely,

Noelle MacKay

Commissioner
Department of Housing & Community Development

Susan Sinclair

Executive Director
Central Vermont Regional Planning Commission

Enclosures

# Vermont Economic Resiliency Initiative

**Agency of Commerce and Community Development**

## Helping Vermont businesses and communities bounce back from disasters

Twenty-five to forty percent of businesses affected by a disaster never reopen. That is an economic impact that residents, businesses, local communities and Vermont cannot afford.

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.

VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open – saving jobs and maintaining our economy.

## Project Overview

In the first phase of the project, the VERI team evaluated and ranked areas where economic activity and associated infrastructure are at high risk of flooding.

Based on this state-wide assessment, input from our steering committee and interest from local municipalities, five areas in seven communities (Barre City and Town, Brandon, Brattleboro, Enosburg Village and Town, and Woodstock) were selected for a more detailed analysis of the local flood risks to the community and businesses. This analysis provides the foundation for the team to develop community-tailored action plans to reduce the loss of jobs, inventory, revenue, as well as the cost to repair roads, bridges and other key infrastructure.

The action plans will help:

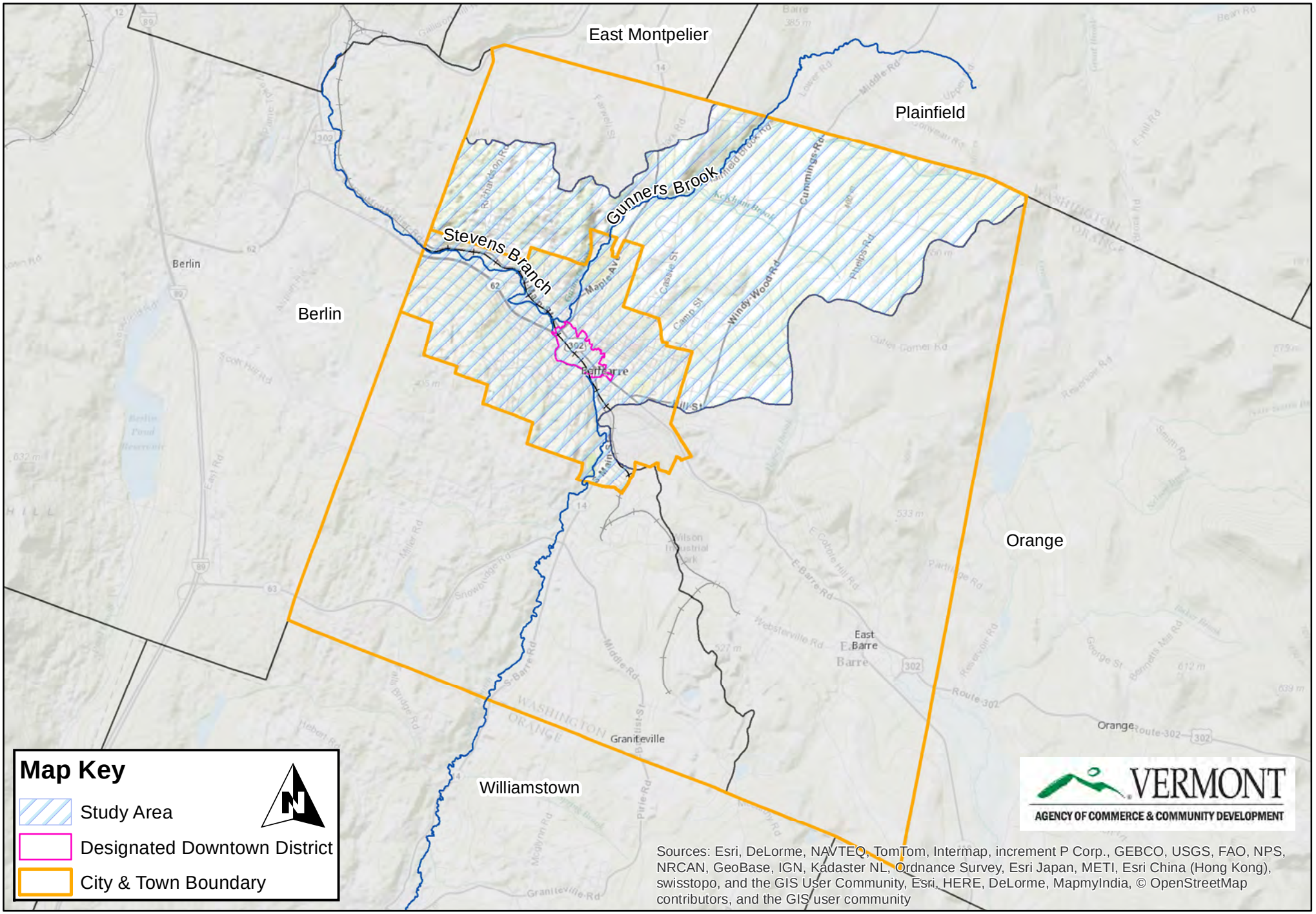
- minimize future damage to buildings roads, power, communications, and sewer and water systems,
- reduce the number of businesses impacted by disasters,
- speed business recovery, resumption and return to productivity,
- assure Vermont goods and services can continue reach their markets, and
- ensure residents return to their jobs more quickly and maintain their incomes.

Taken together, the local action plans will provide templates to help other Vermont communities better understand the risks and consequences of flooding, and take steps to reduce future damages and disruptions to local businesses.

**For more information:**
**http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI**

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

# Gunners Brook and Stevens Branch
# Barre City & Barre Town, VT




Author: Map provided by the Department of Housing & Community Development (DHCD). Map created 7/18/2014.



Photo credits: Milone and MacBroom

# Living with Roaring Branch

## Bennington Case Study

As in most Vermont communities, Bennington's Roaring Branch River flows through its downtown. Dan Monks, Bennington Planning Director described the river aptly, saying, "When there are big storms, it's terrifying and it's loud, that's why they call it the Roaring Branch; so people who live near it are well aware of the destructive power of the river."

Like many towns across Vermont and the nation, Bennington's strategy to manage the Roaring Branch was to build berms, and deepen, narrow and straighten the river channel to make its downtown safe for economic development. Frequent floods and millions of dollars later in damage and reconstruction costs, Bennington began to see that these methods to control the river to protect life and property only made matters worse.

Thanks to the proactive leadership of Bennington's town officials and the State of Vermont; however, Bennington has successfully reduced flood risks to roads and bridges, residential properties, and the commercial center, saving the town and taxpayers' money and staying open for business when flooding occurs.

### The New Approach

Beginning with a public involvement process led by the Bennington Planning Department, the Vermont Agency of Natural Resources, and consultants Milone & MacBroom, residents agreed that work to protect the town's economic center and public safety was needed and long overdue.

First, Bennington identified areas of economic activity that might be impacted by a major flood, noting key employers, infrastructure and support functions such as fire, police, and town offices. They then analyzed the flood risks in specifics locations in their community. Next, Bennington listed changes that could reduce or eliminate risk to key areas by reducing the river's energy during flooding and spreading river water out on open land. Changes included updating policies and regulations, removing levees, identifying key culvert upgrades, and land that could return to use as a floodplain.

Putting this plan into action, Bennington initially adopted new flood hazard zoning regulations to keep new buildings and people out of harm's way. Since no buildings would be permitted within the Roaring Branch's floodplain, the Town became eligible for increased funding from the State of Vermont, and they took advantage of these funds for floodplain restoration work that would follow.

Next came floodplain restoration activities. A four-foot rock wall was constructed to stabilize the riverbank. Thirteen acres of floodplain were reconnected to the river channel, and the river was given more room in which to flow and flood. Together these actions serve to reduce flood risk by slowing the river and lessening its destructive power -- protecting existing properties and minimizing mud and silt build-up on roads.

**For more information:**
http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

# Vermont Economic Resiliency Initiative

**Agency of Commerce and Community Development**

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Taken together, the local action plans will provide templates to help other Vermont communities better understand the risks and consequences of flooding, and take steps to reduce future damages and disruptions to local businesses.

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DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

# Appendix 4.3

## Sample Notification Letter

September 3, 2014

Dear Landowner:

I am writing to you and other landowners along the Whetstone Brook in Brattleboro to let you know about an upcoming study. The Vermont Agency of Commerce and Community Development (ACCD), with assistance from Windham Regional Commission (WRC), is conducting an assessment of the Whetstone Brook in Brattleboro. The study is part of the Vermont Economic Resiliency Initiative (VERI), an ACCD program designed to help municipalities analyze their flood risks and identify steps to minimize recovery and rebuilding costs, and ensure businesses are more resilient and better able to survive disasters.

VERI will offer community leaders and stakeholders guidance to reduce flooding and severe weather threats to life and property, as well as an action plan with strategies to minimize losses and help businesses and communities recover quickly. VERI is modeled on the success of a similar project in Bennington (case study enclosed) that reduced the flood impacts of Tropical Storm Irene and saved the town and businesses millions of dollars in economic damages.

Landslide Natural Resource Planning of East Middlebury, Vt., along with Milone and MacBroom, Inc., is working with ACCD and WRC to conduct this assessment. Field surveys will be done from early September through November 2014. Most of the survey work is conducted in the stream channel. However, it may be necessary for the scientists to access the stream bank to take measurements and make observations. We hope you'll assist this effort by allowing river scientists access to the banks along the brook that runs through your property. The scientists assume all liability during these assessments as they are required to carry comprehensive liability insurance.

Once we have a better understanding of the Whetstone, especially its characteristics post Tropical Storm Irene, a plan will be developed to increase safety by reducing flood and erosion hazards—an initiative that will also save taxpayer money, and achieve a healthier Whetstone Brook overall. The first of two community workshops on VERI and the Whetstone Brook is planned for October of this year.

Please return the enclosed postcard if you do NOT wish to give river scientists access to the stream banks on your property, and /or if you would like more information. If you have questions, please feel free to contact WRC staff members Kim Smith (ksmith@windhamregional.org) or Jeff Nugent (jnugent@windhamregional.org) by email or phone (802-257-4547). Thank you for your help.

Sincerely,

Jeff Nugent
GIS Planner

# Appendix 4.4

## Community Reports

- Barre Community Report
- Brandon Community Report
- Brattleboro Community Report
- Enosburg Community Report
- Woodstock Community Report

# Vermont Economic Resiliency Initiative [VERI]

## Barre, VT

Community Report
July 2015

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

# Acknowledgements

The Vermont Economic Resiliency Initiative was partially supported by U.S. Department of Commerce, Economic Development Administration (EDA). Thanks to EDA's Matthew Suchodolski and Debra Beavin for their support and guidance of the project. Thanks also to the project team for their insight and expertise:

Vermont Department of Housing and Community Development
- Chris Cochran
- Wendy Rice
- Ken Jones
- Faith Ingulsrud
- Melissa Prindiville
- Lucie MacAskill
- Annina Seiler
- Richard Amore

Vermont Department of Environmental Conservation
- Mike Kline
- Sacha Pealer
- Patrick Ross
- Staci Pomeroy
- Gretchen Alexander
- Rebecca Pfeiffer

Vermont Agency of Transportation
- Joe Segale
- Jonathan Croft

Windham Regional Commission
- Jeff Nugent
- Kim Smith

Two Rivers-Ottauquechee Regional Commission
- Peter Gregory
- Pete Fellows

Rutland Regional Planning Commission
- Laura Keir
- Ed Bove
- Steve Schild

Central Vermont Regional Planning Commission
- Daniel Currier
- Gail Aloisio

Northwest Regional Planning Commission
- Bethany Remmers
- Taylor Newton

Thanks also to the Vermont Department of Labor, the Vermont Division of Emergency Management and Homeland Security, Economic & Policy Resources, Inc., and the Office of the State Auditor for their assistance with data gathering and analysis.

Thanks to the consulting firms for their work developing the five community reports and recommendations. Their dedication, creativity and skill not only provided a strong work plan for the municipalities, but serve as models for all Vermont communities. Special thanks to Mary Nealon for her leadership in bringing this talented team together and Matt Murawski for his work as lead in Barre.

- Bear Creek Environmental, LLC: Mary Nealon
- DuBois & King, Inc.: Matt Murawski
- Fitzgerald Environmental Associates, LLC: Evan Fitzgerald
- Landslide Natural Resource Planning, Inc.: Amy Sheldon
- Milone & MacBroom, Inc.: Roy Schiff

Thanks to the Town and City of Barre and all those who participated in stakeholder meetings, community forums, morning coffee meetings and took the time to review, edit, comment and provide the local perspective for this project. Thanks to the members of the General Assembly, Selectboard, Planning Commission, town staff, the Chamber of Commerce, businesses and citizens. Your participation greatly improved the report.

Noelle MacKay, Commissioner of Housing and Community Development

# Table of Contents


Vermont Economic Resiliency Initiative (VERI): Barre Executive Summary ..... i
List of Acronyms ..... v
Glossary of Terms ..... vi
Project Overview ..... 1
  Why was Barre Selected? ..... 2
  Study Area ..... 2
  Research and Outreach ..... 5
Flood History and Town Accomplishments ..... 8
  Flood History and Risks ..... 8
  City and Town Accomplishments ..... 10
    Floodplain Regulations ..... 10
    Local Hazard Mitigation Plans ..... 11
    Vermont- Downtown Action Teams (V-DAT) ..... 11
Strategies and Projects to Protect Barre ..... 12
  Municipal Policy and Program Recommendations ..... 12
    Emergency Relief Assistance Fund (ERAF) ..... 14
  Specific Project Recommendations ..... 15
    Building and Site Improvements ..... 16
    Channel and Floodplain Management ..... 17
    Infrastructure Improvements ..... 18
    Public Safety Improvements ..... 18
Conceptual Project Designs to Protect Barre ..... 19
  Develop Flood Resilient Channel Wall Design Standard ..... 19
    Overview and Objectives ..... 19
    Data Analysis and Results ..... 20
    Steps for Project Implementation ..... 21
    Project Benefits ..... 21
  Purchase the Most At-risk Buildings between Upper Brook Street Bridge and Main Street ..... 21
    Project Overview and Objectives ..... 21
    Data Analysis and Results ..... 22
    Steps to Project Implementation ..... 23
    Project Benefits ..... 23
Next Steps ..... 24
  Education and Outreach ..... 25
  What Can Individuals Do to Reduce their Risks? ..... 27
    Steps to Reduce Risks ..... 27
  What Can Businesses Do to Reduce their Risks? ..... 29
    Steps to Reduce Risks ..... 29
References ..... 32

## Figures and Tables

Figure 1: Map of Gunners Brook study area in red in relation to surrounding towns....2
Figure 2: Map of Gunners Brook study area in red in relation to the Stevens Branch of the Winooski River....2
Figure 3: Slope failures are common on upper Gunners Brook in Barre Town....3
Figure 4: Bedrock keeps the brook vertically stable in Barre Town below Ketchum Brook....3
Figure 5: Good floodplain near the downstream limit of Barre Town that promotes sediment and debris deposition....3
Figure 6: Narrow valley above Barre City....4
Figure 7: Retaining walls and typical small bridge opening in the downstream portion of Barre City....4
Figure 8: Barre Community Forum....5
Figure 9: Flooding of Main Street in Barre City during the Flood of 1927....8
Figure 10: The Bates and Murray building in Barre Town was flooded in May 2011....8
Figure 11: Road damage and sediment deposits following the May 2011 Flood....9
Figure 12: Debris at bridges compounded the May 2011 Flood....9
Table 1: Summary of Barre City Businesses, Employees, and Multi-family Residences in Flood and Erosion Hazard Area....10
Table 2: Categories of Municipal Policies and Programs....13
Table 3: How Barre Town and City Met its ERAF Match....14
Table 4: Categories of Flood Resiliency Projects....15
Figure 13: Failing walls typical in Barre City....19
Figure 14: Drawing of flood resilient channel concept....20
Figure 15: Three areas outlined in red identified for possible property buyouts....22

## Appendices

Appendix A: Maps of Gunners Brook Floodplain Development
Appendix B: City and Town of Barre and Gunners Brook Data Sources
Appendix C: Maps of Tropical Strom Irene Damage near Gunners Brook
Appendix D: Table of Businesses in Flood Hazard Zones
Appendix E: V-DAT One-Page Visual Summary of the Top Recommendations for Barre
Appendix F: Results of EPA's Flood Resilience Checklist for Barre City and Town
Appendix G: Table of Municipal Policy and Program Recommendations
Appendix H: Projects to Protect Businesses and Infrastructure – Maps
Appendix I: Project to Protect Businesses and Infrastructure - Table
Appendix J: Conceptual Design Drawing for Flood Resilient Channel Walls
Appendix K: Conceptual Design Site Plan for Relocation of Most At-Risk Buildings
Appendix L: Community Forum Meeting Notes
Appendix M: Maps of Repetitive Damage for Barre City and Town

# Vermont Economic Resiliency Initiative (VERI): Barre Executive Summary

In communities around Vermont, rapidly melting snow and torrential downpours bring nightmares of washed out bridges, closed roads, flooded basements and shuttered businesses. To calm these fears, Vermonters have been working to better understand the flood risks they face and identify and implement projects that reduce, avoid or minimize these risks. The goal: to protect lives, help businesses remain open and reduce costs to taxpayers for repetitive repair to infrastructure.

After Tropical Storm Irene, Governor Shumlin challenged us to "build back stronger than Irene found us." This project, the Vermont Economic Resiliency Initiative (VERI), is designed to help meet that challenge. It is modeled after a successful project in Bennington, Vermont that minimized business interruption and saved tax payers money by substantially reducing flood recovery costs (DHCD, 2015). With funding from the US Department of Commerce, Economic Development Administration (EDA), the Agency of Commerce and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched VERI to help ensure Vermont recovers quickly and remains open for business after disaster strikes.

In the first phase of the project, the VERI team evaluated and ranked areas where economic activity and associated infrastructure are at high risk of flooding. Based on this state-wide assessment, input from the team's economic steering committee and interest from local municipalities, five areas in seven communities (Barre City and Town, Brandon, Brattleboro, Enosburgh Town and Village, and Woodstock) were selected for a more detailed analysis of the local flood risks to the community and businesses.

Gunners Brook in Barre City and Barre Town was selected because of the unusually high level of development adjacent to the channel, significant economic activity, and history of repeated flooding and flood damages. The communities have worked to identify and manage flood risks through adoption of floodplain regulations and hazard mitigation plans.

The team hosted two community forums, as well as smaller group meetings, and have worked directly with local leaders, municipal staff, local businesses and interested citizens to determine the locations of greatest risk and cost, identified potential projects and highlighted the work communities have accomplished to date to reduce the impact of floods. Based on this community insight, along with data collection and analysis, the team evaluated local flood risk to businesses and infrastructure and identified strategies and projects Barre City and Town can implement to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining the local economy.

This report summarizes the team's work and identifies municipal policy and program recommendations and 22 site-specific projects in Barre City and Town, including the following 11 projects deemed high priority by the team.

## Municipal Policy and Program Recommendations

- **Update Policies that Currently Allow Fill in Flood Hazard Areas:** Allowing landowners to protect buildings using fill may help protect an individual property, but it can increase flood hazards to downstream property owners and reduce the land's ability to slow and store the extra flood water. Regulations can require alternate methods to protect buildings including allowing flood waters to occupy the space beneath the structure which limits impacts to neighboring or downstream properties. Under current city bylaws, onsite filling is allowed.
- **Require Repaired and Rebuilt Structures to be Built Higher:** Owners rebuilding should raise the lowest floor two to three feet higher than the flood elevation to address the increased rainfall patterns and the actual flood heights from recent floods. Current Barre City bylaws require one foot above flood elevation and should be reviewed and considered for updates.
- **Emphasize Watershed-Wide Stormwater Planning to Reduce Flooding Impacts:** As the Barre area and neighboring communities experience growth, collaborative regulation and enhanced stormwater control measures can reduce the flooding experienced in Barre Town and City. All communities in the watershed should develop dialogue and collaborate on ways to limit stormwater run-off from development.

## High Priority Specific Project Recommendations

**Building and Site Improvements:** These are projects which lower the risk of flooding and/or erosion to specific properties through improvements to the building and/or surroundings.

- **Barre City – Floodproof Buildings from the Upper Brook Street Bridge to Stevens Branch:** Retrofits to some of the approximately 115 commercial and residential buildings located within the 100-year floodplain of Gunners Brook would reduce future flood damages when they are flooded again, reducing repair costs and ensuring businesses open quickly.

**Channel and Floodplain Improvements:** These types of projects lower the risk of flooding and/or erosion to properties along the river through the improvement of natural river and floodplain functions.

- **Barre City – Develop a Flood Resilient Design Standard for Channel Walls:** The failing channel walls that line much of Gunners Brook can be reconstructed to reduce flood risk for more than 10 businesses with 40 employees and more than 30 multi-family buildings.

- **Barre City – Remove the Now-Closed Harrington Avenue Bridge:** Removing the bridge deck could help reduce the collection of debris, but additional work to remove the bridge abutments and restore nearby floodplain would do more to reduce the flood risk for more than 10 businesses with 40 employees and more than 30 multi-family buildings
- **Barre Town and City – Develop and Implement a Debris Management Plan:** Flooding on Gunners Brook is often the result of woody debris collecting at bridges and other choke points. Better management of the debris would reduce flood risks for the 20 businesses with 188 employees and the 65 multi-family buildings in the Gunners Brook floodplain in Barre City.

**Infrastructure Improvements:** These are projects which lower the risk of flooding and/or erosion to utilities, roadways and other municipal or state-owned infrastructure.

- **Barre Town – Plainfield Brook Road: Replace Undersized Culvert:** The existing culvert is undersized and is prone to blockage that has required maintenance during past floods and could cause the road to fail, which would disrupt the flow of goods and people to and from approximately 10 businesses with 40 employees.
- **Barre Town – Plainfield Brook Road: Monitor Embankment below Ketchum Brook:** The road parallels the stream for a significant distance and there is an elevated risk of embankment failure and road damage, which would disrupt the flow of goods and people to and from approximately 10 businesses with 40 employees.
- **Barre City – Replace Undersized Bridge on Upper Brook Street:** The 1927 bridge is undersized and contributes to flooding of Farwell Street and adjacent buildings, as well as many downstream locations in the path of floodwaters before they return to the channel. If replaced, it will reduce flood risk for more than 10 businesses with 40 employees and more than 30 multi-family buildings.

**Public Safety Improvements:** These projects lower the risk of flooding and/or erosion to properties by avoiding future flood risks.

- **Barre City – Initiate Feasibility Study to Consider Property Buyouts of High-risk Buildings Located between the Upper Brook Street Bridge and Main Street:** Working with property owners, the City should initiate a project to analyze the cost and benefits of developing a program to purchase these buildings over time. Purchasing the buildings would help reduce threats to families and businesses along this area. It will also reduce the ongoing flood risk for the nearly 20 businesses with 188 employees and approximately 55 multi-family buildings.

Two high-priority projects (property buyouts and flood resilient channel wall design) were further detailed to help Barre City and Town take the next steps and to create model project designs to help other communities learn from VERI project.

## Next Steps

As part of the ongoing community discussion regarding the VERI effort, we recommend the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization;
- Prioritize one to two projects to pursue each year with assistance from the Vermont Department of Environmental Conservation and Central Vermont Regional Planning Commission staff to identify appropriate funding sources and partners;
- Apply for one to two grants each year to advance project development and/or designs.
- Implement projects as funding allows; and
- Monitor project success.

Irene taught us many lessons -- a key one was that no one individual, business, organization, town or state agency can address and tackle large and complicated projects alone. Reducing the risk of future floods in Barre City and Town will require partnerships, funding and time to implement. The Agency of Commerce and Community Development, its sister agencies and the Central Vermont Regional Planning Commission are committed to help Barre City and Town take the steps outlined in this report to save lives and protect jobs and its economy from future storms and floods.

Flooding due to severe storms will happen again, the question is how can we best reduce the recovery costs to communities and ensure businesses remain open.

# List of Acronyms

**ACCD** – Vermont Agency of Commerce and Community Development

**ANR** – Vermont Agency of Natural Resources

**BFE** – Base Flood Elevation

**CDBG-DR** – Community Development Block Grant for Disaster Recovery

**CVRPC** – Central Vermont Regional Planning Commission

**DEC** – Vermont Department of Environmental Conservation

**DEMHS** – Vermont Division of Emergency Management and Homeland Security

**DHCD** – Vermont Department of Housing and Community Development

**EDA** – US Economic Development Administration (EDA)

**EPA** – United States Environmental Protection Agency

**ERAF** – Emergency Relief Assistance Fund

**FEMA** – Federal Emergency Management Agency

**HMGP** – Hazard Mitigation Grant Program

**NFIP** – National Flood Insurance Program

**RLP** – Repetitive Loss Property

**SFHA** – Special Flood Hazard Area

**V-DAT** – Vermont Downtown Action Team

**VERI** – Vermont Economic Resiliency Initiative

**VTrans** – Vermont Agency of Transportation

# Glossary of Terms

Terms are bolded the first time they appear in the text.

**100-Year Floodplain** – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Flood Zone or 100-Year Flood Hazard Area.

**500-Year Floodplain** – The area that will be inundated by the flood event having a 0.2% chance of being equaled or exceeded in any given year. Also called 500-Year Flood Zone or 500-Year Flood Hazard Area.

**Base Flood Elevation** – The computed elevation to which floodwater is anticipated to rise during a 100-year flood.

**Culvert** – A pipe or tunnel underground, usually under roads, that transports flowing water, sediment, debris and ice from one side to the other.

**Emergency Relief Assistance Fund** – This program allows towns in Vermont to increase the amount of state aid money they could receive as a match to federal aid for post-disaster recovery.

**Erosion** – The wearing away of rock or soil by flowing water.

**Fill** – A quantity of earth, stones, etc., for building up the level of an area of ground.

**Flash Flooding** – Rapid, short-term flooding often caused by severe rain and/or rapid snowmelt.

**Floodplain** – Area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge.

**Floodway** – The area immediately adjacent to the channel that must remain open to allow floodwaters to pass.

**Flood Resiliency** – The ability of individuals, communities, organizations and states to adapt to and recover from flooding hazards without compromising long-term prospects for development.

**Hazard Mitigation Plan** – A document and planning process that provides actions to reduce the long-term risk to human life, property, and the economy from natural disasters.

**Mitigation** – Any sustained action taken to reduce or eliminate the long-term risk to life and property from hazard events. It is an on-going process that occurs before, during, and after disasters and serves to break the cycle of repetitive damage and repair.

**National Flood Insurance Program** – A federally funded and locally implemented program to reduce the impacts of flooding through individual insurance policies and incentives for floodplain regulations.

**Riparian Buffer** – Mixed composition, vegetated land adjacent to a stream separating it from other land uses.

**Riprap** – The application of rocks to reduce erosion and protect nearby infrastructure or private property. Also known as rock armoring.

**Special Flood Hazard Area** – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Flood Zone or 100-Year Flood Hazard Area.

**State River Corridor** – Area delineated by the Vermont Rivers Program adjacent to rivers and streams that provide functions that restore and maintain natural stability for a river. These areas are often at higher risk of erosion.

**Tributary** – A stream that flows into another, larger stream.

# Project Overview

In May 2013, the Vermont Agency of Commerce and Community Development (ACCD) received disaster recovery funding from the US Economic Development Administration (EDA) for the Vermont Economic Resiliency Initiative (VERI). The goals of VERI are to:

1. Analyze threats to Vermont's areas of economic activity and their associated infrastructure;
2. Develop plans to reduce impacts and avoid future losses and costs; and
3. Identify projects that communities and businesses can implement that avoid, minimize or reduce their flood risk and thus ensure businesses stay open and communities minimize costs.

The overarching goal is to ensure that businesses and communities bounce back quickly when disaster strikes, saving time and money in recovery costs.

**The primary objective of the focus area assessments is to develop strategies and projects to make businesses and the communities more resilient to floods and other disasters.**

VERI is led by ACCD's Department of Housing and Community Development (DHCD) in partnership with the Agency of Natural Resources (ANR), Agency of Transportation (VTrans), and Vermont's Regional Planning Commissions, which for this study area is the Central Vermont Regional Planning Commission. Early in the process, the agencies mapped where flood hazard risks intersect with areas of economic activity and infrastructure. Five priority communities were selected for a detailed assessment of those risks and include: Barre City and Town, Brandon, Brattleboro, Enosburgh Town and Village, and Woodstock. A river scientist and engineering team consisting of five consulting companies: Bear Creek Environmental, LLC, DuBois & King, Inc., Fitzgerald Environmental Associates, LLC, Landslide Natural Resource Planning, Inc., and Milone & MacBroom, Inc., were hired to analyze the river and assist in developing recommendations to reduce the vulnerability of infrastructure and businesses to flood damage.

A number of factors played a role in the selection of the five areas chosen for more detailed assessments. First, the project team ranked towns across the state by flood risk, economic activity and infrastructure at-risk. Then, the team looked at the 20 highest ranking communities and removed any that had undergone or had funding for similar analysis (i.e., Bennington and Waterbury). Next, the team strived to select five pilot communities that represented different economic profiles (i.e., agriculture, tourism, downtowns) as well as different sizes. Other considerations included risk of future damage, economic factors, and level of community engagement and interest. Together, these factors helped determine the five pilot communities selected.

## Why was Barre Selected?

Barre Town and City was selected as one of the pilot communities for the following reasons:

- The area has significant economic activity and it is a state-designated downtown;
- Critical transportation infrastructure was identified to be at-risk that, if closed, would impact employees and customers trying to get to businesses and the flow of goods and services;
- Numerous buildings were identified to be at-risk near the Gunners Brook;
- Barre City has a history of repeated flooding and flood damages.

## Study Area

Just over three miles of Gunners Brook are included in the VERI study area, which begins at the Barre/Plainfield town line and continues downstream through Barre City to where the brook flows into the Stevens Branch of the Winooski River. Figure 1 shows the Gunners Brook study area in red in relation to surrounding towns.

Barre Town and Barre City are located in northern central Vermont in Washington County. Barre Town covers nearly 31 square miles and lies between Plainfield and East Montpelier to the north, Berlin and Barre City to the west, Williamstown to the south, and Orange to the east. In 2010, the population of Barre Town was approximately 8,000 people (Town of Barre, 2014).

In contrast, Barre City encompasses only four square miles and is home to just over 9,000 people according to the 2010 census. It is the largest city in terms of population in Washington County and the fourth largest in the state of Vermont. It serves as a commercial and residential hub for the area (Barre City, 2014).

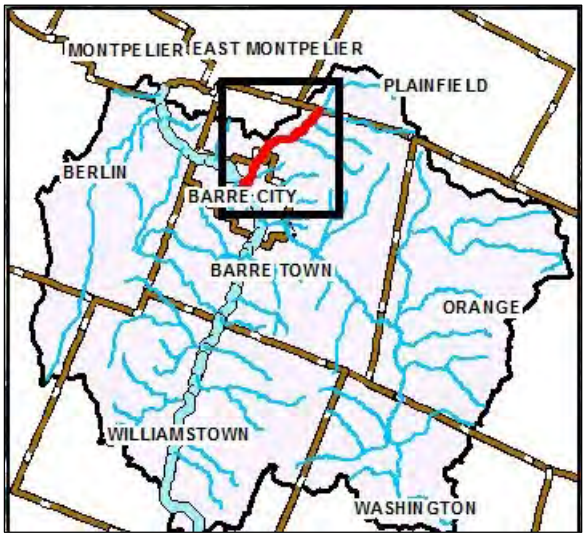


**Figure 1:** Map of Gunners Brook study area in red in relation to surrounding towns


**Figure 2:** Map of Gunners Brook study area in red in relation to the Stevens Branch of the Winooski River

The Gunners Brook drainage area is approximately eight square miles, including a relatively small portion in Plainfield. It is a **tributary** to the larger Stevens Branch of the Winooski River (Figure 2). The brook flows through forested, agricultural, and residential lands in Plainfield and along Plainfield Brook Road throughout most of Barre Town. A few houses and businesses are along the brook in the Town, but otherwise surrounding land is primarily forested. In Barre City, the land surrounding Gunners Brook transitions to densely developed residential and commercial area. Gunners Brook within the study area can be broken into the following zones:

- The most upstream portion in Barre Town drains forested, agricultural, and sparsely developed residential lands. Only a few houses and businesses are near the brook; the adjacent **floodplain** is primarily forested. The river valley is generally relatively wide and the channel has ample access to its floodplain. This zone has a high number of bank and slope failures and gullies (Figure 3), likely the result of unusually frequent recent flood events.

**Figure 3:** Slope failures are common on upper Gunners Brook in Barre Town

- Below Ketchum Brook in Barre Town, the valley width narrows and the brook frequently parallels Plainfield Brook Road. Bedrock outcrops hold the streambed at a vertical grade, as pictured in Figure 4.

**Figure 4:** Bedrock keeps the brook vertically stable in Barre Town below Ketchum Brook

- Toward the downstream end of Barre Town, the valley widens again and the brook has good floodplain access. A photo of this area is shown below in Figure 5. There are significant deposits of trees, smaller woody debris, and gravel in this zone. Much of this material likely originated from upstream slope and bank failures.

- In the vicinity of Hope Cemetery (the upstream part of Barre City), the river valley narrows again (Figure 6) and there is little available floodplain. The floodplain here has been filled in over the years, most notably at the former landfill that is now home to ball fields. A bedrock grade control

**Figure 5:** Good floodplain near the downstream limit of Barre Town that promotes sediment and debris deposition

is present at the downstream end of this zone, which helps keep the channel stable. In spite of a narrow valley and minimal floodplain, there is significant sediment deposition in this zone. This suggests an unnaturally high supply of upstream sediments.

- In the most downstream zone, Gunners Brook flows through the heart of Barre City. Here the brook has been extensively channelized with concrete and granite block retaining walls built to keep the channel from moving laterally (Figure 7). Residential and commercial buildings in close proximity to the channel are common with some buildings built directly on the retaining walls or even overhanging the channel.

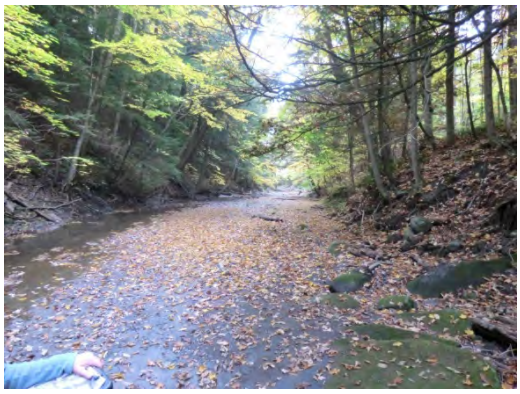

**Figure 6:** Narrow valley above Barre City

**Figure 7:** Retaining walls and typical small bridge opening in the downstream portion of Barre City

The five bridges in this downstream zone are narrower than the natural channel, which restricts the flow of water and catches debris. The valley walls fan out as Gunners Brook joins with the Stevens Branch, and the slope of Gunners Brook becomes flatter. The existing retaining walls along the Gunners Brook prevent the channel from moving, as it would have done naturally. The management of the channel has reduced out of the channel floods from one or more per year to once every five to 10 years, on long-term average. However, when the water overflows, the channel tends to spread out, causing widespread shallow flooding that can accumulate and flow down roads at some distance from the channel. Approximately 83% of the **100-year floodplain** in Barre City (43 of 52 acres) is developed (occupied by buildings, roads, parking lots, driveways, and railroads). That is an unusually high degree of development in a location prone to frequent flooding. A map showing floodplain development is included in Appendix A. More development means higher recovery costs, safety concerns, and faster moving flood waters. Protecting the existing development and infrastructures requires a combination of upstream protection and retrofitting existing development.

**83% of the Gunners Brook 100-year floodplain in Barre City is developed, including 20 businesses, 65 multifamily homes, and many residences. This is an unusually high level of development in a location so prone to flooding.**

## Research and Outreach

The team kicked off the project in August 2014 at a meeting with staff from the Town and City to share information about flood risk reduction strategies for businesses and the recent floods along Gunners Brook. DHCD Commissioner Noelle MacKay emphasized the overall objective of helping businesses bounce back rather than break after disasters. Following this meeting, the team reviewed existing information about the City and Town, Gunners Brook, and associated community hazard planning (see table of data sources in Appendix B).

Following the kick off meeting, DHCD and the Central Vermont Regional Planning Commission (CVRPC) hosted a community Forum on October 24th, 2014 at the Aldrich Public Library in Barre City (Figure 8). Community members, town officials, business owners and homeowners from the region attended and learned more about the background of the VERI study from DHCD Commissioner Mackay. Matt Murawski from DuBois & King provided an overview of the Gunners Brook from the relatively undeveloped channel and floodplain in the upper watershed to the channelized brook and heavily developed floodplain in the lower portion. Then, the floor was open for ideas and questions from the community members.

**Figure 8:** Barre Community Forum

At that forum, participants highlighted successfully completed and ongoing **flood resiliency** projects, including:

- Improved emergency preparedness and response planning, such as staging backhoes in problem spots and public works crews inspecting debris collection locations in advance of big storms.
- Enhanced understanding of the extent of flooding and damage based on mapping.
- Ongoing implementation of city regulations to reduce run-off and risky development.
- Improved preparedness by businesses and property owners including removal of inventory from flood-prone basements.
- Upgraded infrastructure such as Barre City stormwater system improvements with additional capacity.
- Required a City permit for any change in grade of a property.
- Improved City warning system to alert people to inspect and clean drainage infrastructure when storms are pending.

Community members identified factors contributing to flooding and risk in the study area including:

- Woody debris clogging the now-closed Harrington Avenue Bridge and causing out of bank flooding.
- Woody debris clogging and causing flooding at the North Main Street Bridge.
- Dumping of fill into the floodplain near the Hope Cemetery.
- Failing retaining walls along the channel throughout Barre City.
- Clogging of stormwater system due to leaves raked into the streets and streams.
- Filling of stream channels and associated loss of fish habitat (Sterling Hill Brook in south Barre cited as example).
- Run-off from rural roads carrying extra sediment into the rivers.

There were numerous suggestions from the community on potential projects and ideas to improve public safety and reduce future flood risks:

- Install trash racks upstream to capture debris before they get to Barre City bridges.
- Establish a grant or loan program to help repair the retaining walls along the Gunners Brook.
- Remove waste granite dumped in river.
- Work to increase channel and floodplain capacity.
- Expand cooperation with upstream neighbors like Barre Town, Plainfield and Williamstown.
- Schedule biannual river inspections with state river engineers and other regulatory partners.
- Increase floodwater storage capacity upstream of and within the City.
- Develop policies to manage the salt/snow/sand mixture on the roads and snow storage.
- Provide individual landowner education (how to reduce run-off, the risks of putting woody debris or vegetation in the waterway, impacts of snow pack being pushed into the river, etc.).
- Establish a local fund to help businesses recover after storm events (i.e., revolving loan funds).
- Create a regional stormwater management district, mirroring the structure of solid waste districts.
- Develop a buyout program to purchase threatened properties along Gunners Brook- roughly 30-40 properties.

The river scientists on the team also completed field surveys and walked the length of Gunners Brook from the Plainfield Town line to its mouth at the Stevens Branch of the Winooski River to observe current conditions of the river and floodplain and near-by development, and to identify opportunities to reduce flood risks. Team members along with participants from the Town, City, and CVRPC visited a number of Gunners Brook sites in Barre City. Local community insight gained at the community forum helped guide this fieldwork. The team visited the watershed on several occasions between August and December, 2014 and made the following observations:

- Locations and dimensions of bank **erosion** and riprap
- Conditions of retaining walls
- Locations of significant wood debris accumulation in the channel
- Bridge and **culvert** dimensions and conditions
- **Riparian buffer** conditions
- Areas of severe river channel instability

A second community forum occurred on April 16, 2015. At this meeting, community members provided feedback and helped prioritize the projects the team identified to protect businesses and infrastructure.

Input gathered at the workshops and meetings, along with the research completed by the VERI team were used to develop the recommendations to help the community prepare for, manage, and decrease risk, and reduce the economic costs of future losses due to flooding. In the sections that follow, the team has outlined specific projects as well as plan and bylaw updates that can help ensure businesses remain open and infrastructure continues to function. Estimated costs, funding sources and impacts associated with recommended projects are included.

# Flood History and Town Accomplishments

Barre City and Town have experienced severe property and infrastructure damage from flooding along the Gunners Brook since the 1920s. With input from the CVRPC and the community, the team has identified key flood risks in the region.

**Figure 9:** Flooding of Main Street in Barre City during the Flood of 1927. Photo from http://barrequest.com/27-flood-bonus/

## Flood History and Risks

The Gunners Brook has flooded Barre City and Town numerous times in the past century. One of the most severe accounts was the Flood of 1927 that caused the worst flood damages on record throughout much of Central Vermont. A photo of Barre City during the 1927 flood is shown above in Figure 9. Another major flood event occurred in 1973, though did not impact Barre to the degree of the 1927 flood.

Since then, damage from flooding, **flash flooding**, tropical storms, and hurricanes was recorded on eight occasions within a period of twenty years in Barre City and Barre Town. The most damaging of these events were the flash floods that occurred in July 2007 and May 2011.

**Figure 10:** The Bates and Murray building in Barre Town was flooded in May 2011

In July 2007, four to six inches of rain fell over Barre within 24 hours. Barre Town experienced widespread damage to roads and infrastructure totaling over $690,000. Much of this damage cost was due to culvert and road washouts (Town of Barre, 2012). In Barre City, the 2007 flood left two to five feet of water in parts of the City. This inundation caused a loss of access to the City's emergency facilities, and prevented emergency vehicles from responding to calls (City of Barre, 2012).

In May of 2011, flash flooding caused damage at many of the same locations in Barre Town that were damaged in 2007. Culverts and roads washed out, and flooding was noted in basements and storage sheds along Route 14. Damages in Barre Town totaled upwards of $300,000 for the 2011 storm (Town of Barre, 2012). Within the VERI study area, only one commercial business – Bates and Murray Inc., at 103 Plainfield Road was damaged (Figure 10).

Downstream in Barre City, damages from the May 2011 flood were widespread. Water was over five feet in some places, and damage to roads, buildings, and other infrastructure exceeded one million dollars (City of Barre, 2012). Flooding from Stevens Branch, in addition to Gunners Brook, contributed to the damage in the lower portion of Gunners Brook. CVRPC catalogued and mapped Barre City flood damages following this flood (Appendix C). The damage included multiple locations of road damage and sediment deposition (Figure 11), flooding of houses, businesses, and roads, damaged stormwater infrastructure, and collapse of some streambank retaining walls. Debris clogging at bridges (Figure 12) contributed significantly to the flooding by forcing water to spill out of the channel.


**Figure 11:** Road damage and sediment deposits following the May 2011 Flood

**Figure 12:** Debris at bridges compounded the May 2011 Flood

Tropical Storm Irene in August 2011, which caused devastation to many communities in central and southern Vermont, was not particularly significant in Barre Town and Barre City. Damage from Tropical Storm Irene in Barre Town totaled only $15,000, and Barre City recorded minimal flooding in its floodprone areas (Town of Barre, 2012).

Analysis identified 20 at-risk businesses and 65 at-risk multi-family residences located within the Gunners Brook 100-year floodplain in Barre City (Table 1 and Appendix D). This analysis was not conducted for Barre Town because there is no mapped **floodway** or 100-year flood hazard zone for Gunners Brook and development in this area of the brook is limited.

Table 1 below provides a breakdown of the number of businesses and employees that work in the buildings within these three flood/erosion hazard zones. These data only show if buildings are within the boundaries of the floodplain and do not show the elevation of the building relative to the floodplain elevation. Single and multi-family rental properties are also included because they are income-producing and damage to them has a significant potential to disrupt business and impact people getting to work.

| Table 1: Summary of Barre City Businesses, Employees, and Multi-family Residences in Flood and Erosion Hazard Area | | | |
|---|---|---|---|
| | Floodway | 100-year Floodplain | State River Corridor |
| Number of Businesses | 11 | 20 | 9 |
| Number of Employees | 101 | 188 | 56 |
| Single-Family Residences | 14 | 30 | 25 |
| Multi-Family Residences | 28 | 65 | 45 |

Along Gunners Brook, two properties are designated as Repetitive Loss Properties (RLPs) by the Federal Emergency Management Agency (FEMA). A RLP is any building for which two or more insurance claims greater than $1,000 were paid in a 10 year period. These properties are located on Harrington Avenue, directly to the east of Gunners Brook (FEMA, 2013).

## City and Town Accomplishments

Barre Town and Barre City have worked hard developing and implementing projects to reduce the risk of flooding to local businesses, infrastructure, and residences – including adopting floodplain regulations and preparing local **hazard mitigation plans** that address community flood risks.

### *Floodplain Regulations*

Barre Town has adopted regulations that exceed the minimum **National Flood Insurance Program (NFIP**) guidelines. The City of Barre has enacted similar zoning regulations to protect the community from future flood damage and losses. Zoning regulations that both Barre Town and Barre City have adopted include:

**What is the Floodway?**

The floodway is the area immediately adjacent to the channel that must remain open to allow floodwaters to pass.

**What is the 100-year Floodplain?**

The 100-year floodplain is also called the Special Flood Hazard Area, and is the floodplain shown on FEMA maps.

**What is the State River Corridor?**

The River Corridor is the area mapped by the State of Vermont adjacent to rivers and streams that are often at higher risk of erosion and/or flooding.

- All new buildings built within the FEMA 100-year floodplain (outside of the floodway) must have lowest floor elevations (including the basement) constructed at least one foot above the **base flood elevation** (BFE).
- For a building undergoing significant improvements, the lowest floor must be at least one foot above BFE or be floodproofed so that it is water tight to at least one foot above BFE.
- If a new or substantially improved building within the 100-year floodplain has an enclosed area below its lowest floor, this area must be designed to allow for the entry and exit of floodwaters.

Barre City has also enacted regulations that go above the minimum NFIP guidelines for new and substantially improved manufactured homes, storage of hazardous materials in the **special flood hazard area** (SFHA), and the construction of accessory buildings. New FEMA floodplain maps adopted in 2014 puts additional restrictions on existing development close to the Gunners Brook and largely prohibits any new development. Barre City and Barre Town were involved in the assessment and writing of the Stevens Branch River Corridor Management Plan that included recommendations to help maintain or restore the natural condition and function of the river corridors (Friends of the Winooski River, et. al., 2009) and these recommendations were reviewed as part of the VERI project.

### *Local Hazard Mitigation Plans*

Barre Town and Barre City wrote local hazard mitigation plans in 2012 to identify specific goals for the reduction of community flood risks. The Town increased the size of culverts damaged in the May 2011 flood, which reduced subsequent damages from Tropical Storm Irene. Barre Town outlined goals in its hazard mitigation plan to continue to upgrade undersized culverts and adopt policies to reduce stormwater run-off and minimize the impacts of future floods (Town of Barre, 2012). Barre City has also outlined specific flood **mitigation** goals to improve stormwater management and infrastructure, replace problematic culverts, and adopt road and bridge standards and floodproof buildings on Main Street (City of Barre, 2012).

### *Vermont- Downtown Action Teams (V-DAT)*

With funding from a Community Development Block Grant for Disaster Recovery (CDBG-DR), the DHCD hired a team of experts in community design and economic development and partnered with eight communities, including Barre City, to help speed recovery from Tropical Storm Irene. The Vermont-Downtown Action Teams (V-DAT) team visited Barre on a number of occasions to gather input, develop projects and build consensus on the recommendations. The final reports included short, mid and long-term recommendations to support local economic development efforts. Barre's complete report and supporting documents are available on DHCD's website (http://accd.vermont.gov/strong_communities/opportunities/revitalization/vdat). A one-page visual summary of the top recommendations is included in Appendix E. Several of the V-DAT recommendations have been completed in Barre, including:

- Implemented a consistent branding and marketing program including the installation of downtown banners, development of shopping and dining guidebook, and branding of downtown events;
- Upgraded buildings and two storefronts; and
- Broke ground on a multi-million dollar project to improve Enterprise Alley in Barre City.

# Strategies and Projects to Protect Barre

The team developed a list of recommended strategies and projects to protect Barre Town and Barre City's businesses and infrastructure during future floods. Based on data collection and analysis, review of previous reports and community input, the team developed a list of flood mitigation objectives for Gunners Brook to address specific flood damages. These objectives include:

1. Reduce flood risks in the densely developed Barre City;
2. Keep major roadways open during floods; and
3. Protect businesses and residences from flooding and erosion.

Strategy and project recommendations are summarized below, including municipal policy and program suggestions first, followed by site-specific project options.

## Municipal Policy and Program Recommendations

Reducing the impacts of floods involves an ongoing process of evaluating and adjusting policies to minimize risks through protection, prevention and education. Accordingly, the VERI team first reviewed Barre City and Town's Municipal Plan, Hazard Mitigation Plans and land use regulations to identify the policies they contain and those that are absent. The team also reviewed related plans for capital improvements, conservation, emergency and preparedness and continuity of operations. These documents were reviewed with the goal of identifying gaps and opportunities to improve the flood preparedness, safety and resilience of residents, visitors, businesses and local government.

The team then used the US Environmental Protection Agency's (EPA) flood resiliency checklist that was developed from a study in the Mad River Valley in Vermont (US EPA, 2014). This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

The check list review found that Barre City currently employs 10 of 56 items on the checklist including the discussion of strategies to determine whether to relocate structures that have been repeatedly flooded (Appendix F). Barre Town currently employs 17 of 56 items on the checklist including the implementation of non-regulatory strategies to conserve land in river corridors through easements, buyouts, and the transfer of development rights (Appendix F).

The results of both reviews identified 17 planning or policy opportunities in Barre City and 19 in Barre Town that were then organized into four groups: Regulations, Community Planning, Emergency Planning, and Education and Outreach. The distribution of opportunities to improve policy and program is show in Table 2.

| Table 2: Categories of Municipal Policies and Programs | | | |
|---|---|---|---|
| **Category** | **Description/Overview** | **Barre City Policies or Programs** | **Barre Town Policies or Program** |
| Land Use Regulations | Avoid and minimize land use conflicts around watershed resources that help lower the risk of flooding and/or erosion to properties | 5 | 6 |
| Community Planning | Develop long term goals, recommendations and budgets to improve flood resilience | 4 | 5 |
| Emergency Planning | Specific projects for supporting mitigation and recovery actions for flooding and other hazards | 5 | 5 |
| Education and Outreach | Programs targeted at critical businesses and vulnerable populations to educate them about flood risk, mitigation and recovery | 3 | 3 |

The results of the plan and policy reviews were then combined and scored with either a one (ineffective), three (limited) or five (effective) using the following three objectives:

1. Reduces flood risk (proposed project lowers the flood level);
2. Reduces erosion risk (proposed project lessens the vulnerability to erosion); and
3. Protects businesses, infrastructure and property.

The three scores were added to provide a total score. Cost and ease of implementation, political realities and limitations as well as input from the community were also considered. To assist the town with implementation, potential partners and funding sources were identified. Each recommendation was further explained and next steps were identified. This information was compiled into easy-to-read charts found in Appendix G.

The top priority policy and programs recommendations (below) were presented at the community forum and local feedback was incorporated into the final prioritization.

- **Update policies allowing fill in flood hazard areas:** Allowing landowners to protect buildings using fill may help protect an individual property, but it can increase flood hazards to downstream property owners and reduce the land's ability to slow and store the extra flood water. Regulations can require alternate methods to protect buildings including allowing flood waters to occupy the space beneath the structure, which limits impacts to neighboring or downstream properties. Under current city bylaws, onsite filling is allowed.
- **Require repaired and rebuilt structures to be built higher**: Owners rebuilding should raise the lowest floor two to three feet higher than the flood elevation to address the increased rainfall patterns and the actual flood heights from recent floods. Current city bylaws require one foot above flood elevation and should be reviewed and considered for updates.

- **Emphasize watershed-wide stormwater planning to reduce flooding impacts:** As the Barre area and neighboring communities experience growth, collaborative regulation and enhanced stormwater control measures can reduce the flooding experienced in Barre Town and City. All communities in the watershed should develop dialogue and collaborate on ways to limit stormwater run-off from development.

Local stakeholders (residents, businesses, planning commission, Selectboard, etc.) are encouraged to review these recommendations and seek assistance from the identified partners and programs and take these steps to reduce flood risk over time.

## *Emergency Relief Assistance Fund (ERAF)*

In 2014, the State of Vermont established an **Emergency Relief Assistance Fund (ERAF)** to provide matching funding for federal assistance after federally declared disasters. This program allows towns in Vermont to increase the amount of state aid money they could receive as a match to federal aid for post-disaster recovery. Certain damage costs from federally declared disasters are reimbursed 75% by federal money. The State of Vermont contributes an additional 7.5% of the total cost, but will increase that up to 17.5% if towns adopt certain plans, policies, and programs to reduce the risk of floods (State of Vermont, 2015). Currently, Barre Town and Barre City qualify for 12.5% and 7.5% in state aid, respectively and Table 3 summarizes the ERAF ratings.

**Table 3: How Barre Town and City Met its ERAF Match**

| Town | Barre Town | Barre City |
|---|---|---|
| **Steps to increase State aid to 12.5%** | | |
| Participation in the National Flood Insurance Program | Yes | Yes |
| Adoption of 2013 State Road & Bridge Standards | Yes | No |
| Adoption of Local Emergency Operations Plan | Yes | Yes |
| Adoption of Local Hazard Mitigation Plan | Yes | Yes |
| **Steps to increase State aid to 17.5% (need one to qualify)** | | |
| Adopt no new development in a River Corridor | No | No |
| Adoption of a River Corridor or Flood Hazard Protection areas and Participation in the Federal **Community Rating System** Program | No | No |
| **ERAF Match** | **12.5%** | **7.5%** |

In order to maximize state and federal funding after a federally declared disaster, Barre City and Town should review Table 3 and consider implementing those steps not currently in place in the municipality. CVRPC, the Vermont Division of Emergency Management and Homeland Security (DEMHS) and VTrans can help with these suggested updates.

## Specific Project Recommendations

The team identified a number of projects to protect businesses and infrastructure within the study area based on the objectives above, field data collection, review of flood history and stakeholder input. The specific projects identified are presented in the maps and tables located in Appendix H. High priority projects are described below, and conceptual designs for some are presented in the following section.

The projects fall into the four primary categories shown in Table 4.

**Table 4: Categories of Flood Resiliency Projects**

| Category | Description | Number of Projects |
|---|---|---|
| Building and Site Improvements | Improvements to buildings and/or surroundings including relocating heating and electrical systems out of basements and improving onsite drainage | 2 |
| Channel and Floodplain Management | Improvements to river and floodplain function, which may include physical measures such planting trees to stabilize river bank and non-structural measures such as Town or City regulations or policies. | 6 |
| Infrastructure Improvements | Upgrades of roads, stream crossings, and utilities to more flood resilient design standards | 10 |
| Public Safety Improvements | Avoidance of future risk including the purchase of buildings at high risk to future floods | 4 |

The priority of each project was based on the project's effectiveness in addressing each of the following three objectives:

1. Reduces flood risk (proposed project lowers the flood level);
2. Reduces erosion risk (proposed project lessens the vulnerability to erosion); and
3. Protects businesses, infrastructure and property.

Each project received a score of one (ineffective), three (limited), or five (effective) for the each objective. The three scores were added to provide a total score, which was then weighted based on the economic benefits of the project. Projects that would have regional or Town-wide or City-wide economic benefits were weighted higher than those that would offer more limited economic benefit (e.g., benefits a single business).

Project partners and stakeholders, including representatives from DHCD, ANR, CVRPC, and the City and Town of Barre, provided feedback on a draft list of mitigation strategies and their priorities in November, 2014. The feedback was incorporated into the final prioritization of projects. Below are brief descriptions of the high priority projects from each of the project categories described in Table 4. A summary of efforts to develop conceptual designs for two of the high priority projects follows, with additional supporting information provided in Appendices I and J.

### *Building and Site Improvements*

**Floodproof Buildings from the Upper Brook Street Bridge to Stevens Branch:** There are approximately 115 commercial and residential buildings located within the 100-year floodplain of Gunners Brook, and many are at-risk of damage due to flooding ranging from water in the basement, to flooding of first floor living space, to building damage and collapse due to flowing water. While selection of a specific floodproofing strategy is building specific, several are widely applicable in the Gunners Brook floodplain:

- **Elevate buildings:** For buildings prone to first floor flooding, raising the structure (by temporarily jacking it up and replacing it on top of an elevated foundation) can reduce flood damages. Utilities such as furnaces and electrical panels are also relocated to a higher floor, above the flood elevation, as part of the project.
- **Fill in Basements**: Filling basements with clean fill material, along with the relocation of utilities to higher floors above the flood elevation, can also reduce damages and save money.
- **Dry floodproofing:** When elevation is not possible or feasible walls can be made watertight. Openings are in-filled and the walls and floors covered with waterproof materials. Typically the foundation and walls must be strengthened to withstand pressure and energy of the water on the building. This approach likely has limited applicability due to the age and construction methods of many buildings in the floodplain. However, it may be suitable for heavy masonry buildings constructed of block, brick or reinforced concrete.
- **Wet floodproofing:** This option is used in situations where elevation and dry floodproofing are not viable. Floodwaters are allowed into the building with combination of flood vents/openings. Durable building materials that can withstand water, mud, and other pollutants are installed and cleaned up after the flood. This, along with the relocation of furnaces and electrical panels out of harm's way, can reduce losses and recovery costs.
- **Retrofitting flood vents in outbuildings:** Particularly in buildings with limited use, installing flood vents that allow water to readily enter and exit the structure can significantly reduce flood damages.

The cost of floodproofing varies widely depending on the specific approach selected. Addition of flood vents on outbuildings could be completed for less than $1,000, while raising a structure and utilities is considerably more expensive.

These approaches are among the requirements of the City's flood hazard area regulations for new construction or when a building is "substantially" improved or repaired, meaning the improvement or repair cost is 50% or more of the value of the building. While not required for less than "substantial" improvement or repair, the FEMA Hazard Mitigation Grant Program (HMGP) can help offset these initial costs and reduced future flood insurance premiums.

## *Channel and Floodplain Management*

**Barre City – Develop a Flood Resilient Design Standard for Channel Walls:** Nearly the entire length of Gunners Brook in Barre City is walled. Developing a plan to build a wider channel with at least one bank slope where debris can collect would help reduce flooding and property damages for more than 10 businesses with 40 employees and for more than 30 multi-family buildings. It would require property owners to give up some land to the brook, but incremental progress toward a larger, safer channel would reduce flood risk over time and may even qualify for grant funding. The new channel design would be developed in coordination with property owners, the City, ANR river engineers and federal regulators. The cost of the design would range from $10,000 to $50,000 depending on the degree of analysis and detail. Implementation of the upgrade could happen over many years at a cost of greater than $200,000. The FEMA Hazard Mitigation Program is a potential source of funding. A conceptual design is presented in the next section of the report.

**Barre City – Remove the Now-Closed Harrington Avenue Bridge:** The Harrington Avenue Bridge span is narrow, catches debris and has contributed to four floods since 1998. Each flood impacted businesses, municipal infrastructure, and residences, and each required public and private funds to recover. The bridge was heavily damaged in the May 2011 flood and is now closed to traffic. Removing the bridge deck could reduce the risk of debris collection and associated flooding; however, a more comprehensive project to consider includes removal of some of the channel walls and restoring a floodplain on the left bank (looking downstream). This would both lower flood levels and provide a location for woody debris to collect before reaching the next downstream bridge. The latter approach is more costly and may require easements. This project would help keep roads open and reduce flood risk for more than 10 businesses with 40 employees and more than 30 multi-family buildings. The cost of the project is expected to range from $50,000 to $100,000. FEMA Hazard Mitigation Grant Program is a potential source of funding.

**Barre Town and City – Develop and Implement a Debris Management Plan:** The flooding on Gunners Brook is often the result of woody debris collecting at bridges and other choke points. Numerous upstream landslides have created a large supply of wood that will continue to increase flood risk to Barre City. Developing a state-approved Management Plan that provides specific direction to public works staff would allow more efficient and active reduction of this risk. Improved management of debris would reduce flood risks for the 20 businesses with 188 employees and the 65 multi-family buildings in the Gunners Brook floodplain in Barre City. Developing this plan would cost $10,000 to $50,000. The FEMA Hazard Mitigation Program is a potential source of funding.

## *Infrastructure Improvements*

**Barre Town – Plainfield Brook Road**

Plainfield Brook Road is the primary north-south route for Barre Town (and beyond) and Barre City. The suggested projects below will help keep Plainfield Brook Road open during a flood and thereby maintain the flow of goods and people between Barre City and Barre Town.

**Barre Town – Replace Undersized Culvert:** The existing corrugated metal culvert is undersized (approximately 40% of channel width) and is prone to blockage that has required maintenance during past floods and could cause the Plainfield Brook Road to wash out. The cost to increase the size of this culvert would range from $100,000 to $200,000. VTrans Structures Grant is a potential source of funding.

**Barre Town – Monitor Embankment below Ketchum Brook:** Because the road parallels the stream for a significant distance, there is an elevated risk of embankment failure and road damage. While bedrock on the channel bottom helps stabilize the embankment, its long-term stability is uncertain. Procedures should be adopted to visually inspect the embankment following significant storm events. Monitoring and proactive repairs can ensure the road remains open during a flood and avoids more costly repairs.

**Barre City – Replace Undersized Bridge on Upper Brook Street:** The Bridge was constructed in 1927. The opening is undersized and contributes to flooding on Farwell Street and adjacent buildings as well as many downstream locations in the path of floodwaters before they return to the channel. If replaced it will reduce flood risk for more than 10 businesses with 40 employees and more than 30 multi-family buildings. The cost to replace this bridge is greater than $200,000. A VTrans Structures Grants and FEMA Hazard Mitigation Grant Program are potential funding sources.

## *Public Safety Improvements*

**Barre City – Feasibility Study to Consider Property Buyouts of High-Risk Buildings Located between the Upper Brook Street Bridge and Main Street:** Working with property owners, the City should initiate a project to analyze the cost and benefits of developing a program to purchase these buildings over time. Purchasing the buildings would help reduce threats to families and business along this area. Restoring floodplain along this area would help reduce downstream flooding and allow public access to the brook. The cost of the buyouts would be greater than $1,000,000 and would include the purchase of the properties, demolition of the buildings, reshaping of the floodplain, creating public open space and the associated legal and administrative fees. The FEMA Hazard Mitigation Grant Program is potential source of funding. A conceptual design is included in the next section of the report.

# Conceptual Project Designs to Protect Barre

Using community input and the team's professional judgment of priority flood mitigation projects, two projects were selected to advance to the conceptual design stage. These projects include developing a flood resilient channel wall design standard and the relocation of the most at-risk buildings between upper Brook Street Bridge and Main Street. The conceptual designs require additional design and engineering work to advance toward implementation. Should the community wish to advance the projects, the designs include sufficient detail to include as part of grant applications.

## Develop Flood Resilient Channel Wall Design Standard

### *Overview and Objectives*

Nearly the entire length of Gunners Brook in Barre City has been walled for many years and currently are failing in many locations (Figure 13). The walls belong to the adjacent landowner, and unless the walls are integral to a bridge or other infrastructure, the City does not take responsibility for maintaining them. Collapse of the walls into the channel leads to unpredictable erosion and loss of land that may threaten adjacent buildings. In extreme cases, the presence of fallen wall rocks in the channel may reduce flood capacity, as well as lead to collection of woody debris.

**Figure 13:** Failing walls typical in Barre City

Landowners interested in reconstructing their walls must receive a state stream alteration permit from the Agency of Natural Resources and are generally permitted to reconstruct walls provided they are built no closer to the channel and no higher than the original walls. The owners are responsible for designing and permitting any wall repair and must cover the full cost of design and construction of the repairs. Currently no public funds are available to help cover these costs.

The "Flood Resilient Wall Design Standard" would create a wider channel with at least one bank slope where debris can collect and help reduce property damages and culvert failures. It would require property owners to give up some land to the brook, but incremental progress toward a larger, safer channel would reduce flood risk over time and may qualify for grant funding. The new channel design would be developed in coordination property owners, the City, ANR river engineers and federal regulators.

## *Data Analysis and Results*

Components of a successful flood resilient wall design standard would include:

- Increased size to provide more flow capacity than was provided with the original walls. This would be accomplished by specifying minimum channel bottom and top widths that are at least as wide as the original walls and wider if possible.
- Designed to provide opportunities for trees and floating debris to collect on the channel margins to reduce the potential for debris clogging within the channel and at bridge openings. This would mean creating a floodplain on at least one bank, which may in many cases require owners return some land to the brook to reduce their flood risks. The floodplain would be vegetated.
- Designed to provide effective transport of sediment so that there is neither excessive scour nor deposition in the channel, and it remains stable in the long-term. Based on field observations of both relatively stable and unstable portions of the channel, a channel bottom width of approximately 20 feet and a vegetated sloping bank on at least one side appears to provide the desired channel stability.

A schematic of an initial design concept for the flood resilient walls is shown in Figure 14. Additional detail is included in Appendix J.

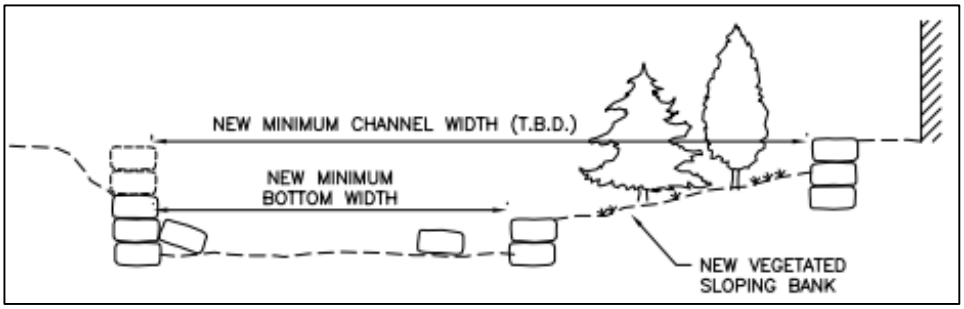


**Figure 14:** Drawing of flood resilient channel concept

The team conducted a hydraulic analysis of the brook using the computer program on which the FEMA Flood Insurance Study is based to evaluate the hydraulic benefits of larger channel dimensions. In general, the degree of channel enlargement possible given the presence of existing buildings and infrastructure will only provide a modest reduction in flood levels.

The more significant benefit of the conceptual design is the potential for debris collection on the restored floodplain. The flood history of Gunners Brook indicates that flooding frequently occurs because of the debris that catches at the bridges. Without debris, the channel could otherwise pass the flood flows; however, the vertical walls lining the existing channel provides no opportunity for the debris to deposit, and it is instead transported downstream where it can jam at the bridges. Even a small area of restored floodplain as part of a new wall design standard would help reduced velocity and provide an opportunity for debris to settle out for easy removal after the flood. That in turn

reduces flooding at bridges and other known choke points that impacts businesses, City roads, and homes.

### *Steps for Project Implementation*

The City should pursue the design and regulatory approval of a flood resilient channel design. Development of the standard would include all or most of the following:

- Inventory and mapping of existing walls.
- Hydraulic and geomorphic justification for standard wall design(s).
- Engineering drawings for standard design (two to three variations to be applied depending on the specific location and space constraints).
- City-wide plan showing preferred locations for design variations.
- Coordination with regulators and regulatory approval.
- Pursuit of grant funding for implementation.

The cost of developing an approved design standard is expected to range from $10,000 to $50,000 depending on the degree of analysis and level of detail included in the plan and the level of effort invested in pursuing grant funding for implementation. Implementation of the plan would likely be done over the course of many years at a cost of greater than $200,000.

### *Project Benefits*

Implementation of a flood resilient channel design would reduce flood risk and flood damages throughout the Gunners Brook floodplain, including the 20 businesses with 188 employees and the 65 multi-family buildings. It would also reduce flooding of City streets and the associated repair and cleanup costs.

## Purchase the Most At-risk Buildings between Upper Brook Street Bridge and Main Street

### *Project Overview and Objectives*

Purchasing and removing the most at-risk buildings would prevent repeated damages and allow the floodplain to be restored to promote deposition of woody debris in the floodplain instead of at bridge openings. A buyout program for these properties has the obvious effect of eliminating potential for future damages, but would also provide space that could be used to restore a channel and natural floodplain that reduces the frequency of out-of-bank flooding and provides locations other than bridges for debris to collect. The restored floodplain could conceivably also serve as a park.

It is worth noting that many of the buildings that would be candidates for buyouts are located within the 2014 update of the mapped FEMA Floodway. This floodway designation brings new restrictions

on repairs and improvements to the buildings, markedly higher flood insurance premiums and a likelihood of reduced marketability due in part to those higher premiums.

Buyouts are frequently funded by FEMA Hazard Mitigation Grant Program. General elements of the buyout program include:

- A municipality applies for the funding.
- Buyouts are voluntary.
- The community sponsors a buyout project on behalf of the property owner.
- 75 % of the buyout project is funded by FEMA.
- Buyout property must remain as open space.
- Communities can offer the property owner up to the fair market value of the structure pre-disaster.

## *Data Analysis and Results*

Potential buyouts in the Gunners Brook study area have been identified in three adjacent zones between upper Brook Street Bridge and Main Street, as described below and shown in Figure 15. A larger scale map of the potential buyout areas is included in Appendix K.

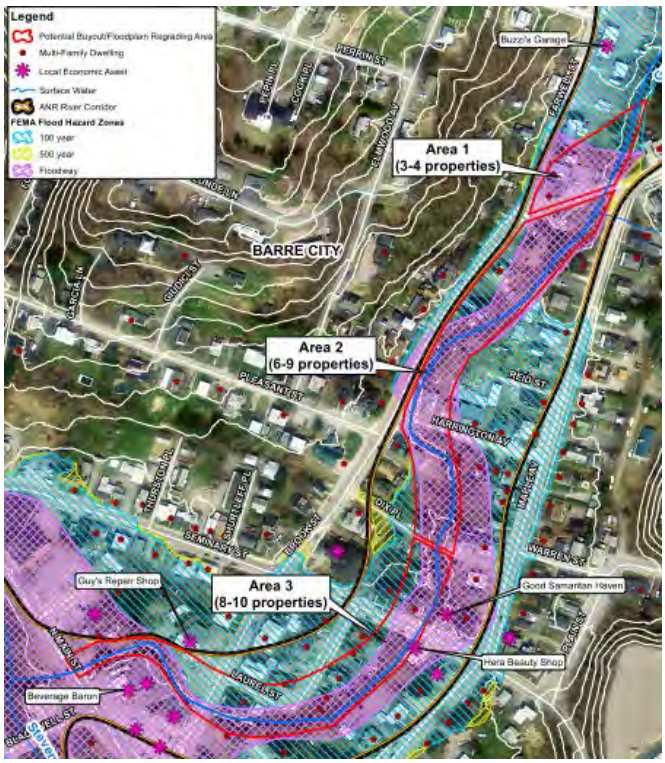


**Figure 15:** Three areas outlined in red identified for possible property buyouts

### Area 1: Three to four at-risk buildings on right bank above upper Brook Street Bridge

Purchasing and removing buildings in this upstream zone would provide an important location for debris collection upstream of the major areas of development. It would also allow portions of Brook Street to be raised to keep floodwaters off it, which cannot currently be done without negatively impacting the existing buildings.

### Area 2: Six to nine of the most at-risk buildings between upper Brook Street Bridge and Dix Place

In this zone, the buildings on the right bank (looking downstream) are generally subject to the greatest flood depths and speeds. Purchasing and removing them would allow restoration of the floodplain to promote deposition of woody debris in this zone instead of at bridge openings. It would also help reduce the amount of flood waters flowing down Brook Street.

**Area 3: Eight to ten of the most at-risk buildings between Dix Place and Main Street**

Properties in this downstream zone are subject to flooding from both Gunners Brook and from Stevens Branch. In combination with buyouts in the two upstream zones, floodplain restoration in this area would help create a largely unobstructed floodway throughout the City.

## *Steps to Project Implementation*

The team recommends that the City further study the feasibility of property buyouts. The study would include identification of specific buildings and an evaluation of the pros and cons including direct and indirect flood damage reductions, impact on housing stock, cost, and funding sources. Robust public participation, meetings with individual property owners and smaller neighborhood meetings are a critical part of the evaluation because these buyouts represent peoples' lives, history, family memories and neighborhood cohesion.

## *Project Benefits*

This project would eliminate the risk of flood damage to the removed buildings, which are likely to include at least one business and on the order of 10 single and multifamily buildings. The project would reduce the flood risk for the remaining properties in the floodplain, which include nearly 20 businesses with 188 employees and approximately 55 multi-family buildings.

# Next Steps

On April 16, 2015 the team hosted the second community forum to share the list of policy and project recommendations to decrease flood risk for Barre Town and Barre City. At the forum, community members asked questions, provided input and helped rank the proposed list of priority recommendations (see Appendix L).

The projects with the most support included replacing the undersized bridge on Upper Brook Street, considering voluntary buy-outs for the most at-risk buildings between Upper Brook Street and Dix Place and removing the Harrington Avenue Bridge. Top polices included the development of a debris management plan, updated polices regarding filling land in the floodplain and creating watershed-wide stormwater management plans.

The tables included in Appendix G and I provide a comprehensive list of high priority projects for Barre Town and City to further discuss, explore and advance as resources permit. The conceptual designs summarized in the section above and in Appendices J and K are intended to provide examples for how to advance high priority projects to the next level and acquire funding for final design and implementation. As part of the ongoing community discussion regarding the VERI effort, we recommend the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization;

On the evening of July 19, 2015, as much as six inches of rain fell on parts of central Vermont causing serious flash flooding and damage to 80 homes and apartments along Gunners Brook. While touring the damage in the Harrington Avenue neighborhood, Governor Shumlin and Barre's Mayor Thom Lauzon noted VERI's recommendations to reduce flood impacts with a long-term strategy to buyout homes and restore floodplains along the brook. The Governor said, "Implementing the recommendations could give water, mud and debris more space to spill, reducing the impacts on homes and businesses." He also noted that this areas was affected by similar flooding in 2011 and that carrying out these changes would help break the cycle of repetitive loss. The Vermont Division of Emergency Management and Homeland Security collected damage information from communities impacted and determined there was not enough damage to qualify for federal disaster aid. While Vermont businesses and homeowners have access to state flood assistance programs, there was no program to help repair flood damaged rental properties. Mayor Lauzon noted that "Many of these properties will require significant repairs and clean-up in order to put them back to pre-flood condition." For this reason, the Mayor worked closely with the Governor and the Vermont Economic Development Authority (VEDA) to create a new loan program to fill this gap, help the neighborhood recover and provide the community the time it needs to develop a long-term solution.

- Prioritize one to two projects to pursue each year with assistance from the Vermont Department of Environmental Conservation (DEC) and CVRPC staff to identify appropriate funding sources and partners;
- Apply for one to two grants each year to advance project development and/or designs.
- Implement projects as funding allows; and
- Monitor project success.

The City and Town of Barre, its businesses and homeowners are not alone in implementing the recommendations outlined in this report. For example, the CVRPC can help gather and review sample bylaws, capital plans and hazard mitigation plans and help draft town specific language for review and local adoption. DHCD's Municipal Planning Grants http://accd.vermont.gov/strong_communities/opportunities/funding/overview/municipal_planning_grants , the Vermont Rivers Program http://www.anr.state.vt.us/dec/waterq/rivers.htm and www.floodready.vermont.gov can help support these efforts. The State's Hazard Mitigation Grant Program http://vem.vermont.gov/mitigation can help implement projects within Barre Town and City's Hazard Mitigation Plan. The Vermont Small Business Development Center http://www.vtsbdc.org/ has offered extensive disaster assistance to businesses as well as compiling a great guide for owners to navigate these programs. Several federal and state programs can assist in funding the recommendations outlined in the report. Working together we can reduce the risk and financial burden of future flooding events.

## Education and Outreach

Vermont has a long tradition of managing its rivers to limit or prevent flood damage including armoring riverbanks with rocks, moving or straightening river channels and building dams and berms. Despite these efforts, flooding is the most common natural disaster in Vermont (ANR). Tropical Storm Irene showed Vermonters that rivers and streams are powerful and tend to make their own way during a flood. Because we cannot reliably control flooding, educating citizens, business and property owners about rivers and potential flood risks within their communities is critical.

> *"We all have short memories when it comes to flooding. It's just human nature to think it couldn't happen here again anytime soon."*
>
> Chris Campany, Executive Director
> Windham Regional Commission

Ongoing community education and outreach is an important part of any effort to promote flood safety and to protect local business and economies. Ultimately, the better informed everyone in the community is about the behavior of local rivers and streams, the more likely it is that they will make sound decisions.

**Make Information Readily Available:** Easy access to river and floodplain information is an essential way to help citizens and businesses incorporate flood risks into decisions they make. Most communities offer printed information at the town office or library as well as on town webpages.

**Common Handouts or Webpage Information Includes:**

- Maps of the local flood hazard areas and the permitting requirements in the floodplain.
- Information about flood insurance and floodproofing buildings.
- Information about how rivers, streams and watersheds work.
- Benefits of green infrastructure and conservation of existing floodplain.

**Actively Engage:** Many communities work to increase the understanding of rivers and risks via email or by posting information on their local Front Porch Forum. Communities often include flood maps and permitting information in their town meeting reports and other municipal mailings like sewer and water bills. Others promote awareness of flood history and risk by placing high water lines on prominent buildings in the community.

However, education and outreach efforts should not be the sole responsibility of local governments, and community groups like chambers of commerce, downtown business associations, neighborhood groups, and watershed organizations are encouraged to partner with state, regional and local groups to offer local workshops and education sessions.

**Potential Workshop Topics, Partners or Presenters:**

- Flood Insurance and What You Need to Know (Department of Finance Regulation, Division of Emergency Management and Homeland Security, Vermont League of Cities and Towns )
- Developing a Continuity of Operations Plan (Small Business Development Centers, Regional Planning Commissions, Regional Development Corporations )
- Resilient Road Designs to Reduce Recurring Damage and Improve Water Quality (Agency of Natural Resources, Agency of Transportation)
- Planning for Resilience (Regional Planning Commissions)
- Flood Risk, Preparedness and Safety (Division of Emergency Management and Homeland Security, Regional Planning Commissions)
- Extreme Weather and Climate Change (Agency of Natural Resources, Vermont Natural Recourses Council )
- How Rivers, Streams and Watersheds Work (Agency of Natural Resources, Vermont Natural Resources Council, Vermont Land Trust )
- Low Cost Techniques to Reduce Flooding and Improve Water Quality (Agency of Natural Resources, Vermont Natural Resources Council, Regional Planning Commissions, Vermont League of Cities and Towns)

**Invest in Staff Training and Certification:** In many of Vermont's cities and towns, floodplain management is just one of many responsibilities of the local planning office or zoning administrator. Yet, administration of a floodplain ordinance is quite complex and the consequences of limited staff time and understanding of the regulations can easily allow inappropriate development in dangerous

areas. The consequences of granting improper variances and not enforcing against violations may preclude the community from participating in the federal flood insurance program. Therefore, local government officials are strongly encouraged to support staff training and certification in floodplain management.

## What Can Individuals Do to Reduce their Risks?

Most of us remember to annually change the batteries in our smoke alarms to reduce the risk of fire, but few of us prepare for floods or disasters. Since 2000, Vermont has had more than one federally-declared disaster per year and floods have occurred nearly everywhere in the state (ANR). Buildings located in a 100-year floodplain have 1% chance of being flooded every year. Over a 30 year period (length of most home mortgages), there is a 26% chance of a 100-year flood.

The good news is that there are many steps that individuals can take to reduce the risks, loss, disruption and costs associated with flooding. Understanding what the risks of flooding are for your home and family will help you:

- Make sure that you have the right amount of insurance coverage.
- Protect your home and take steps to limit potential damage.
- Prepare plans detailing how your family will respond if flooding looks likely.
- Practice so family members know what actions to take in the event of a flood or upon receiving a flood warning.

### *Steps to Reduce Risks*

- **Identify Flood Risk.** The first step is to identify your risk so you can plan appropriately. Floodplain maps are available at most town offices or click this link http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your home or apartment is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** Homeowners' or renters' insurance helps pay to repair or rebuild your home and replace personal property due to a covered loss, however it does not cover any damages caused by floods or your rent and living expenses while your home is rebuilt. All insurance policies have overall policy limits and specific limits for different types of coverage. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Fill Gaps in Your Insurance Coverage.** If your home is underinsured at the time of a loss, there is frequently a penalty or reduction in the amount the insurance company will pay for the loss. Property insurance also does not cover flood damages or your expenses if you cannot live in your home due to flood damages. All homeowners who live in flood-prone

areas should carry flood insurance. Flood insurance is available for your home and personal property and can be obtained from your local agent.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

- **Plan Ahead.** Draft an emergency response and communications plan (family phone numbers) for your home and family. Use the process as an opportunity to bring family members together to discuss the roles needed during an emergency and how best to assign responsibilities. Make sure you have a designated place to meet other family members in the event of an emergency. Also, don't forget to plan for individuals with special needs like prescription medication and for your pets as many public shelters or hotels do not allow animals.
    - Pack an emergency kit and make sure family members know where it is located.
    - Keep copies of your insurance policy, computer data and other important documents like tax returns and financial information safe from flooding on upper floors or stored offsite.
    - Document your home and possessions with photos or video to help simplify the insurance claims process. Generally, the more detailed documentation (receipts, serial numbers, etc.) you can supply during the claims process, the fewer problems you will experience.

- **Train and Practice.** Many of us participate in fire drills at work or school, but few of us practice at home for disasters. Training and practicing your emergency response and communications plan will help assure the plan is workable and family members understand their roles and responsibilities.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. If you know a storm is headed your way, fill up your gas tank in case you must evacuate. (If the power is out, it is not always easy to find an operating gas station.) If you must evacuate, try to contact your employer and let them know your plans. Having a plan and a few extra minutes to evacuate can make a difference.

FEMA http://www.ready.gov/make-a-plan and the Vermont Division of Emergency Management and Homeland Security http://vem.vermont.gov/preparedness/hazards/floods both provide more detailed information on how to prepare and protect your home and family from disasters and floods.

## What Can Businesses Do to Reduce their Risks?

According to FEMA, nearly 40% of businesses do not reopen after a disaster and data from the US Small Business Administration indicates that over 90% of businesses fail within two years after being struck by a disaster.

It can take years to repair the damage to the building, furnishings, equipment and inventory. Disasters can also require businesses to relocate or cease operation temporarily, which may lead to canceled contracts and customers going elsewhere for goods or services. Even if the event does not impact the business directly, severe weather from snow or rain or even extended power outages can strand employees at home and complicate deliveries.

Identifying your risk can significantly reduce potential damages and business recovery costs. Understanding what the risks of flooding are for your business will help you:

- Make sure that you have the right insurance coverage for business interruption.
- Plan ahead and take steps like developing a continuity of operations plan to limit potential damage.
- Train employees so they know what actions to take in the event of a disaster or after receiving a flood warning.

### *Steps to Reduce Risks*

- **Identify Flood Risk.** Since 2000, Vermont has had more than one federally-declared disaster per year and floods have occurred nearly everywhere in the state (ANR). Identifying your risk is a good place to start. Floodplain maps are available at most town offices or click here http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your business is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** Many types of disasters are not covered under normal insurance policies and funding or loans from government agencies is often too little and too late. All insurance policies have overall policy limits and specific limits for different types of coverage and any business located in a flood-prone area should carry flood insurance. Also check to make sure your insurance includes business interruption coverage and that it reimburses other unexpected costs (like service interruptions from lost power or Internet access, law suits and unemployment compensation claims filed by employees). Business interruption insurance compensates a business for lost income, expenses and profits if a disaster, such as a flood, closes your doors. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

- **Plan Ahead.** There are also a number of low-cost steps you can take to reduce the impacts of a flood. At a minimum, regularly back up computer data and store important tax and financial records and information such as your insurance policy details in a flood safe place. Documenting your building, furnishings, equipment and inventory with photos or video can speed the insurance claims process.

  All businesses should have a continuity of operations plan. A continuity of operations plan is a written document that outlines how your business will respond and recover from a flood or other disaster. At a minimum, your plan should include:

  - A list of important contacts including your insurance company, key customers and vendors and evacuation contacts for staff.
  - A map showing locations of important equipment to relocate (computers and servers) and where to shut off electricity, gas and other services.
  - Procedures to protect your property and minimize business disruption – e.g. remote back up of computer files, a plan to relocate inventory or livestock.
  - A back up location to conduct business while the building is being repaired.

  Having a continuity of operations plan will help you identify and assign essential tasks that will help minimize the damage caused by flooding. Training and practice will help assure the plan is workable and employees are properly trained.

  The Vermont Small Business Development Center http://www.vtsbdc.org and many of Vermont's Regional Development Corporations http://accd.vermont.gov/business/partners/rdc and Regional Planning Commissions http://www.vapda.org can also provide training and one-on-one assistance to help your business develop a continuity of operations plan.

  CERF+ (Craft Emergency Relief Fund + Artists' Emergency Resources) offers tailored disaster guidance and recourses for artists (http://studioprotector.org/OnlineGuide/DisasterPlanning/DisasterSpecificPlanningResources.aspx ).

- **Train and Practice.** Employees need to understand flood warnings and what to do when they get one. This includes understanding the dangers of flooding and how to evacuate the building safely. Train all staff on procedures to shut down the business and how to deploy loss reduction measures like relocating equipment and inventory to upper floors and deploying door and window dams reduce flooding. Finally, remember that flooding can also

affect employees' ability to work, as their priority may be to protect their home and family first.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. Having a continuity of operations plan and a few extra minutes to evacuate can save lives and your business.

The US Small Business Administration https://www.sba.gov/content/disaster-preparedness offers more detailed information on how to prepare and protect your employees and business and from disasters and floods.

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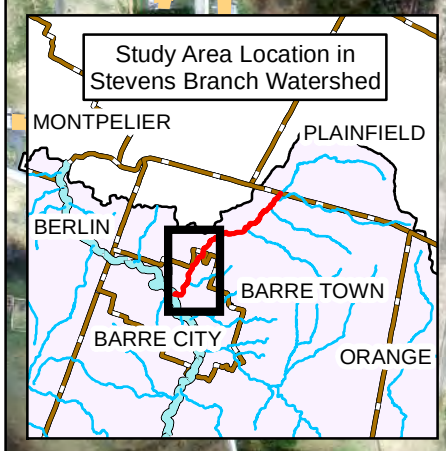
# Appendix A:
# Map of Gunners Brook Floodplain Development

# Gunners Brook Floodplain Development
## Barre, Vermont - Map 1 of 1
## Vermont Economic Resiliency Initiative

VERMONT
AGENCY OF COMMERCE AND COMMUNITY DEVELOPMENT




Le Page Gravel Pit
BARRE TOWN
Ricker Holdings LLC
Trio Motor Transfer INC
FARWELL ST
BECKLEY HILL RD
GREEN ST
TURTLE ROCK DR
EMONTPELIER RD
BROMUR ST
CABOT ST
HILLSIDE AV
AVON ST
BECKLEY ST
OLLIVER ST
COLBY ST
PERRIN ST
BEECH ST
PINE ST
NEWTON ST
SCHOOL ST
Buzzi's Garage
Hope Cemetery
Gunners Brook
Wildersburg Antiques
UNION ST
ANDERSEN AV
FORTNEY PL
LUNDE LN
ELMWOOD AV
GARCIA LN
PLEASANT ST
MAPLE AV
HARRINGTON AV
JARVIS ST
MILNE ST
BANK ST
LONG ST
BARRE CITY
SEMINARY ST
DIX PL
Good Samaritan Haven
CLEARY ST
QUINLAN DR
MAPLEWOOD AV
O'SOLA PL
LAUREL ST
WARREN ST
BROOK ST
CORTI ST
Beverage Baron
City of Barre Alumni Hall & Auditorium
SUMMER ST
BUGBEE AV
COTTAGE ST
MERCHANT ST
BURNS ST
SHERIDAN ST
BEACON ST
FRANKLIN ST
Downstream Extent of VERI Study Area
Stevens Branch
CENTER ST
HOWARD ST
GEORGE ST
PIKE ST
RIVER ST
N MAIN ST
CAMPBELL PL
WEST ST
WELLINGTON ST
TREMONT ST
GABLE PL
GRANITE ST
ENTERPRISE ALY
BUZZELL PL
PEARL ST

**VERI Study Area Floodplain Development Summary**
**Percent of Floodplain Developed: 83% (43.3 Acres)**
**Percent of Floodplain Undeveloped: 17% (9 Acres)**

### Legend
- Local Economic Asset
- Surface Water
- Building Footprint
- ANR River Corridor
- Developed Floodplain
- Undeveloped Floodplain
- Town Boundary

N

0 250 500 1,000 Feet

1 inch = 500 feet

Bear Creek Environmental

Floodplain development was determined based on an analysis of aerial imagery. Development includes the following: buildings, parking lots, paved roads, gravel roads, driveways, and railroads. Floodplain, in this analysis, is defined as the FEMA 100 Year Flood Hazard Zone.

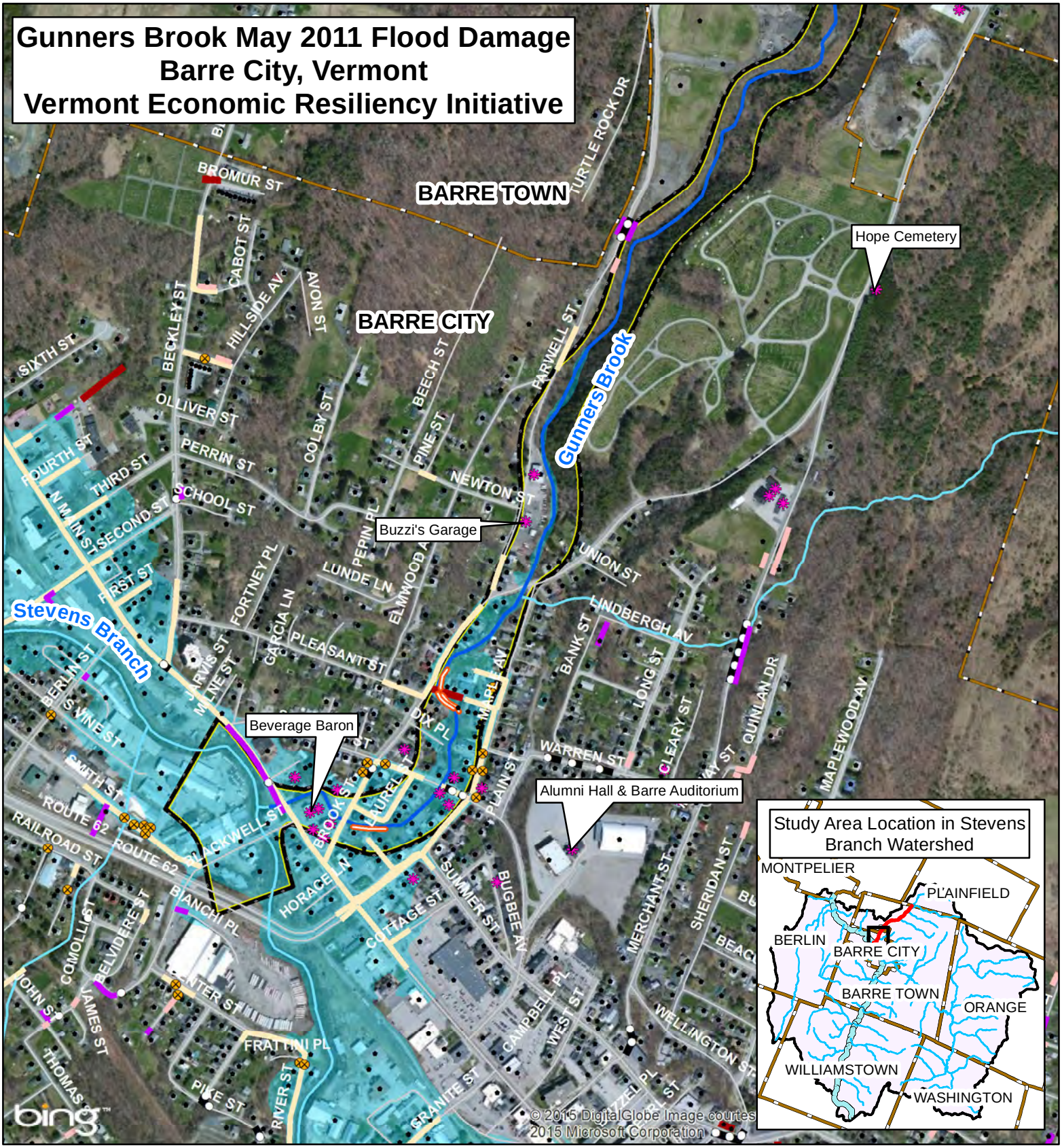
Background Imagery from VCGI. Map Composed on January 7, 2015.

# Appendix B:
# City and Town of Barre and Gunners Brook Data Sources

| Resource | Reference |
|---|---|
| Flood Damage Information | CVRPC |
| Town of Barre Local Hazard Mitigation Plan | Town of Barre and CVRPC (2012) |
| City of Barre Local Hazard Mitigation Plan | City of Barre and CVRPC (2012) |
| FEMA Flood Insurance Study | FEMA (2014) |
| State River Corridor | Vermont Agency of Natural Resources |
| Business Assets | CVRPC |

# Appendix C:
# Maps of May 2011 Flood Damage near Gunners Brook

# Gunners Brook May 2011 Flood Damage
# Barre City, Vermont
# Vermont Economic Resiliency Initiative







## Legend

**Flood Damage 2011**

- Sand and Debris on Site
- Minor Washouts on side of Streets
- Major Washouts on side of Streets
- Pavement Missing/Pothole
- Critical/Urgent Repair
- Stream Wall Failure
- Damage to Stormwater Catch Basin
- May 2011 Approximate Flood Extent
- Local Economic Asset
- Building
- VERI Study Area
- Surface Water
- ANR River Corridor
- Roads
- Town Boundary

Background is Bing Imagery. Damage and flood extent information from Central Vermont Regional Planning Commission.



0 1,000 2,000 Feet

N

Bear Creek Environmental

# Appendix D:
# Table of Businesses in Flood Hazard Zones

Businesses in Flood Hazard Zones along Gunners Brook
Barre City, Vermont
Vermont Economic Resiliency Initiative (VERI)
March 13, 2015



| Businesses Name | E911 Business Address | Number of Employees | FEMA Floodway | FEMA 100-Year Flood Hazard Zone | FEMA 500-Year Flood Hazard Zone | ANR River Corridor | May 2011 Flood Inundation Area |
|---|---|---|---|---|---|---|---|
| Ayers Auto | 32 Maple Avenue | 3 | X | X | X | X | X |
| Beverage Baron | 411 North Main Street | 24 | X | X | X | X | X |
| Brook Street School | 45 Brook Street | 6 | | X | X | X | |
| Busy Bubble Laundromat | 425 North Main Street | 2 | X | X | X | | X |
| Buzzi's Garage | 25-35 Farwell Street | 7 | | X | X | X | |
| Church of God of Prophecy | 10 Brook Street | 2 | X | X | X | X | X |
| Dente's Market | 406 North Main Street | 1 | X | X | X | | X |
| Energy Safe Homes, LLC | 9 Brook Street | 1 | X | X | X | X | X |
| Fastop Stores | 377 North Main Street | 5 | | X | X | | X |
| Good Samaritan Haven | 105 Seminary Street | 7 | X | X | X | X | X |
| Guy's Repair Shop | 16 Brook Street | 3 | | X | X | X | X |
| Mister Z's Italian Restaurant | 379 North Main Street | 30 | | X | X | | X |
| Mulligans Irish Pub | 9 Maple Avenue | 25 | | X | X | | X |
| Nationwide Insurance | 3 Maple Avenue | 3 | | X | X | | X |
| Norway & Sons, Inc. | 393 North Main Street | 47 | X | X | X | | X |
| Reflecting Beauty | 415 North Main Street | 2 | | X | X | | X |
| Richard Venmar Dental Office | 20 Maple Avenue | 6 | | X | X | | X |
| SixString Station | 4 Blackwell Street | 1-4 | | | X | | X |
| Trade Winds Hair Styling | 102 Seminary Street | 3 | X | X | X | X | X |
| Videovision Production Company | 386 North Main Street | 6 | X | X | X | | X |
| Yipes Auto Detailing | 439 North Main Street | 5-9 | X | X | X | | X |
| **TOTAL NUMBER OF BUSINESSES** | | **21** | **11** | **20** | **21** | **9** | **19** |
| **TOTAL NUMBER OF EMPLOYEES** | | **189** | **101** | **188** | **189** | **56** | **176** |

Analysis involved the intersection of Vermont E-911 building points with f ood hazard zones in ArcGIS. Results were further modif ed using 2013 aerial imagery from VCGI. If any por. on of a building is within a f ood hazard zone, as determined visually with aerial imagery, the building is considered to be within the zone. Inclusion of a building within these zones is based solely on the location of the building and does not reflect the building's elevation.

Number of Single and Multi-Family Dwellings in Flood Hazard Zones along Gunners Brook
Barre City, Vermont
Vermont Economic Resiliency Initiative (VERI)
March 18, 2015

| Dwelling Type | FEMA Floodway | FEMA 100-Year Flood Hazard Zone | FEMA 500-Year Flood Hazard Zone | ANR River Corridor | May 2011 Flood Inundation Area |
|---|---|---|---|---|---|
| Single Family Dwelling | 14 | 30 | 30 | 25 | 16 |
| Multi-Family Dwelling | 28 | 65 | 67 | 45 | 51 |

Analysis involved the intersection of Vermont E-911 building points with f ood hazard zones in ArcGIS. Results were further modif ed using 2013 aerial imagery from VCGI. If any por. on of a building is within a flood hazard zone, as determined visually with aerial imagery, the building is considered to be within the zone. Inclusion of a building within these zones is based solely on the location of the building and does not reflect the building's elevation.

# Appendix E:
# V-DAT One-Page Visual Summary of the Top Recommendations for Barre

DOWNTOWN Barre

# Conceptual Vision Plan for **Our Community**

Downtown Barre has been the governmental, civic, and retail heart of the community from its earliest days. Like many downtowns, Barre was the center of commerce for the community but experienced outmigration of retail to suburban locations during the 1970's and 1980's. For many years, the City explored ways to revitalize downtown. In the spring of 2011, Barre's downtown would be forever changed with the spring flood that inundated the core of the community. Shortly thereafter, Barre would begin the multi-million dollar "big dig" that would reconstruct the entire Main Street corridor including utilities buried deep beneath the street.

The Big Dig was completed and has led to significant additional investment in downtown. As a result, the V-DAT team was tasked with several efforts for Barre. First, Barre wanted to better understand its current and future market potential for downtown in light of the significant investments taking place. Second, the Barre Partnership and its partners at the City of Barre and the Barre Area Development Corporation desired a marketing strategy that would carry the community forward. Third, Barre desired a way to "connect the dots" between the many efforts occurring with its planning efforts. Finally, the community wanted to explore ways for the Barre Partnership to be a successful and vibrant partner with key groups throughout the City

## About the Project

The Vermont Downtown Action Team (V-DAT) was selected by the State of Vermont, Department of Housing and Community Development, Vermont Downtown Program in May 2013 to conduct a community planning and economic development charrette in Wilmington. The V-DAT was comprised of experts in architecture, planning, landscape architecture, historic preservation, economic development, organizational structure, landscape architecture, engineering and community branding.

The V-DAT planning charrette operates on three key tenants: utilizing an asset based approach, addressing the community in a holistic manner, and conducting the exercise in a public forum.

## Market Opportunities

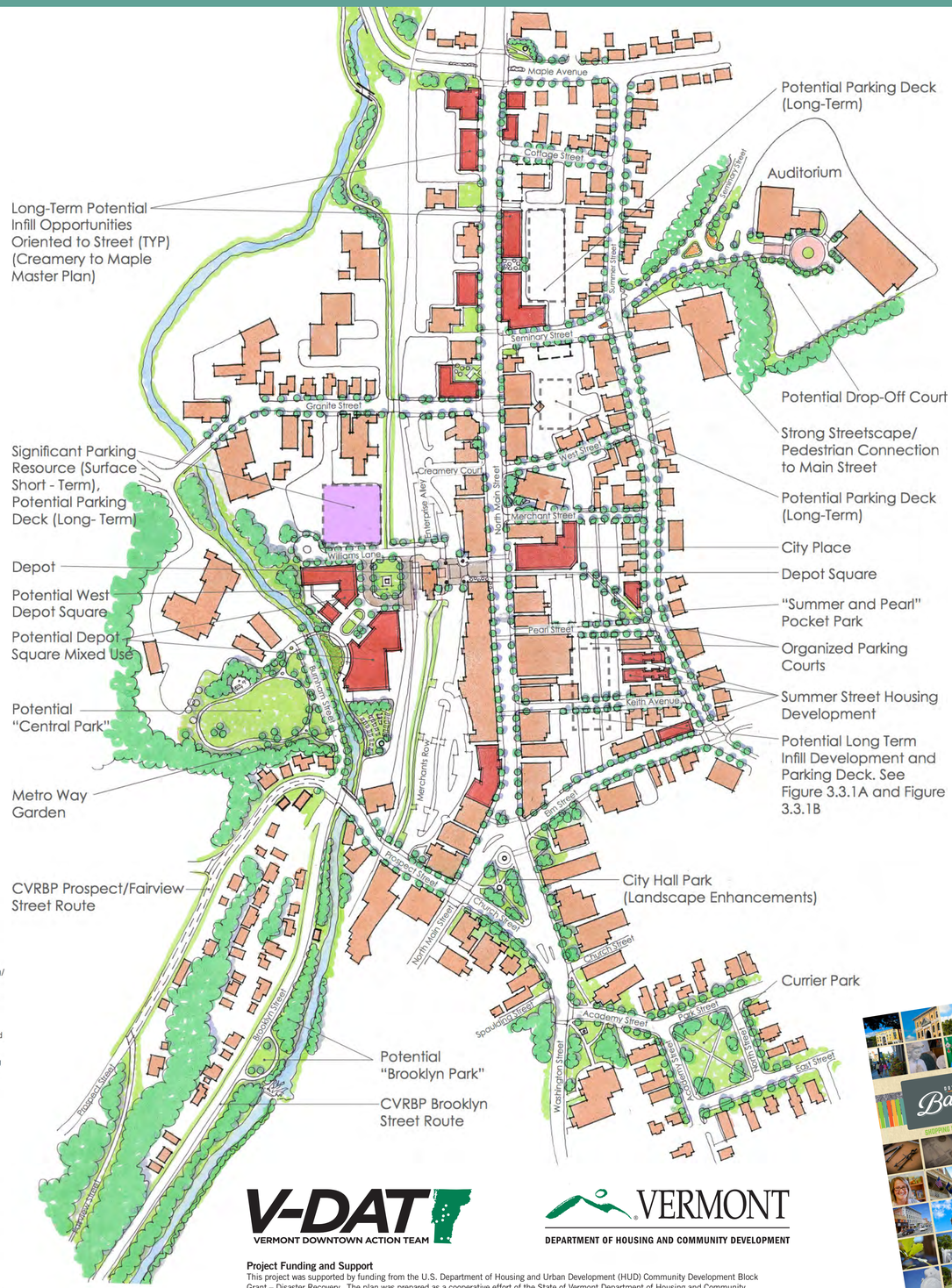
Barre has a significant opportunity to reinforce its role as a regional retail destination with a variety of retail uses that can round out the excellent retail and restaurant mix already in place downtown.

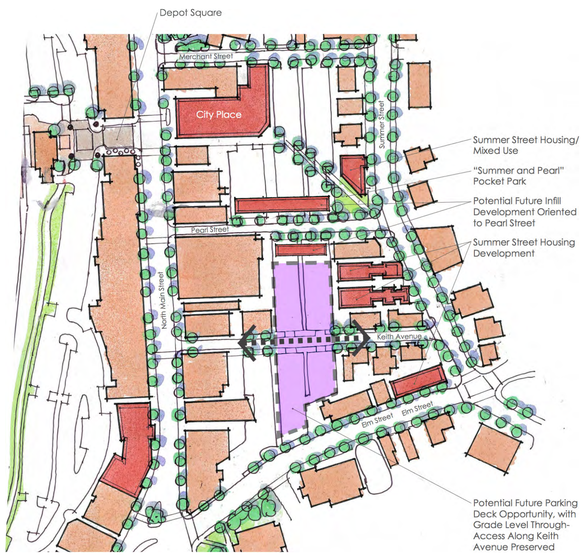
The visitor market is a strong opportunity for Barre by connecting major visitor attractions in the region and downtown Barre. Attractions like the Rock of Ages and the Granite Museum coupled with downtown attractions such as the Barre Opera House, the Vermont Historical Society, and the Barre Civic Center can all attract visitors that will, in turn, shop and dine in Barre.

There is a great opportunity for consistent pride building messaging for Downtown to celebrate accomplishments and point to future plans. Downtown Barre is only going to get better as current plans come to fruition and having a clear message will be critical for the Barre Partnership to work with the City of Barre and the Barre Area Development Corporation.

Investors come to a community that has a plan, has demonstrated commitment to that plan through public infrastructure, and stand ready to partner with the private sector to see a project come to fruition. Barre has demonstrated that commitment.

Finally, and perhaps most importantly, Barre should continue to create connections among the major amenities in the community. There are great plans underway in Barre and "connecting the dots" will be a key goal of the coming years.




V-DAT VERMONT DOWNTOWN ACTION TEAM

VERMONT DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

**Project Funding and Support**

This project was supported by funding from the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant – Disaster Recovery. The plan was prepared as a cooperative effort of the State of Vermont Department of Housing and Community Development, the Division of Community Planning and Revitalization and the Town of Barre. The contents of this document do not necessarily reflect the official views or policy of HUD or the State of Vermont. For more information on the Vermont Downtown Action Team (V-DAT) program and links to the detailed presentation and report for Barre please visit http://accd.vermont.gov/strong_communities or call (802) 828-5229.

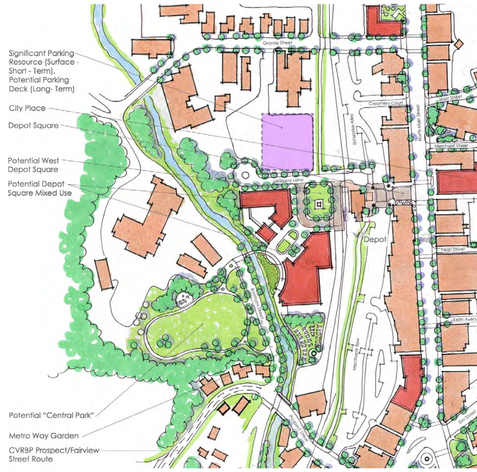
## Physical Plan

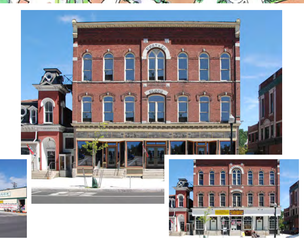
Barre is fortunate to have well written and viable plans already underway. The current Merchants Row Master Plan and the Summer to Main Master Plan clearly illustrate the potential to continue investment in downtown Barre. These plans couple well with efforts to continue the Central Vermont Recreation and Bike Path (CVRBP) through downtown Barre and the Metro Way Community Garden.

As Barre moves ahead, the V-DAT physical plan is designed todo three things. First, it will reinforce the validity of current initiatives underway showing how they work in a broader context. Second, it will "connect the dots" between existing initiatives to show how the variety of excellent projects and plans underway work together to make for a more cohesive, investment friendly, and visitor oriented downtown. Finally, the plans look to the future to show how existing initiatives and plans for the next five years might evolve into even more investment opportunity in the long term.

Façade Improvements

Downtown Barre has several opportunities for public and private sector building owners to enhance their facades. From ornate Victorian buildings to more simple 1950's era architecture, Barre has an opportunity to continue to improve the buildings along Main Street and throughout downtown.



## The Barre Brand

Barre is an authentic community and functioning City in a state known for its small villages and hamlets. Barre has the opportunity to assert its historic role in building the state and the nation while reflecting on the beauty, the arts, and the opportunities in the City and its downtown. This calls for a fresh look at Barre's brand identity. The following brand statement describes Barre:

Years ago, as the blade of a plow cut through the fertile Vermont soil, it was brought to an abrupt halt. Early settlers certainly knew of the granite outcroppings but few knew that beneath the dirt was a treasure that would change this place, our nation, and the world.

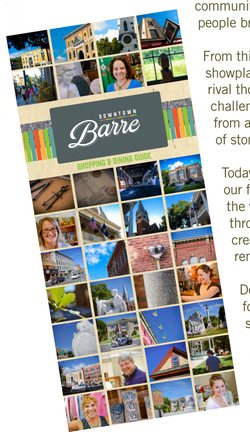
Barre granite became the solid foundation on which Vermont was built. Blocks carried to our neighbor created a capitol that inspired others to seek Barre granite for monuments and buildings that span the globe. At the same time the world was coming to Barre as artisans and craftsmen journeyed here to create a mixture of cultures that make our community rich in heritage from many lands. These same people brought creative thinking and innovation to Barre.

From this history, Barre grew as one of Vermont's showplaces. Our architecture, sculpture, and monuments rival those in the most cosmopolitan of cities. We met challenges with a resilience and courage that is born from a people who deal with molding the strongest of stone into the most intricate pieces of art.

Today, we are using the strength of our past to transform our future. Whether it is revitalizing our downtown: the very heart of Barre, serving people less fortunate through innovative training, providing artists a place to create unencumbered by intellectual restrictions, or presenting our remarkable story to those who seek to know this truly unique place.

Downtown Barre has re-emerged, built on a strong foundation, developing through strong partnerships, and looking forward to a strong future.

**We are Downtown Barre, strength through vision.**




# Appendix F:
# Results of EPA's Flood Resilience Checklist for Barre City and Town

# Flood Resilience Checklist

Is your community prepared for a possible flood? Completing this flood resilience checklist can help you begin to answer that question. This checklist was developed as part of the U.S. Environmental Protection Agency's Smart Growth Implementation Assistance project in the state of Vermont. More information about the project can be found by reading the full report, *Planning for Flood Recovery and Long-Term Resilience in Vermont*, found online at www.epa.gov/smartgrowth/sgia_communities.htm#rec1.

## What is the Flood Resilience Checklist?

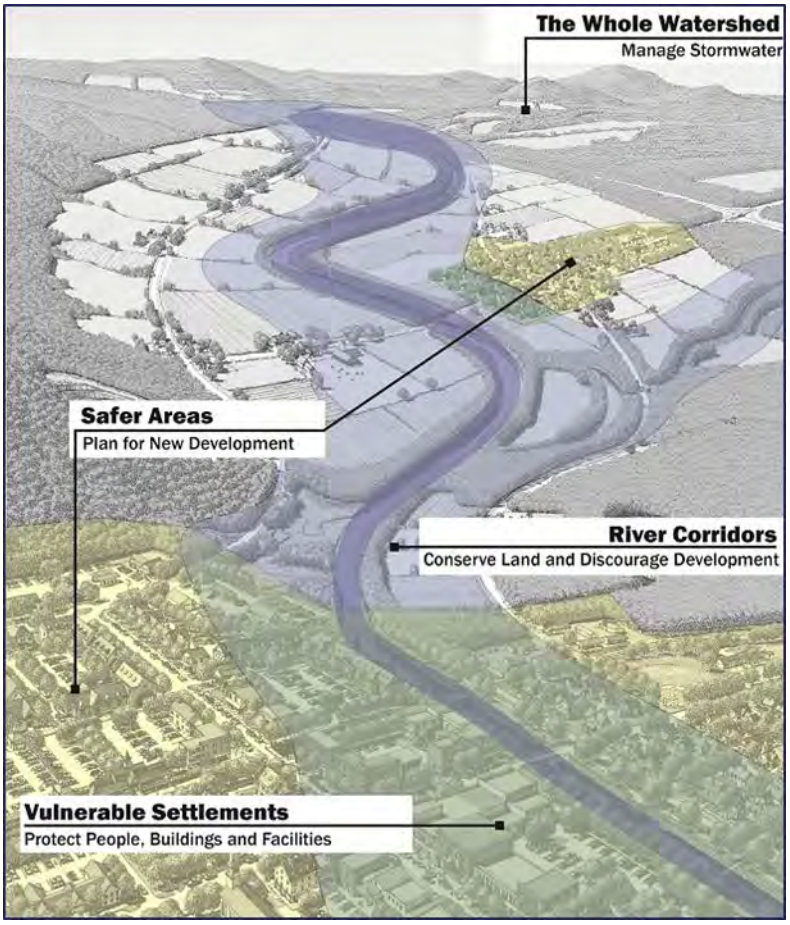
This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

## Who should use it?

This checklist can help communities identify opportunities to improve their resilience to future floods through policy and regulatory tools, including comprehensive plans, Hazard Mitigation Plans, local land use codes and regulations, and non-regulatory programs implemented at the local level. Local government departments such as community planning, public works, and emergency services; elected and appointed local officials; and other community organizations and nonprofits can use the checklist to assess their community's readiness to prepare for, deal with, and recover from floods.

## Why is it important?

Completing this checklist is the first step in assessing how well a community is positioned to avoid and/or reduce flood damage and to recover from floods. If a community is not yet using some of the strategies listed in the checklist and would like to, the policy options and resources listed in the *Planning for Flood Recovery and Long-Term Resilience in Vermont* report can provide ideas for how to begin implementing these approaches.




*This graphic illustrates the four categories of approaches to enhance resilience to future floods. Credit: Vermont Agency of Commerce and Community Development.*

# BARRE CITY FLOOD RESILIENCE CHECKLIST

**Overall Strategies to Enhance Flood Resilience**
(Learn more in Section 2, pp. 9-11 of
*Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Does the community's comprehensive plan have a hazard element or flood planning section? | ☐ Yes | ☐ No |
| a. Does the comprehensive plan cross-reference the local Hazard Mitigation Plan and any disaster recovery plans? | ☐ Yes | ☐ No |
| b. Does the comprehensive plan identify flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas, if applicable? | ☐ Yes | ☐ No |
| c. Did the local government emergency response personnel, flood plain manager, and department of public works participate in developing/updating the comprehensive plan? | ☐ Yes | ☐ No |
| 2. Does the community have a local Hazard Mitigation Plan approved by the Federal Emergency Management Agency (FEMA) and the state emergency management agency? | ☐ Yes | ☐ No |
| a. Does the Hazard Mitigation Plan cross-reference the local comprehensive plan? | ☐ Yes | ☐ No |
| b. Was the local government planner or zoning administrator involved in developing/updating the Hazard Mitigation Plan? | ☐ Yes | ☐ No |
| c. Were groups such as local businesses, schools, hospitals/medical facilities, agricultural landowners, and others who could be affected by floods involved in the Hazard Mitigation Plan drafting process? | ☐ Yes | ☐ No |
| d. Were other local governments in the watershed involved to coordinate responses and strategies? | ☐ Yes | ☐ No |
| e. Does the Hazard Mitigation Plan emphasize non-structural pre-disaster mitigation measures such as acquiring flood-prone lands and adopting No Adverse Impact flood plain regulations? | ☐ Yes | ☐ No |
| f. Does the Hazard Mitigation Plan encourage using green infrastructure techniques to help prevent flooding? | ☐ Yes | ☐ No |
| g. Does the Hazard Mitigation Plan identify projects that could be included in pre-disaster grant applications and does it expedite the application process for post-disaster Hazard Mitigation Grant Program acquisitions? | ☐ Yes | ☐ No |
| 3. Do other community plans (e.g., open space or parks plans) require or encourage green infrastructure techniques? | ☐ Yes | ☐ No |

| BARRE CITY FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Do all community plans consider possible impacts of climate change on areas that are likely to be flooded? | ☐ Yes | ☐ No |
| 5. Are structural flood mitigation approaches (such as repairing bridges, culverts, and levees) and non-structural approaches (such as green infrastructure) that require significant investment of resources coordinated with local capital improvement plans and prioritized in the budget? | ☐ Yes | ☐ No |
| 6. Does the community participate in the National Flood Insurance Program Community Rating System? | ☐ Yes | ☐ No |
| **Conserve Land and Discourage Development in River Corridors**<br>(Learn more in Section 3.A, pp. 14-19 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Has the community implemented non-regulatory strategies to conserve land in river corridors, such as: | | |
| a. Acquisition of land (or conservation easements on land) to allow for stormwater absorption, river channel adjustment, or other flood resilience benefits? | ☐ Yes | ☐ No |
| b. Buyouts of properties that are frequently flooded? | ☐ Yes | ☐ No |
| c. Transfer of development rights program that targets flood-prone areas as sending areas and safer areas as receiving areas? | ☐ Yes | ☐ No |
| d. Tax incentives for conserving vulnerable land? | ☐ Yes | ☐ No |
| e. Incentives for restoring riparian and wetland vegetation in areas subject to erosion and flooding? | ☐ Yes | ☐ No |
| 2. Has the community encouraged agricultural and other landowners to implement pre-disaster mitigation measures, such as: | | |
| a. Storing hay bales and equipment in areas less likely to be flooded? | ☐ Yes | ☐ No |
| b. Installing ponds or swales to capture stormwater? | ☐ Yes | ☐ No |
| c. Planting vegetation that can tolerate inundation? | ☐ Yes | ☐ No |
| d. Using land management practices to improve the capability of the soil on their lands to retain water? | ☐ Yes | ☐ No |
| 3. Has the community adopted flood plain development limits that go beyond FEMA's minimum standards for Special Flood Hazard Areas and also prohibit or reduce any new encroachment and fill in river corridors and Fluvial Erosion Hazard areas? | ☐ Yes | ☐ No |

| BARRE CITY FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Has the community implemented development regulations that incorporate approaches and standards to protect land in vulnerable areas, including: | | |
| a. Fluvial erosion hazard zoning? | ☐ Yes | ☐ No |
| b. Agricultural or open space zoning? | ☐ Yes | ☐ No |
| c. Conservation or cluster subdivision ordinances, where appropriate? | ☐ Yes | ☐ No |
| d. Other zoning or regulatory tools that limit development in areas subject to flooding, including river corridors and Special Flood Hazard Areas? | ☐ Yes | ☐ No |
| **Protect People, Buildings, and Facilities in Vulnerable Settlements**<br>(Learn more in Section 3.B, pp. 19-26 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Do the local comprehensive plan and Hazard Mitigation Plan identify developed areas that have been or are likely to be flooded? | ☐ Yes | ☐ No |
| a. If so, does the comprehensive plan discourage development in those areas or require strategies to reduce damage to buildings during floods (such as elevating heating, ventilation, and air conditioning (HVAC) systems and flood-proofing basements)? | ☐ Yes | ☐ No |
| b. Does the Hazard Mitigation Plan identify critical facilities and infrastructure that are located in vulnerable areas and should be protected, repaired, or relocated (e.g., town facilities, bridges, roads, and wastewater facilities)? | ☐ Yes | ☐ No |
| 2. Do land development regulations and building codes promote safer building and rebuilding in flood-prone areas? Specifically: | | |
| a. Do zoning or flood plain regulations require elevation of two or more feet above base flood elevation? | ☐ Yes | ☐ No |
| b. Does the community have the ability to establish a temporary post-disaster building moratorium on all new development? | ☐ Yes | ☐ No |
| c. Have non-conforming use and structure standards been revised to encourage safer rebuilding in flood-prone areas? | ☐ Yes | ☐ No |
| d. Has the community adopted the International Building Code or American Society of Civil Engineers (ASCE) standards that promote flood-resistant building? | ☐ Yes | ☐ No |
| e. Does the community plan for costs associated with follow-up inspection and enforcement of land development regulations and building codes? | ☐ Yes | ☐ No |

| BARRE CITY FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 3. Does the community require developers who are rebuilding in flood-prone locations to add additional flood storage capacity in any new redevelopment projects such as adding new parks and open space and allowing space along the river's edge for the river to move during high-water events? | ☐ Yes | ☐ No |
| 4. Is the community planning for development (e.g., parks, river-based recreation) along the river's edge that will help connect people to the river AND accommodate water during floods? | ☐ Yes | ☐ No |
| 5. Does the comprehensive plan or Hazard Mitigation Plan discuss strategies to determine whether to relocate structures that have been repeatedly flooded, including identifying an equitable approach for community involvement in relocation decisions and potential funding sources (e.g., funds from FEMA, stormwater utility, or special assessment district)? | ☐ Yes | ☐ No |
| **Plan for and Encourage New Development in Safer Areas**<br>(Learn more in Section 3.C, pp. 26-27 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Does the local comprehensive plan or Hazard Mitigation Plan clearly identify safer growth areas in the community? | ☐ Yes | ☐ No |
| 2. Has the community adopted policies to encourage development in these areas? | ☐ Yes | ☐ No |
| 3. Has the community planned for new development in safer areas to ensure that it is compact, walkable, and has a variety of uses? | ☐ Yes | ☐ No |
| 4. Has the community changed their land use codes and regulations to allow for this type of development? | ☐ Yes | ☐ No |
| 5. Have land development regulations been audited to ensure that development in safer areas meets the community's needs for off-street parking requirements, building height and density, front-yard setbacks and that these regulations do not unintentionally inhibit development in these areas? | ☐ Yes | ☐ No |
| 6. Do capital improvement plans and budgets support development in preferred safer growth areas (e.g., through investment in wastewater treatment facilities and roads)? | ☐ Yes | ☐ No |
| 7. Have building codes been upgraded to promote more flood-resistant building in safer locations? | ☐ Yes | ☐ No |

# BARRE CITY FLOOD RESILIENCE CHECKLIST

**Implement Stormwater Management Techniques throughout the Whole Watershed**
(Learn more in Section 3.D, pp. 27-31 of *Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Has the community coordinated with neighboring jurisdictions to explore a watershed-wide approach to stormwater management? | ☐ Yes | ☐ No |
| 2. Has the community developed a stormwater utility to serve as a funding source for stormwater management activities? | ☐ Yes | ☐ No |
| 3. Has the community implemented strategies to reduce stormwater runoff from roads, driveways, and parking lots? | ☐ Yes | ☐ No |
| 4. Do stormwater management regulations apply to areas beyond those that are regulated by federal or state stormwater regulations? | ☐ Yes | ☐ No |
| 5. Do stormwater management regulations encourage the use of green infrastructure techniques? | ☐ Yes | ☐ No |
| 6. Has the community adopted tree protection measures? | ☐ Yes | ☐ No |
| 7. Has the community adopted steep slope development regulations? | ☐ Yes | ☐ No |
| 8. Has the community adopted riparian and wetland buffer requirements? | ☐ Yes | ☐ No |

# BARRE TOWN FLOOD RESILIENCE CHECKLIST

**Overall Strategies to Enhance Flood Resilience**
(Learn more in Section 2, pp. 9-11 of
*Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Does the community's comprehensive plan have a hazard element or flood planning section? | ☐ Yes | ☐ No |
| a. Does the comprehensive plan cross-reference the local Hazard Mitigation Plan and any disaster recovery plans? | ☐ Yes | ☐ No |
| b. Does the comprehensive plan identify flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas, if applicable? | ☐ Yes | ☐ No |
| c. Did the local government emergency response personnel, flood plain manager, and department of public works participate in developing/updating the comprehensive plan? | ☐ Yes | ☐ No |
| 2. Does the community have a local Hazard Mitigation Plan approved by the Federal Emergency Management Agency (FEMA) and the state emergency management agency? | ☐ Yes | ☐ No |
| a. Does the Hazard Mitigation Plan cross-reference the local comprehensive plan? | ☐ Yes | ☐ No |
| b. Was the local government planner or zoning administrator involved in developing/updating the Hazard Mitigation Plan? | ☐ Yes | ☐ No |
| c. Were groups such as local businesses, schools, hospitals/medical facilities, agricultural landowners, and others who could be affected by floods involved in the Hazard Mitigation Plan drafting process? | ☐ Yes | ☐ No |
| d. Were other local governments in the watershed involved to coordinate responses and strategies? | ☐ Yes | ☐ No |
| e. Does the Hazard Mitigation Plan emphasize non-structural pre-disaster mitigation measures such as acquiring flood-prone lands and adopting No Adverse Impact flood plain regulations? | ☐ Yes | ☐ No |
| f. Does the Hazard Mitigation Plan encourage using green infrastructure techniques to help prevent flooding? | ☐ Yes | ☐ No |
| g. Does the Hazard Mitigation Plan identify projects that could be included in pre-disaster grant applications and does it expedite the application process for post-disaster Hazard Mitigation Grant Program acquisitions? | ☐ Yes | ☐ No |
| 3. Do other community plans (e.g., open space or parks plans) require or encourage green infrastructure techniques? | ☐ Yes | ☐ No |

| BARRE TOWN FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Do all community plans consider possible impacts of climate change on areas that are likely to be flooded? | ☐ Yes | ☐ No |
| 5. Are structural flood mitigation approaches (such as repairing bridges, culverts, and levees) and non-structural approaches (such as green infrastructure) that require significant investment of resources coordinated with local capital improvement plans and prioritized in the budget? | ☐ Yes | ☐ No |
| 6. Does the community participate in the National Flood Insurance Program Community Rating System? | ☐ Yes | ☐ No |
| **Conserve Land and Discourage Development in River Corridors**<br>(Learn more in Section 3.A, pp. 14-19 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Has the community implemented non-regulatory strategies to conserve land in river corridors, such as: | | |
| a. Acquisition of land (or conservation easements on land) to allow for stormwater absorption, river channel adjustment, or other flood resilience benefits? | ☐ Yes | ☐ No |
| b. Buyouts of properties that are frequently flooded? | ☐ Yes | ☐ No |
| c. Transfer of development rights program that targets flood-prone areas as sending areas and safer areas as receiving areas? | ☐ Yes | ☐ No |
| d. Tax incentives for conserving vulnerable land? | ☐ Yes | ☐ No |
| e. Incentives for restoring riparian and wetland vegetation in areas subject to erosion and flooding? | ☐ Yes | ☐ No |
| 2. Has the community encouraged agricultural and other landowners to implement pre-disaster mitigation measures, such as: | | |
| a. Storing hay bales and equipment in areas less likely to be flooded? | ☐ Yes | ☐ No |
| b. Installing ponds or swales to capture stormwater? | ☐ Yes | ☐ No |
| c. Planting vegetation that can tolerate inundation? | ☐ Yes | ☐ No |
| d. Using land management practices to improve the capability of the soil on their lands to retain water? | ☐ Yes | ☐ No |
| 3. Has the community adopted flood plain development limits that go beyond FEMA's minimum standards for Special Flood Hazard Areas and also prohibit or reduce any new encroachment and fill in river corridors and Fluvial Erosion Hazard areas? | ☐ Yes | ☐ No |

| BARRE TOWN FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Has the community implemented development regulations that incorporate approaches and standards to protect land in vulnerable areas, including: | | |
| a. Fluvial erosion hazard zoning? | ☐ Yes | ☐ No |
| b. Agricultural or open space zoning? | ☐ Yes | ☐ No |
| c. Conservation or cluster subdivision ordinances, where appropriate? | ☐ Yes | ☐ No |
| d. Other zoning or regulatory tools that limit development in areas subject to flooding, including river corridors and Special Flood Hazard Areas? | ☐ Yes | ☐ No |
| **Protect People, Buildings, and Facilities in Vulnerable Settlements**<br>(Learn more in Section 3.B, pp. 19-26 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Do the local comprehensive plan and Hazard Mitigation Plan identify developed areas that have been or are likely to be flooded? | ☐ Yes | ☐ No |
| a. If so, does the comprehensive plan discourage development in those areas or require strategies to reduce damage to buildings during floods (such as elevating heating, ventilation, and air conditioning (HVAC) systems and flood-proofing basements)? | ☐ Yes | ☐ No |
| b. Does the Hazard Mitigation Plan identify critical facilities and infrastructure that are located in vulnerable areas and should be protected, repaired, or relocated (e.g., town facilities, bridges, roads, and wastewater facilities)? | ☐ Yes | ☐ No |
| 2. Do land development regulations and building codes promote safer building and rebuilding in flood-prone areas? Specifically: | | |
| a. Do zoning or flood plain regulations require elevation of two or more feet above base flood elevation? | ☐ Yes | ☐ No |
| b. Does the community have the ability to establish a temporary post-disaster building moratorium on all new development? | ☐ Yes | ☐ No |
| c. Have non-conforming use and structure standards been revised to encourage safer rebuilding in flood-prone areas? | ☐ Yes | ☐ No |
| d. Has the community adopted the International Building Code or American Society of Civil Engineers (ASCE) standards that promote flood-resistant building? | ☐ Yes | ☐ No |
| e. Does the community plan for costs associated with follow-up inspection and enforcement of land development regulations and building codes? | ☐ Yes | ☐ No |

| BARRE TOWN FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 3. Does the community require developers who are rebuilding in flood-prone locations to add additional flood storage capacity in any new redevelopment projects such as adding new parks and open space and allowing space along the river's edge for the river to move during high-water events? | ☐ Yes | ☐ No |
| 4. Is the community planning for development (e.g., parks, river-based recreation) along the river's edge that will help connect people to the river AND accommodate water during floods? | ☐ Yes | ☐ No |
| 5. Does the comprehensive plan or Hazard Mitigation Plan discuss strategies to determine whether to relocate structures that have been repeatedly flooded, including identifying an equitable approach for community involvement in relocation decisions and potential funding sources (e.g., funds from FEMA, stormwater utility, or special assessment district)? | ☐ Yes | ☐ No |
| **Plan for and Encourage New Development in Safer Areas**<br>(Learn more in Section 3.C, pp. 26-27 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Does the local comprehensive plan or Hazard Mitigation Plan clearly identify safer growth areas in the community? | ☐ Yes | ☐ No |
| 2. Has the community adopted policies to encourage development in these areas? | ☐ Yes | ☐ No |
| 3. Has the community planned for new development in safer areas to ensure that it is compact, walkable, and has a variety of uses? | ☐ Yes | ☐ No |
| 4. Has the community changed their land use codes and regulations to allow for this type of development? | ☐ Yes | ☐ No |
| 5. Have land development regulations been audited to ensure that development in safer areas meets the community's needs for off-street parking requirements, building height and density, front-yard setbacks and that these regulations do not unintentionally inhibit development in these areas? | ☐ Yes | ☐ No |
| 6. Do capital improvement plans and budgets support development in preferred safer growth areas (e.g., through investment in wastewater treatment facilities and roads)? | ☐ Yes | ☐ No |
| 7. Have building codes been upgraded to promote more flood-resistant building in safer locations? | ☐ Yes | ☐ No |

# BARRE TOWN FLOOD RESILIENCE CHECKLIST

**Implement Stormwater Management Techniques throughout the Whole Watershed**
(Learn more in Section 3.D, pp. 27-31 of *Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Has the community coordinated with neighboring jurisdictions to explore a watershed-wide approach to stormwater management? | ☐ Yes | ☐ No |
| 2. Has the community developed a stormwater utility to serve as a funding source for stormwater management activities? | ☐ Yes | ☐ No |
| 3. Has the community implemented strategies to reduce stormwater runoff from roads, driveways, and parking lots? | ☐ Yes | ☐ No |
| 4. Do stormwater management regulations apply to areas beyond those that are regulated by federal or state stormwater regulations? | ☐ Yes | ☐ No |
| 5. Do stormwater management regulations encourage the use of green infrastructure techniques? | ☐ Yes | ☐ No |
| 6. Has the community adopted tree protection measures? | ☐ Yes | ☐ No |
| 7. Has the community adopted steep slope development regulations? | ☐ Yes | ☐ No |
| 8. Has the community adopted riparian and wetland buffer requirements? | ☐ Yes | ☐ No |

# Appendix G:
# Table of Municipal Policy and Program Recommendations

# Barre City

**City-wide Policy and Program Options**

**Vermont Economic Resiliency Initiative (VERI)**

**Legend**

● Effective ◒ Limited ○ Ineffective

* Priority rating based on degree of community benefit

| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Land Use Regulations** | | | | | | | | | | |
| Update policies allowing fill in flood hazard areas. | **Medium** | ● | ◒ | ● | Moderate | < $10K | RPC, DEC River Management, VLCT, Consultant | MPG | Allowing landowners to elevate buildings using fill may help protect an individual property, but it can increase flood hazards to downstream property owners and reduce the land's ability to slow and store the extra flood water. Regulations can require alternate methods of elevating structures that allow flood waters to occupy the space beneath the structure, preventing it from being pushed off to neighboring or downstream properties. Under current city bylaws, filling is allowed to elevate improvements out of the floodplain. | Contact Town Planner and Planning Commission |
| Require repaired and rebuilt structures to be built higher. | **High** | ● | ○ | ● | Easy | < $10K | DEC River Management Program, RPC, VLCT, Consultant | MPG | Owners rebuilding should raise the lowest floor 2 to 3 feet higher than the flood elevation to address the new rainfall patterns and actual flood heights from recent floods. Current city bylaws require 1 foot above flood elevation and this can be revised. | Contact Town Planner and Planning Commission |
| Follow best practices for reconstruction after the flood. | **Medium** | ● | ○ | ● | Easy | < $10K | RPC, DEC River Management, VLCT, Consultant | MPG | When rebuilding after a flood, property owners should utilize flood resilient re-construction methods recommended by FEMA, in consultation with the Agency of Natural Resources Floodplain Manager. This protects reconstructed property from the next flood. | Contact Town Planner and Planning Commission |
| Make room for rivers to flow naturally. | **Lower** | ● | ● | ● | Moderate | < $10K | DEC River Management Program, RPC, VLCT, Consultant | MPG | Creating more space for rivers, restoring flood plains, and wetlands and maintaining natural vegetation and forest cover is a major contribution to flood prevention and protection. | Contact Town Planner and Planning Commission |
| Monitor rebuilding after a disaster. | **Medium** | ● | ● | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | People want to return to normal as quickly as possible after a disaster but local officials need to monitor rebuilding work to ensure that it does not violate town and federal regulations. Without close monitoring, improper rebuilding may result in future federal disaster funding being unavailable for the town and its residences and businesses. | Work with Zoning Administrator. |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

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|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Town Plan** | | | | | | | | | | |
| Emphasize watershed-wide stormwater planning to reduce flooding impacts. | **High** | ● | ● | ● | Moderate | < $10K | ANR Basin Planning Program, RPC, VLCT, DEC Rivers Management, Consultant | MPG | As Barre City and neighboring communities, particularly Barre Town, experience growth, regulation and design of stormwater management will have direct impacts on flooding experienced in Barre City. All communities should emphasize the importance of developing dialog and collaboration regarding stormwater management within the shared watershed. | Contact Town Planner and Planning Commission |
| Quantify potential losses in Fluvial Erosion Hazard Zones. | **Medium** | ● | ● | ● | Easy | < $1K or In House | DEC Rivers Management, RPC, VLCT, Consultant | MPG | This information will help inform Barre City's decisions about specific provisions for the FEH Zone the city would like to adopt into the Land Use Regulations. River Corridor maps are now available from the Agency of Natural Resources, allowing a determination of which structures are at risk. With a better understanding of the nature of the risk to these structures, and future development in the River Corridors, Barre City can make the best decisions about regulatory standards. State planning law also now requires that River Corridors be addressed in flood resiliency elements of municipal plans. | Contact Town Planner and Planning Commission or Regional Planning Commission |
| Document damages from flood events. | **High** | ● | ● | ● | Easy | < $10K | RPC, VLCT, DEC Utilities Programs, Agency of Transportation, Vermont Local Roads, Consultant | MPG, Better Backroads | Disasters are easily forgotten over time and damages from the 2011 floods as well as other recent rain and flood events should be documented and retained. This will help the community consider the implications of new investments in areas damaged. | Work with Public Works Dept. and Administrative Staff |
| Document road, sewer, and water infrastructure vulnerabilities in municipal and capital plans. | **Medium** | ○ | ○ | ● | Easy | < $10K | VLCT, RPC, Financial Advisors | MPG | Specific areas that were damaged or have known vulnerabilities should be documented so the community can plan for their replacement in their long-term budgets, easing the impact on taxpayers. More detailed budgets and plans can be developed with the help of your RPC and financial advisors. | Work with Municipal Administration and Regional Planning Commission |

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# Barre City

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|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Emergency Planning** | | | | | | | | | | |
| Incorporate VERI mitigation strategies into the Local Hazard Mitigation Plan. | **Medium** | ● | ● | ● | Easy | < $10K | RPC, town | HMGP grants | Evaluating recommended VERI mitigation strategies during the LHMP process will allow them to be integrated alongside Barre City's other hazard mitigation projects and line projects up to receive state and federal funding. | Contact Regional Planning Commission |
| Incorporate the above plan and bylaw recommendations in the local Hazard Mitigation Plan. | **Medium** | ● | ● | ● | Easy | < $10K | RPC, town | HMGP grants | Including regulatory and policy actions in the strategies section of the plan before the next disaster can help communities qualify for federal funding. | Contact Regional Planning Commission |
| Develop a local recovery fund. | **Medium** | ○ | ○ | ● | Diffecult | Cost of Organizing Fund & Cost of Initital Funds Raised | Chamber of Commerce, local community support orgs such as churches | VT Community Foundation | Towns will recover much more quickly after a disaster if they create a local fund to address urgent needs. Federal and state money will come, but these funds are slow to arrive. Establishing a local household and business small grant or loan fund is proven to speed recovery efforts. | Work with local committee |
| Develop a local building retrofit fund. | **Medium** | ○ | ○ | ● | Diffecult | Cost of Organizing Fund & Cost of Initital Funds Raised | Chamber of Commerce, local community support orgs such as churches | VT Community Foundation | Again state and federal grants take time and may not be available for small projects. As part of the recovery or pre-disaster mitigation plan and fund, towns could offer mini grants for retrofits such as backflow preventers (that keep stormwater and sewage from flooding buildings via the drainage system), elevation of exterior utilities, and flood barriers for doors. | Work with local committee |
| Educate people about the causes, risks and warning signs of floods. | **Lower** | ● | ● | ● | Moderate | < $10K | Schools, RPC, Towns | HMGP grants | Schools can include flood awareness and preparedness in spring and fall science and history programs. Schools and towns and other local groups such as the Rotary or the senior center can publicize flood risk areas, warning signs and evacuation plans. Working with the state and the RPCs, these groups can distribute flood hazard maps so that people know where there is a risk of flooding. | Reach out to schools and community groups |
| **Education and Outreach** | | | | | | | | | | |
| Promote and educate property owners on the value of flood insurance. | **Medium** | ○ | ○ | ● | Easy | < $10K | Chamber, Homeowners Associations | HMGP grants | Homeowners insurance does not pay for any flood related damage. Only flood insurance does. In Barre City, 53% of buildings in the flood hazard area have flood insurance. | Gather NFIP informational materials for distribution, and reach out to real estate agents. |
| Help businesses plan for disasters. | **Medium** | ○ | ○ | ● | Easy | < $10K | Chamber, Rotary | EDA grants | If a home is damage or washed away, occupants can go stay in a hotel, with friend or family, or find a rental. When a business is flooded, it is much harder or impossible to relocate. Continuity of operations plan that outlines the steps business can take during and after a disaster. | Offer continuity of operations planning training for businesses. |
| Educate business owners, landlords and contractors about flood resilience. | **High** | ○ | ○ | ● | Moderate | < $10K | Realtors | HMGP grants | Many business owners, landlords and contractors may not understand the requirements for rebuilding after a flood. Specific standards must be met to maintain eligibility for flood insurance and other federal grants. Education programs are critical component to raising awareness. | Reach out to landlords and contractors. |

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## Barre Town

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| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Land Use Regulations** | | | | | | | | | | |
| Encourage development outside of the flood hazard area. | **High** | ● | ● | ● | Moderate | < $10K | RPC, VLCT, Consultant | MPG | New development in the floodplain puts owners at risk and reduces available floodplain. This can worsen flooding and puts emergency responders, the public and downstream property owners at risk. In the flood hazard portion of the town zoning bylaw, consider prohibiting all new development in the mapped flood areas. | Contact Town Planner and Planning Commission |
| Limit improvements after the flood. | **High** | ● | ● | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | When rebuilding after a flood, property owners should limit their improvements to their flood prone properties so any expansions do not create additional hazards to the community. These limits can be added to the development standards portion of the flood hazard section of the town zoning bylaw. | Contact Town Planner and Planning Commission |
| Update policies allowing fill in flood hazard areas. | **High** | ● | ◒ | ● | Moderate | < $10K | RPC, DEC River Management, VLCT, Consultant | MPG | Allowing landowners to fill low lying areas may help protect an individual property, but it can reduce the land's ability to slow and store the extra flood water and it can increase flood hazards to downstream property owners. These policies can be added to the development standards in the flood hazard section of the town zoning bylaw. | Contact Town Planner and Planning Commission |
| Require repaired and rebuilt structures to be built higher. | **High** | ● | ○ | ● | Easy | < $10K | DEC River Management Program, RPC, VLCT, Consultant | MPG | Owners rebuilding should raise the lowest floor 2 to 3 feet higher than the most recently recorded flood elevation in high-risk areas. These requirements can be added to the development standards in the flood hazard section of the town zoning bylaw. | Contact Town Planner and Planning Commission |
| Make room for rivers to flow naturally. | **High** | ● | ● | ● | Moderate | < $10K | DEC River Management Program, RPC, VLCT, Consultant | MPG | Creating more space for rivers, restoring flood plains, and wetlands and maintaining natural vegetation and forest cover is a major contribution to flood prevention and protection | Contact Town Planner and Planning Commission |
| Monitor rebuilding after a disaster. | **High** | ● | ● | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | People want to return to normal as quickly as possible after a disaster but local officials need to monitor rebuilding work to ensure that it does not violate town and federal regulations. Without close monitoring, improper rebuilding may result in future federal disaster funding being unavailable for the town and its residences and businesses. | Work with Zoning Administrator. |

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|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Town Plan** | | | | | | | | | | |
| Emphasize watershed-wide stormwater planning to reduce flooding impacts. | **High** | ● | ● | ● | Moderate | < $10K | ANR Basin Planning Program, RPC, VLCT, DEC Rivers Management, Consultant | MPG | As Barre Town and neighboring communities experience growth, regulation and design of stormwater management will have direct impacts on flooding experienced in Barre Town. All communities should emphasize the importance of developing dialog and collaboration regarding stormwater management within the shared watershed. | Contact Town Planner and Planning Commission |
| Document damages from flood events. | **High** | ● | ● | ● | Easy | < $10K | RPC, VLCT, DEC Utilities Programs, Agency of Transportation, Vermont Local Roads, Consultant | MPG, Better Backroads | Disasters are easily forgotten over time and damages from 2007 and 2011 floods as well as other smaller recent rain and flood events should be documented. This will help the community consider the implications of new investments in areas damaged by floods including Sterling Hill Rd. The state law now requires that a new flood resiliency chapter or element be added to all town plans and CVRPC has several templates and samples available. | Work with Public Works Dept. and Administrative Staff |
| Limit new development in floodplain and river corridor. | **High** | ● | ● | ● | Moderate | < $10K | RPC, VLCT, Consultant | MPG | Language in the municipal plan that restricts development in risky locations enables adoption of corresponding regulations and policies. Likewise, the municipal plan should identify areas safe from floods and encourage development in those areas. This can be a component of the new flood resiliency chapter or element in the municipal plan. | Contact Town Planner and Planning Commission |
| Document road, sewer, and water infrastructure vulnerabilities in municipal and capital plans. | **Medium** | ○ | ○ | ● | Easy | < $10K | VLCT, RPC, Financial Advisors | MPG | Specific areas that were damaged or have known vulnerabilities should be documented so the community can plan for their replacement in their long-term budgets, easing the impact on taxpayers. Capital programs and budgets are not common in smaller towns but the local Selectboard may start this process with a list and a capital reserve fund. More detailed budgets and plans can be developed with the help of your RPC and financial advisors. | Work with Municipal Administration and Regional Planning Commission |
| Identify areas for conservation. | **Medium** | ● | ● | ● | Easy | < $10K | Town, Conservation Commission | DEC-ERP | The Steven's Branch River Corridor Plan identifies potential riparian easement sites. The Planning Commission can identify and work with willing landowners to establish conservation sites along the river to prevent future development in flood-prone locations. | Contact Conservation Commission |

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# Barre Town

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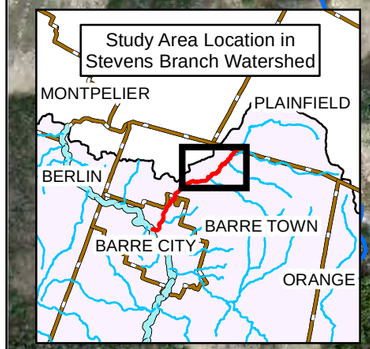
| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Emergency Planning** | | | | | | | | | | |
| Incorporate VERI mitigation strategies into the Local Hazard Mitigation Plan. | **Medium** | ● | ● | ● | Easy | < $10K | RPC, town | HMGP grants | Evaluating recommended VERI mitigation strategies during the LHMP process will allow them to be integrated alongside Barre Town's other hazard mitigation projects and line projects up to receive state and federal funding. | Contact Regional Planning Commission |
| Develop a local recovery fund. | **Medium** | ○ | ○ | ● | Diffecult | Cost of Organizing Fund & Cost of Initital Funds Raised | Chamber of Commerce, local community support orgs such as churches | VT Community Foundation | Towns will recover much more quickly after a disaster if they create a local fund to address urgent needs. Federal and state money will come, but these funds are slow to arrive. Establishing a local household and business small grant or loan fund is proven to speed recovery efforts. | Work with local committee |
| Develop a local building retrofit fund. | **Medium** | ○ | ○ | ● | Diffecult | Cost of Organizing Fund & Cost of Initital Funds Raised | Chamber of Commerce, local community support orgs such as churches | VT Community Foundation | Again state and federal grants take time and may not be available for small projects. As part of the recovery or pre-disaster mitigation plan and fund, towns could offer mini grants for retrofits such as backflow preventers (that keep stormwater and sewage from flooding buildings via the drainage system), elevation of exterior utilities, and flood barriers for doors. | Work with local committee |
| Develop evacuation plans. | **Medium** | ○ | ○ | ● | Moderate | < $10K | Homeowners Associations | HMGP grants | Municipal facilities and schools as well as private facilities such as mobile home parks, senior centers, nursing homes and workplaces should all have evacuation plans. | Work with local Emergency Management Director and VEMHS |
| Educate people about the causes, risks and warning signs of floods. | **Lower** | ● | ● | ● | Moderate | < $10K | Schools, RPC, Towns | HMGP grants | Schools can include flood awareness and preparedness in spring and fall science and history programs. Schools and towns and other local groups such as the Rotary or the senior center can publicize flood risk areas, warning signs and evacuation plans. Working with the state and the RPCs, these groups can distribute flood hazard maps so that people know where there is a risk of flooding. | Reach out to schools and community groups |
| **Education and Outreach** | | | | | | | | | | |
| Promote and educate property owners on the value of flood insurance. | **Medium** | ○ | ○ | ● | Easy | < $10K | Chamber, Homeowners Associations | HMGP grants | Homeowners' insurance does not pay for any flood related damage. Only flood insurance through the National Flood Insurance Program does. In Barre Town, 67% of buildings in the flood hazard area have flood insurance. | Gather NFIP informational materials for distribution, and reach out to real estate agents. |
| Help businesses plan for disasters. | **Medium** | ○ | ○ | ● | Easy | < $10K | Chamber, Rotary | EDA grants | If a home is damaged or washed away, occupants can go stay in a hotel, with friend or family, or find a rental. When a business is flooded, it is much harder or impossible to relocate. Continuity of operations plans outlines the steps business can take during and after a disaster to reduce disruption and losses. | Offer continuity of operations planning training for businesses. |
| Educate business owners, landlords and contractors about flood resilience. | **High** | ○ | ○ | ● | Moderate | < $10K | Realtors | HMGP grants | Many business owners, landlords, and contractors may not understand the requirements for rebuilding after a flood. Specific standards must be met to maintain eligibility for flood insurance and other federal grants. Education programs are critical component to raising awareness. | Reach out to landlords and contractors. |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

# Appendix H:
# Projects to Protect Businesses and Infrastructure – Maps

APPENDIX H

# Projects to Protect Businesses and Infrastructure
## Barre, Vermont - Map 1 of 2
## Vermont Economic Resiliency Initiative




PLAINFIELD

BARRE TOWN

Upstream Extent of VERI Study Area

CLARK RD
SWIFT RD
E MONTPELIER RD
PINE RIDGE RD
TH 199
MORGAN LN
SPRUCE MTN VIEW DR
MITCHELL RD
PLAINFIELD BROOK RD
TH 23
HIGUERA RD
HARTLEY RD
PINE HILL RD
GAUTHIERS DR
CASSIE ST
CAMP ST
Gunners Brook
Ketchum Brook

1
2
3
4
5
6

Eastmans Auto
Rebtek Diamond Blades & Bits, LLC
Canadian Club, Inc.
Cheney Trucking
Bates & Murray, Inc.
B&R Enterprises, Inc.
Bates & Murray, Inc.
Office/Retail Building

Map 2 Match Line

**Legend**

- Mitigation Site
- Local Economic Asset
- Surface Water
- ANR River Corridor
- Town Boundary

| Site Number | Site Description | Notes |
|---|---|---|
| 1 | Mitchell Rd culvert just west of intersection with Plainfield Brook Rd | Replace/upgrade undersized culvert |
| 2 | Plainfield Brook Rd embankment just northeast of intersection with Mitchell Rd | Improve river and road stability |
| 3 | Plainfield Brook Rd culvert just south of intersection with Mitchell Rd | Replace/upgrade undersized culvert |
| 4 | Bates and Murray, Inc. at 103 Plainfield Brook Rd | Floodproof |
| 5 | Plainfield Brook Rd embankment just downstream of Ketchum Brook confluence | Monitor river/road stability; repair erosion |
| 6 | East Montpelier Rd culvert just north of intersection with Plainfield Brook Rd | Replace/upgrade undersized culvert |

0 250 500 1,000 Feet

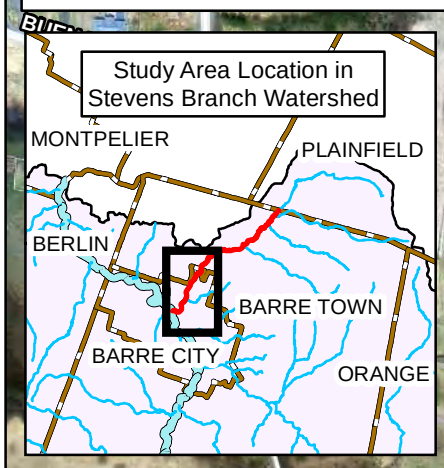
1 inch = 500 feet

N

Bear Creek Environmental

Background imagery from VCGI. Map composed on February 2, 2015.

# Projects to Protect Businesses and Infrastructure
## Barre, Vermont - Map 2 of 2
## Vermont Economic Resiliency Initiative




**Legend**

- Mitigation Site
- Local Economic Asset
- Multi-Family Dwelling
- Surface Water
- ANR River Corridor

**FEMA Flood Hazard Zones**

- Floodway
- 100 year
- Town Boundary

N

0 250 500 1,000 Feet

1 inch = 500 feet

Bear Creek Environmental

Le Page Gravel Pit

Ricker Holdings, LLC

Map 1 Match Line

BARRE TOWN

FARWELL ST

TURTLE ROCK DR

E MONTPELIER RD

Gunners Brook

Hope Cemetery

OLLIVER ST

PERRIN ST

SCHOOL ST

COLBY ST

BEECH ST

PINE ST

NEWTON ST

Buzzi's Garage

Wildersburg Antiques

UNION ST

ANDERSEN AV

FORTNEY PL

LUNDE LN

ELMWOOD AV

GARCIA LN

PLEASANT ST

JARVIS ST

MILNE ST

BROOK ST

MAPLE AV

BANK ST

LONG ST

QUINLAN DR

MAPLEWOOD AV

CAMELS HUMP DR

Good Samaritan Haven

Guy's Repair Shop

BARRE CITY

Beverage Baron

CORTI ST

Hera Beauty Shop

SUMMER ST

BUGBEE AV

COTTAGE ST

**Downstream Extent of VERI Study Area**

Stevens Branch

CENTER ST

HOWARD ST

GEORGE ST

PIKE ST

RIVER ST

CABLE PL

GRANITE ST

ENTERPRISE ALY

FOSTER ST

WILLIAMS LN

| Site Number | Site Description | Notes |
|---|---|---|
| 7 | Ricker Holdings, LLC at 304 East Montpelier Rd | Remove channel debris from old dump |
| 8 | Woody debris build-up in channel just north of Barre City/Barre Town line | Develop and implement a debris management plan |
| 9 | Gunners Brook floodplain near Barre City/Barre Town line | Preserve floodplain |
| 10 | Farwell St stormwater infrastructure between Turtle Rock Dr & Elmwood Ave | Improve stormwater drainage |
| 11 | Four Buildings on West Bank of Gunners Brook at Intersection of Farwell St & Maple Ave | Consider removing at-risk buildings |
| 12 | Brook St bridge near intersection with Maple Ave | Replace/upgrade undersized bridge |
| 13 | Nine buildings on both banks of Gunners Brook between upper Brook St bridge & Dix Place | Consider removing at-risk buildings and regrading floodplain |
| 14 | Harrington Ave bridge near intersection with Brook St | Remove closed bridge |
| 15 | Channel retaining walls throughout Barre City | Develop flood resilient design standard & repair failing channel walls |
| 16 | Eight to ten buildings on both banks of Gunners Brook between Dix Place & Main St | Consider removing at-risk buildings & regrading floodplain |
| 17 | Seminary St crossing and road between Laurel St & Maple Ave | Replace/upgrade undersized bridge |
| 18 | Lower Brook St bridge between Seminary St & N. Main St | Replace/upgrade undersized bridge |
| 19 | Buildings & outbuildings at risk of frequent flooding from upper Brook St bridge to Stevens Branch | Consider removing at-risk buildings |
| 20 | N. Main St bridge between Blackwell St & Ossola Pl | Replace/upgrade undersized bridge |

Background imagery from VCGI. Map composed on February 2, 2015.

# Appendix I:
# Projects to Protect Businesses and Infrastructure – Table

## Barre

**Recommended Projects to Protect Businesses and Infrastructure from Flooding**
**Vermont Economic Resiliency Initiative (VERI)**
**March 31, 2015**

**Legend**
● Effective ◒ Limited ○ Ineffective

* Priority rating based on objectives and potential business impact

| | | | | OBJECTIVES | | | FEASIBILITY | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| **Building and Site Improvements** | | | | | | | | | | |
| Floodproof multiple buildings in floodplain from upper Brook Street bridge down to the Stevens Branch **(see site 19 on Map 1)** | Commercial Buildings, single and multi-family homes | 18 local businesses and 170 employees, >65 multi-family dwellings | **High** | ○ | ○ | ● | Moderate | <$10K per building | 2-5 years | Floodproofing would include operational measures (e.g., no storage of materials below flood level) and physical measures specific to each building (e.g., flood barriers at entrances) in accordance with FEMA floodproofing guidance. Buildings below Seminary Street are at risk of flooding from both Gunners Brook and Stevens Branch. Above Seminary Street the flood source is exclusively Gunners. |
| Floodproof the Bates & Murray, Inc. building **(see site 4 on Map 1)** | Parking lot and commercial building | 1 local business with 51 employees | Medium | ○ | ○ | ● | Moderate | <$10K | 1-2 years | May 2011 eroded Gunners Brook bank and a tributary (Ketchum Brook) eroded the parking lot and damaged retaining wall. The building flooded. Gunners and tributary banks have been reconstructed. With a large enough storm, the building will flood again. The building is on a conrete floor, so raising it is not practical. Floodproofing would reduce damages. |
| | | | | | | | | | | |
| **Channel and Floodplain Management** | | | | | | | | | | |
| Develop a Flood Resilient Design Standard for channel walls throughout the City. **(see site 15 on Map 2)** | Land and buildings adjacent to channel in Barre City | >10 local businesses and 40 employees; >30 multi-family dwellings | **High** | ◒ | ● | ● | Easy | $10K-$50K | 1-2 years | Nearly the entire length of channel downstream of the upper Brook Street bridge is walled. The "Flood Resilient Design Standard" would provide a larger channel with at least one bank slope on which debris has an opportunity to collect. It would likely require property owners to give up some land to the brook. The intent would be to facilitate permitting of wall repairs, incrementally progress toward a larger more flood resilient channel, and possibly (in the name of flood resiliency) qualify the work to public funding. The design would be developed in coordination with State and Federal regulators. |
| Repair failed channel walls throughout City using the Flood Resilient Design Standard. **(see site 15 on Map 2)** | Land and buildings adjacent to channel in Barre City | >10 local businesses and 40 employees; >30 multi-family dwellings | **High** | ◒ | ● | ● | Moderate | >$200K | >5 years | This is implementation of the "Flood Resilient Design Standard" developed in the previous mitigation strategy. |
| Remove the now-closed Harrington Avenue Bridge **(see site 14 on Map 2)** | Town Road and adjacent buildings | >10 local businesses and 40 employees; >30 multi-family dwellings | **High** | ● | ● | ● | Easy | $50K-$100K | 1-2 years | Bridge damaged during May 2011 flood and has not been open to traffic since. Adjacent homeowner reports four out-of-bank flood events at the bridge since 1998, all involving debris. There are no utilities associated with the crossing. Initial public input suggests loss of pedestrian access is acceptable. Removing the bridge deck could help reduce the collection of debris, but additional work to remove the bridge abutments and restore nearby floodplain would do more to reduce the flood risk. |
| Develop and implement a Debris Management Plan **(see site 8 on Map 2)** | Buildings and roads in the Gunners Brook floodplain in Barre City | >10 local businesses and 40 employees; >30 multi-family dwellings | **High** | ● | ◒ | ● | Moderate | $10K-$50K | 1-2 years | There is a risk of woody debris observed in this area moving downstream into developed area and snagging at undersized structures causing out-of-bank flooding. However, the woody material observed in this area is acting as a trap for more wood and for sediment. A strategy to identify and manage debris risk would serve the City well. |
| Preserve floodplain near the Barre City/Barre Town line **(see site 9 on Map 2)** | Buildings and roads in the Gunners Brook floodplain in Barre City | >10 local businesses and 40 employees; >30 multi-family dwellings | Medium | ◒ | ◒ | ◒ | Moderate | $10K-$50K | 2-5 years | There is particularly good floodplain access in this area that reduces flood flows and promotes sediment and woody debris deposition (before they reach more developed locations). Mechanisms for preserving floodplain include easements, adoption of River Corridors, and zoning. |
| Remove debris adjacent to channel from former dump at Ricker Holdings, LLC **(see site 7 on Map 1)** | Buildings and roads in the Gunners Brook floodplain in Barre City | limited | Low | ◒ | ◒ | ◒ | Moderate | $50K-$100K | 2-5 years | Debris blockage from trash and poor aesthetics (character). Possible contaminated soils and access to private property could complicate the project. |
| | | | | | | | | | | |
| **Infrastructure Improvements** | | | | | | | | | | |
| Replace undersized culvert on Plainfield Brook Road **(see site 3 on Map 1)** | Town Road | >10 local businesses and 40 employees | **High** | ● | ● | ● | Moderate | $100K-$200K | 2-5 years | Existing culvert is undersized (approximately 40% of channel width) and is prone to debris blockage that could cause road to overtop and fail. The road delivers vehicles to US Route 14, the main North-South link between Barre City and Barre Town. |
| Monitor stability of Plainfield Brook Road Embankment below Ketchum Brook Tributary and repair erosion **(see site 5 on Map 1)** | Town Road | >10 local businesses and 40 employees | **High** | ○ | ● | ● | Easy | <$10K | 1-2 years | Because the road parallels the stream for a significant distance, there is elevated risk of embankment erosion and road damage. The embankment should be monitored following significant storm events. |
| Replace undersized bridge on Upper Brook Street **(see site 12 on Map 2)** | City Streets and adjacent buildings | >10 local businesses and 40 employees; >30 multi-family dwellings | **High** | ● | ● | ● | Difficult | >$200K | 2-5 years | Bridge was constructed in 1927. The opening is undersized and causes flooding during approximately the 10-year flow. The flooding impacts multiple single and multi-family structures and water flows down Farwell Street. |

[1]**Reduces Flood Risk** - The proposed project/strategy lowers the flood level.
[2]**Reduces Erosion Risk** - The proposed project/strategy lessens the vulnerability of a location to erosion.

## Barre

**Recommended Projects to Protect Businesses and Infrastructure from Flooding**
**Vermont Economic Resiliency Initiative (VERI)**
**March 31, 2015**

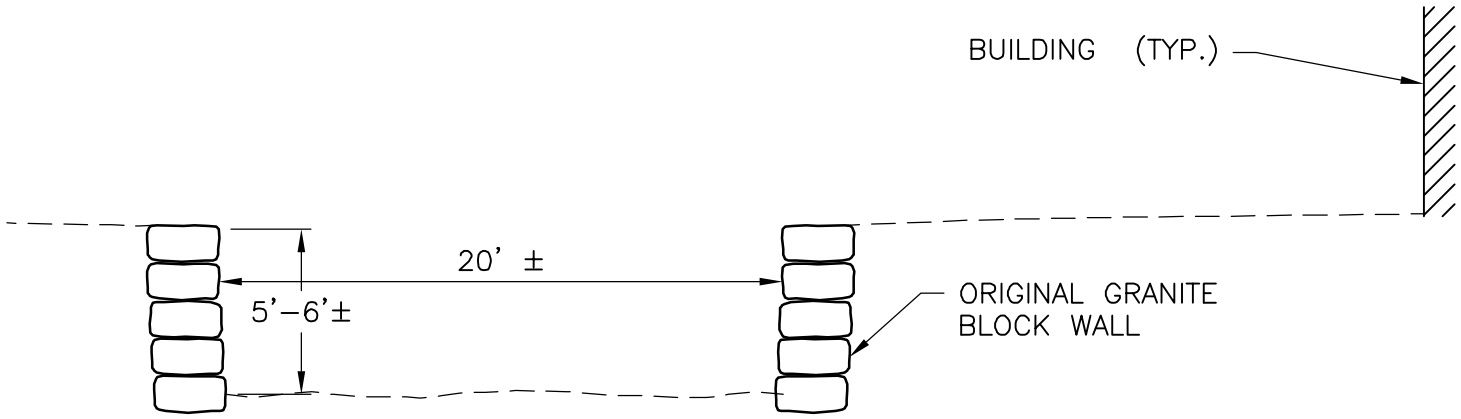
**Legend**
● Effective ◒ Limited ○ Ineffective

* Priority rating based on objectives and potential business impact

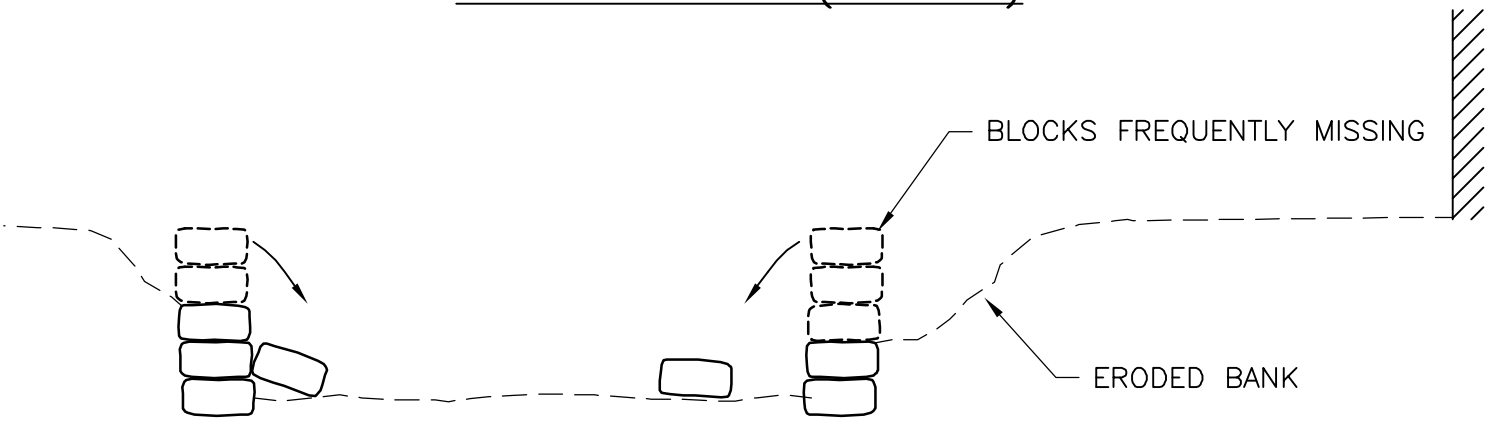
| | | | | OBJECTIVES | | | FEASIBILITY | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| Replace undersized culvert on Mitchell Road **(see site 1 on Map 1)** | Town Road | limited | Medium | ● | ● | ● | Moderate | $100K-$200K | 2-5 years | Existing culvert is undersized (approximately 40% of channel width) and is prone to debris blockage that could cause road to overtop and fail. Road is unpaved and has relatively low traffic volume. |
| Improve river and road stability on Plainfield Brook Road **(see site 2 on Map 1)** | Town Road | >10 local businesses and 40 employees | Medium | ○ | ● | ● | Easy | $10K-$50K | 1-2 years | The road embankment has been repaired (presumably following May 2011) but remains vulnerable to future erosion. Repairs should be done to current flood resilient standards that include larger rock than was used in previous repairs. The road delivers vehicles to US Route 14, the main North-South link between Barre City and Barre Town. |
| Replace undersized culvert on East Montpelier Road (US Route 14) **(see site 6 on Map 1)** | State Highway | >10 local businesses and 40 employees | Medium | ◒ | ◒ | ◒ | Difficult | >$200K | >5 years | Existing culvert is undersized (approximately 55% of channel width), but it is in good condition. Though it is narrow, it is relatively tall and is reported to effectively pass debris during flood events. |
| Replace undersized bridge on Seminary Street **(see site 17 on Map 2)** | City Streets and adjacent buildings | >10 local businesses and 40 employees; >30 multi-family dwellings | Medium | ◒ | ◒ | ◒ | Difficult | >$200K | >5 years | Bridge was constructed in 1972 and is located at approximately the upstream limit of the 100-year flood on the Stevens Branch. Adjacent buildings and other site constraints make installation of a taller or wider structure very difficult. |
| Replace undersized bridge on Lower Brook Street **(see site 18 on Map 2)** | City Streets and adjacent buildings | >10 local businesses and 40 employees; >30 multi-family dwellings | Medium | ◒ | ◒ | ◒ | Difficult | >$200K | >5 years | Bridge appears to be 1930s construction. The surroudnign channel walls are narrower than the bridge opening. The bridge would be fully submerged by the 100-year flood on the Stevens Branch. |
| Replace undersized bridge on N. Main Street **(see site 20 on Map 2)** | State Highway and adjacent buildings | >10 local businesses and 40 employees; >30 multi-family dwellings; regional impacts | Medium | ◒ | ◒ | ◒ | Difficult | >$200K | >5 years | The bridge opening is 19' side by 6.4' high. The width matches surrounding channel walls. There is a sewer crossing inside the bridge on the stream bed. The bridge is fully submerged by the 100-year flood on the Stevens Branch. |
| Improve stormwater drainage on Farwell Street **(see site 10 on Map 2)** | City streets | limited | Low | ○ | ● | ◒ | Moderate | $50K-$100K | 2-5 years | There were washouts and areas of missing pavement on Farwell St following the May 2011 storm. Mitigation efforts should address locations of prior repeat damage. |
| | | | | | | | | | | |
| **Public Safety Improvements** | | | | | | | | | | |
| Consider buyouts for 3-4 at-risk buildings on right bank above upper Brook Street bridge **(see site 11 on Map 2)** | Single and multi-family homes | 2 multi-family and 2 single family dwellings | **High** | ● | ● | ● | Difficult | >$200K | >5 years | This is a long-term strategy that would follow a feasibility study. Removing the buildings would prevent repeated damages and allow the floodplain to be restored to promote deposition of woody debris in the floodplain instead of at bridge openings. Some buildings are located in the newly-mapped FEMA floodway. |
| Consider buyouts for 6-9 of the most at-risk buildings between upper Brook Street bridge and Dix Place **(see site 13 on Map 2)** | Single and multi-family homes | >2 multi-family and >4 single family dwellings | **High** | ● | ● | ● | Difficult | >$200K | >5 years | This is a long-term strategy that would follow a feasibility study. The buildings on the right bank are generally subject to the greatest flood depths and velocities. Removing them would prevent repeated damages and allow the floodplain to be restored to promote deposition of woody debris in the floodplain instead of at bridge openings. Some buildings are located in the newly-mapped FEMA floodway. |
| Consider buyouts for 8 - 10 of the most at-risk buildings between Dix Place and Main Street **(see site 16 on Map 2)** | Single and multi-family homes | 7 multi-family dwellings and 1 local business with 3 employees | **High** | ● | ● | ● | Difficult | >$200K | >5 years | This is a long-term strategy that would follow a feasibility study. Removing these buildings would prevent repeated damages and allow the floodplain to be restored. These properties are subject to flooding from both Gunners Brook and from Stevens Branch. In combination with additional buyouts upstream of Dix Place, this project would provide a largely unobstructed floodway throughout the City. Some buildings are located in the newly-mapped FEMA floodway. |
| Remove multiple unused outbuildings adjacent to channel from upper Brook Street bridge to Stevens Branch **(see site 19 on Map 2)** | Commercial Buildings, single and multi-family homes | >10 local businesses and 40 employees; >30 multi-family dwellings | Medium | ◒ | ○ | ● | Moderate | $10K-$50K | 1-2 years | There are a number of damaged and unused garages and sheds immediately adjacent to the channel. During flood events they elevate flood levels and may become sources of debris that worsens flooding downstream. Many of these are now (as of 2014) in the mapped FEMA floodway, which limits the ability to repair or replace them. |

[1]**Reduces Flood Risk** - The proposed project/strategy lowers the flood level.
[2]**Reduces Erosion Risk** - The proposed project/strategy lessens the vulnerability of a location to erosion.

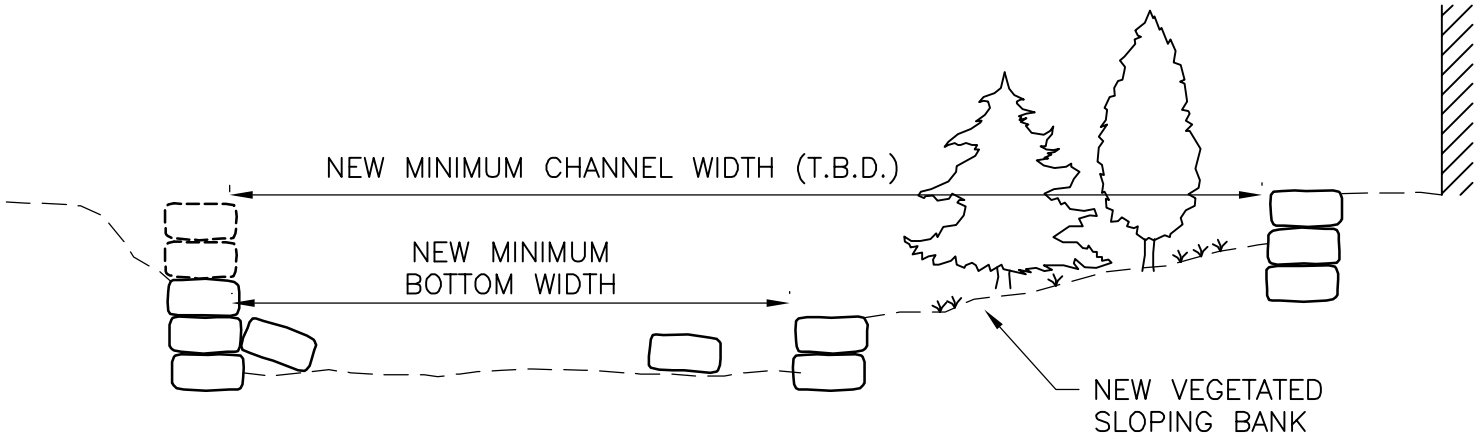
# Appendix J:
# Conceptual Design Drawing for Flood Resilient Channel Walls




ORIGINAL WALL (TYPICAL)




CURRENT CONDITION (TYPICAL)




FLOOD RESILIENT DESIGN CONCEPT

DuBois & King inc.
ENGINEERING • PLANNING •
MANAGEMENT • DEVELOPMENT

VERI-BARRE
GUNNARS BROOK

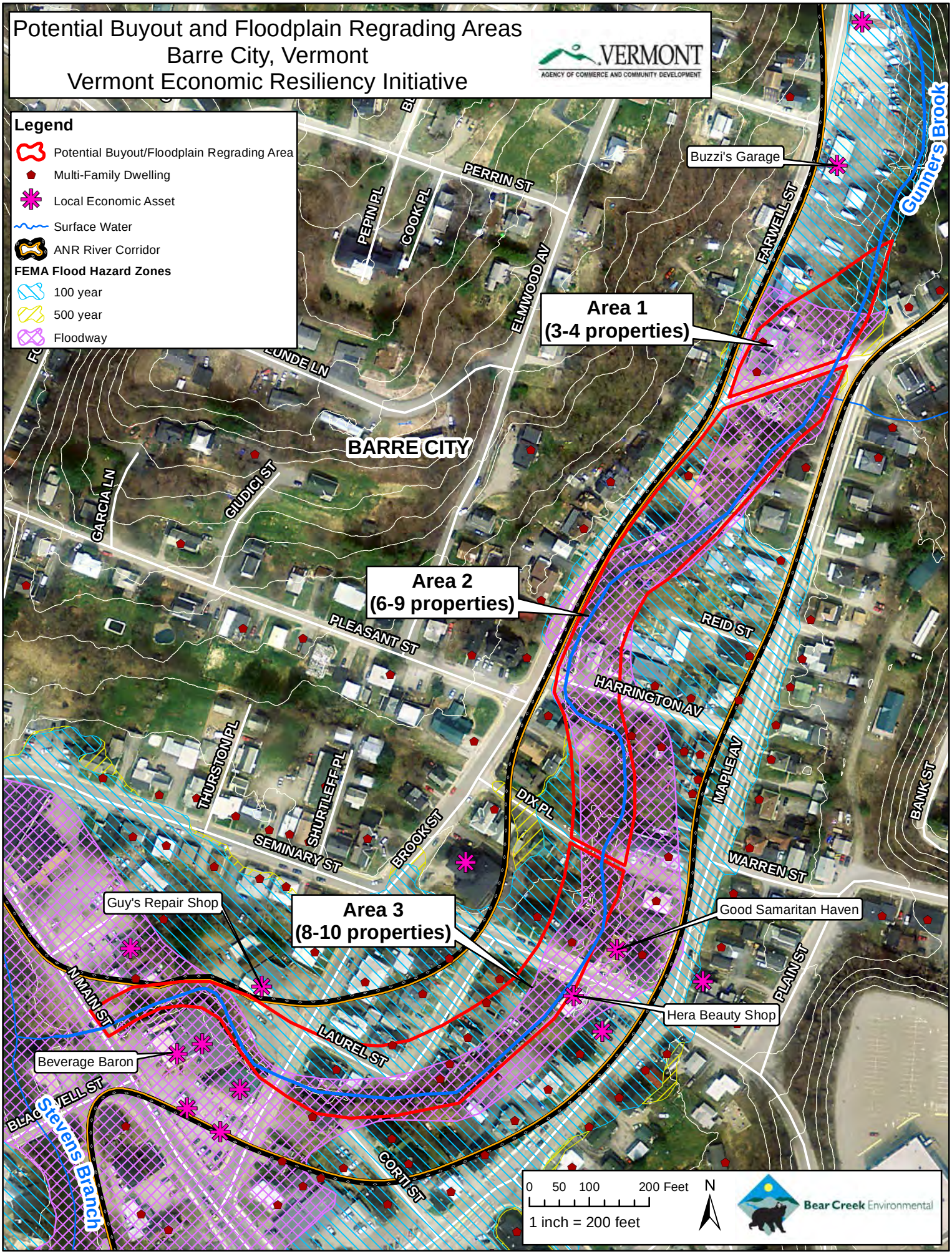
FLOOD RESILIENT
CHANNEL WALL DETAILS

| DRAWN BY | DATE |
|---|---|
| ZDC | FEB. 2015 |
| CHECKED BY | D&K PROJECT # |
| MTM | 122618L |
| PROJ. ENG. | SCALE |
| MTM | N.T.S. |

FIGURE

I:\122618_VERI_Flood_Resiliency\Barre-Gunnars\CAD\122618L Barre-DT01.dwg 2/27/2015 12:07 PM

# Appendix K:
# Conceptual Design Site Plan for Relocation of Most At-Risk Buildings






Background imagery from VCGI. Map composed on January 2, 2015.

# Appendix L:
# Community Forum Meeting Notes

# Vermont Economic Resiliency Initiative (VERI)

# Community Forum – Barre City and Barre Town

## MEETING NOTES

October 27, 2014 – 6:00 – 8:00 PM

### Project Overview

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.
VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy.

### For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI

### Summary

25 community members, business owners, and homeowners from the Gunners Brook watershed Barre City and Barre Town attended the Vermont Economic Resiliency Community Forum. The community identified numerous river and flooding problems along the Gunners Brook. They include Harrington Ave Bridge which traps large debris forcing flood waters out of the river channel and onto the streets. And collapsed and failing retaining walls that line Gunners brook and narrow the river channel width. Further analysis and technical assistance needs of the community emphasized the need to trap and store debris upstream of Barre City so that it does not become lodged under the bridges. Repair or removal of the retaining walls so that the channel can have more access to flood plain. Also education on river dynamics and being good stewards of them is an important step.

### Present

- Residents and Business Owners: Samantha Davisthocock, Lucille Dente (Dente's Market), Patrick Gilbert, Scott Bascom, Al Flory (Northfield Savings Bank), Casey and Bob Harrington (Beverage Baron), Ken Alger, Wendy Alger, Connie Godin
- Barre City: Steven E. Mackenzie, Thom Lauzon, Jackie Calden, Michael Smith

- Barre Town: Andrew Dorsett, Jack Mitchell, Tom White
- Technical Assistance: Mary Nealon (Bear Creek Environmental) and Matt Murawski (DuBois and King)
- Regional Planning Commission: Susan Sinclair, Dan Currier, Emily Nosse-Leirer
- State of Vermont: Noelle MacKay and Wendy Rice (DHCD), Sasha Pealer (VT ANR DER River Program)

## Introduction

Steven MacKenzie (Barre City Manager) welcomed everyone and gave a brief statement as to why Barre City is participating in the Vermont Economic Resiliency Initiative (VERI) project. Namely that the VERI project study would help provide the research and strategies needed to deal with the flooding that occurs along Gunners Brook. He next introduced Commissioner Mackay from the Vermont Department of Housing and Community Development. Commissioner MacKay welcomed everyone and thanked people for participating in a first round of community forums presently being held in five Vermont communities state-wide. She next introduced the VERI project team including staff from the Central VT Regional Planning Commission, the Consultant team, and staff from VT ANR River Program. The Commissioner explained that the community forums are examining ways to improve economic resiliency for natural disaster impacted communities in the aftermath of Tropical Storm Irene. Through the Vermont Economic Resiliency Initiative, the State will analyze risks to public infrastructure, alongside economic activity, river corridor and flood data, to better mitigate future flood hazards and to ensure businesses rebound quickly. The Commissioner provided the audience with a VERI project overview and the findings of the first two phases of the project. After her introductory remarks, the Commissioner explained that the purpose of the meeting was to collect information about risks to infrastructure and economic activity observed during Irene, subsequent risk reduction, and suggested improvements for long-term resiliency.

## Overview of the Riverine Study Area

The State has contracted with a team of river scientist and engineers to review the geomorphology (defined as the study of landforms interacting with flowing water), flood hazard risks, sediment deposition potential, and impacts to the built environment of select rivers and tributaries within each targeted VERI community. The scientists presented an overview of their work and initial observations in the river corridors at each of the community forums and provided technical assistance to the respective community throughout the meeting.

Notes

- Matt Murawski of DuBois and King talked about the data gathered along Gunners Brook which includes: stream crossing, hydrology, river channel widths, exposed bedrock, bank erosion, landslides, and encroachments from development, floodplain areas, and bridge crossings. Additionally the river engineers are also modeling the flood levels along Gunners Brook and Stevens Branch to determine how they affect each other.
- Some of the observations so far include: the stream varies greatly from top to bottom with a more natural channel up stream and a more managed channel downstream. There are many landslides which are providing large amounts of sediment and debris into Gunners Brook. Matt also noted that the first bridge crossing in Barre City measures only 29 feet and that the bridge crossings become narrower as one moves down stream to the junction with the Stevens Branch. In past flooding events, the geomorphology of Gunner's Brook caused the water to rise relatively slowly over time, instead of being a rushing current. The consultant team will be look at all of these factors and more when they develop their strategies and recommendation for Gunners Brook.
- The draft of the study report will be ready by January 2015 with the project end date sometime in June 2015? The study and report will focus only on the Gunners Brook in Barre Town and Barre City and it will not analyze the headwaters in Plainfield.

### For more information on past river studies

This area has had a river study completed in the past and the consultants are incorporating this past work in to the VERI project. That study can be found here: http://map1.msc.fema.gov/data/50/S/PDF/50023CV001A.pdf.

### Public Input

The DHCD Commissioner solicited input from forum participants with regard to flood risk and mitigation opportunities in Barre City and Town. The questions posed were:

1) What are the hazards and risk areas in the town?
2) What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?
3) What still needs to be addressed in the interests of long-term security and sustainability?
4) What information should the final report include and how should this information be presented?

Identified hazards and risks will be further analyzed in Phases 3 and 4 of VERI.

## Identified Natural Disaster Hazards and Business Risks

What are the hazards and risk areas in the town?

Notes: Responses from the Public

1. Harrington Avenue Bridge
    - It's narrow, low, and fills up with flood-causing debris during storms
    - Residents want the debris to be removed from that area, either through removing the bridge or replacing it with a better structure
    - It made Maple Avenue impassible during the May 2011 flooding
2. The North Main Street Bridge also clogs during flooding
3. The infill near Hope Cemetery is a problem area
4. Retaining walls throughout Barre City are falling into the brook
    - They are hard to repair because no one knows who owns them, who is responsible for maintaining them, and what the prevailing regulations governing work in the waterway are
5. Berlin Street near the lumberyard serves as a choke point as well
6. Community members rake leaves into the street which flow into the stormwater system, clogging it and leading to overflow
7. Buzzi's has a huge deposition area where water just flows over a dirt road
8. Sterling Hill Brook (South Barre) has been in-filled and critical fish habitat loss has been lost
9. Rural roads (Class 3 roads) carry extra sediment into the rivers

## Effective Hazard Mitigation and Risk Reduction

What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?

Notes: Responses from the Public

1. There is better prevention before and during flooding, such as staging bulldozers in problem spots to make sure they don't clog
2. The city has better models and more awareness about the possible extent of flooding and damage
3. The city is implementing planning and zoning that takes flood risk into account

4. Emergency Preparation Plan – public works crews check catch basins, choke points, culverts etc. to decrease flood potential before big storms; Stage backhoes at the 5 bridges in anticipation of major storms.
5. Businesses and property owners are more prepared (for example, not storing inventory or furnaces in basement)
6. City has installed a stormwater catchment area at 62 and North Main Street
7. All of downtown repaved, businesses recovering
8. Stormwater system has more capacity than it did, but this capacity could still get exceeded
9. Planning office requires a permit if you are going to change the grade of your property at all
10. City has a better warning system alerting people to clean culverts etc. when storms are imminent

## Resiliency and Sustainability Planning

What still needs to be addressed in the interests of long-term security and sustainability?

Notes: Responses from the Public

1. Trash racks upstream to capture debris before it get to Barre City bridges
2. A grant or loan program for repairing the retaining walls
3. The granite excavators have filled the river with grout and this probably needs to be dredged. Need to be able to accept more floodwater in the future.
4. Cooperation with upstream neighbors like Plainfield and Williamstown
5. Biannual river inspections with regulatory partners
6. Uphill storm water storage
7. Are there areas in the city that can act as catchment and retention areas
8. A plan for handling the salt/snow/sand mixture on the roads in the winter (sometime these debris are pushed into the river)
9. Channel widening
10. Individual landowner education (how to create water sinks on private property, the risks of putting woody debris or vegetation in the waterway, impacts of snow pack being pushed into the river etc.)
11. Immediate financial aid for businesses after storm events (revolving loan funds?)
12. Regulatory and financial cooperation between the State and municipalities
13. Creation of a regional stormwater management district, mirroring perhaps the structure of the solid waste district approach

14. Try to find a way to related storm water management to Lake Champlain cleanup projects
15. Strategic plan to acquire properties along Gunner's Brook- probably 30-40 places that could be candidates for acquisition

## Information Sharing and Dissemination

What information should the final report include and how should this information be presented?

Notes: Responses from the Public

1. Clarification of who owns and is responsible for the waterway and structures within the waterway such as retaining wall
2. Analysis of the historic flood plain
3. Talk about dredging and its benefits and drawbacks
4. Keep educating business owners on flood resilience
5. Contact information for the appropriate people to get in touch with regarding river and brook issues
6. A timeline of projects to help plan budgeting
7. Prioritization of projects and details about those projects
8. Identification of small but impactful projects

# Vermont Economic Resiliency Initiative (VERI)

# Community Forum – Barre City & Barre Town

## MEETING NOTES

April 16, 2015 – 6:00 – 8:00 PM

### VERI Project Overview

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.
VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy.

### For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI/Barre

### Summary

32 community members, business owners, and town officials from the Gunner's Brook watershed attended the third VERI community forum in Barre City. The forum showcased eight high priority projects which could significantly decrease flood risk for Barre Town and Barre City, if implemented. Community members were given the opportunity to ask questions, provide input, and rank the proposed projects. The projects which the community most supported included: replacing the undersized bridge on Upper Brook Street, considering voluntary buy-outs for the most at-risk buildings between Upper Brook Street and Dix Place, and removing the Harrington Avenue Bridge. Integrating these projects into the municipal bylaws, policies, and plans will help Barre City and Barre Town to be safer and more resilient to future floods.

### Welcome and Overview

[Noelle MacKay, Commissioner of the Department of Housing and Community Development]

Noelle MacKay provided background information on the VERI project and talked about a successful project in Bennington that led to this project. She also explained the process for selecting the five towns included in VERI– each town demonstrated an intersection between flood risk, economic activity and at-risk infrastructure. Barre Town and Barre City were selected as a VERI pilot community

because they ranked high in the state-wide assessment of economic activity and associated infrastructure that is at risk of flooding. Barre City also participated in the Leahy Center Environmental Summit where they talked about the projects and strategies coming out of this study. Commissioner MacKay went over the agenda for the evening and emphasized the importance of community input on the proposed flood reduction projects. The Agency of Commerce and Community Development will work with partners to help identify funding sources once priority projects are chosen.

## Overview of Municipal Policies and Programs to Reduce Future Floods

[Dan Currier, GIS Manager, Central Vermont Regional Planning Commission]

Dan Currier gave a presentation on the accomplishments that Barre City and Barre Town have made toward improving flood resilience, and recommendations from the VERI team for further improvement. Both municipalities have made accomplishments in their community planning programs, and collaboration between the two communities in the future is a key way to reduce flood risk. Land use regulations that meet the National Flood Insurance Program's minimum requirements, like raising buildings one foot above base flood elevation are used in both municipalities. Each also has a Local Hazard Mitigation Plan which recognizes that upgrading bridges and culverts will reduce damage from heavy rainfall and flooding. In Barre City, recommendations from the Vermont Downtown Action Team have been implemented including applying consistent marketing across the city and making improvements to Enterprise Alley.

Dan reviewed the Emergency Relief Assistance Fund (ERAF) chart which summarizes steps each municipality has taken to qualify for State reimbursement for a federally declared disaster. Barre Town currently qualifies for 12.5% State reimbursement and Barre City currently qualifies for 7.5% State reimbursement. These community profiles can be viewed at floodready.vt.gov.

When presenting recommendations, Dan described how activities throughout the Gunners Brook Watershed, in both Barre Town and Barre City, have an impact on flood severity. An example of this is that debris pushed into the river upstream can wash downstream during high water, clogging culverts and making flooding worse. Developing dialogue and collaboration about land use and stormwater management is a low to no cost strategy to minimize damage. Other recommendations are to elevate buildings and basement utilities two to three feet above the baseline flood height, and not to allow fill in flood hazard areas. Filling to elevate buildings pushes water to nearby properties and reduces the land's ability to store the extra floodwater.

## Overview of Project Recommendations

[Matt Murawski, Engineer at Dubois & King, Inc.]

A team of river scientists and engineers conducted field surveys along Gunners Brook, and with community input, developed 22 recommended projects that will protect businesses and infrastructure. Matt Murawski, an engineer with the firm Dubois & King, Inc., presented the top eight recommended projects as follows:

1. Floodproof Buildings from Upper Brook Street to Stevens Branch: Modifications to a building itself such as elevating it, raising basement utilities, sealing the building, filling the basement or using water resistant building materials reduces the costs of damage when the building is flooded. It has been calculated that there is as many as 115 structures at risk in the flood plain along Gunners Brook.

2. Develop a Flood Resilient Design Standard for Channel Walls throughout the City: Downstream of upper Brook Street Bridge, nearly the entire channel is walled. Replacing deteriorating, vertical retaining walls, with more sloped walls, would give more room for the Brook to spread out, and provide a place for debris to settle. This would require landowners to lose some of their level land, but improves the possibility of accessing federal funding to make repairs, which would otherwise have to be paid for by the landowner.

   Notes and Responses from the Public: There was concern that the change along the streambank from a sloped bank to a vertical bank could cause churning of the water at that transition. The solution to this is making the transition gradual rather than a sharp angled change to a vertical wall.

   Participants also wanted to know how much property would need to be consumed to slope back the channel walls. This will vary depending on the width and other characteristics of the stream channel at each property, but a typical distance would be 12-15 feet in from the existing top of the bank.

3. Develop and Implement a Debris Management Plan: Woody debris from upstream clogs undersized bridges and culverts causing out-of-bank flooding. Barre Town and Barre City

could work with the Agency of Natural Resources to develop a plan for preventing and/or removing some woody debris that has fallen in the channel.

Notes and Responses from the Public: A participant noted that debris also catches on the railroad trestle across the Stevens Branch. It is possible a debris management plan would help to protect this structure as well.

4. Remove the Closed Harrington Avenue Bridge: This bridge was closed after flood damage in May 2011 and has experienced at least 4 debris clogs since 1998. Initial public input suggests loosing the pedestrian crossing would be acceptable.

   Notes and Responses from the Public: If the Harrington Ave. Bridge is removed, the problem could just move downstream to the Seminary St. Bridge. Regrading on the left side of the former bridge location could give debris a place to catch and prevent damage downstream.

   Conversation continued about the East Barre Dam, and whether or not putting flood gates on it could reduce flooding downstream. The dam, however, has been designed to retain the maximum flood waters already though. It is unlikely there are modifications that would detain a significant amount of additional floodwater.

   Dredging is a technique that is often thought to reduce flood problems by making the channel deeper to hold more water. However, dredged channels typically fill in again within a few years. Dredging also scours the bottom of the river, and where it starts to eat away at the toes of the river walls or banks, they risk collapsing or eroding further.

5. Replace Undersized Culvert on Plainfield Brook Road: This road provides important access to Route 14 and the culvert is prone to debris blockage. Subsequent flooding could overtop and wash out the road.

6. Monitor Stability of Plainfield Brook Road Embankment: The road parallels the brook, elevating risk of erosion to the bank and damage to the road. The embankment should be checked after significant storm events.

   Notes and Responses from the Public: A participant was interested to know if there was potential for flood water storage in retention ponds along Gunners Brook. This is sometimes possible, but a great deal of space has to be set aside to make a difference in flood levels. The city owned ball field could conceivably be designed to store floodwater. The corner of

Route 62 stormwater project, e.g. the "big dig" will retain stormwater coming off of Main Street.

7. Replace Undersized Bridge on Upper Brook Street: Built in 1927, the undersized opening causes flooding during 10-year storm events. Flooding impacts single & multi-family structures and flows down Farwell Street.

   Notes and Responses from the Public: There is a property where Brook Street meets Maple, and the house is 30 feet from the brook. Sloping the bank back here would reduce the property owner's land. Mr. Murawski explained that engineers take many constraints into consideration when making recommendations and that ultimately communities are often faced with tough decisions when planning for the future.

   High water from the Steven's Branch will back up into Gunners Brook regardless of debris build up on steel beams or other structures on the Stevens Branch. This issue warrants further investigation to better understand the impacts of the Steven's Branch on flooding in Gunners Brook.

8. Consider Voluntary Buy-outs of the Most At-Risk Buildings: This is recommended for the following reaches, and is a long-term strategy that would follow a feasibility study:
   a. Right bank above upper Brook St. Bridge (3-4 structures)
   b. Upper Brook Street Bridge to Dix Place (6-9 structures)
   c. Dix Place to Main Street (8-10 structures)

   Removing these buildings would end repeated damages and restore space for the river to use the floodplain. It would also allow woody debris to be deposited there in the floodplain instead of hanging up at bridges.

   Notes and Responses from the Public: Buy-outs are conducted by evaluating the fair market value of the structure *before* the damage occurred. The FEMA Hazard Mitigation Grant program makes funding available for buy-outs, but there is also a 25% local match that would have to be provided by the municipality. Other communities have used Housing Conservation Board, and the Federal Housing & Urban Development Community Development Block Grants to meet this local contribution. Property owners must also demonstrate repeated occurrences of damage to access FEMA funding for buy-outs.

Other concerns regarding buy-outs were that the properties would no longer generate revenue for the Town/City grand list, and that a significant amount of housing capacity would be lost. Many of the properties recommended for buy-out are multi-family. The feasibility study investigating this recommendation further could look into alternatives for replacement housing capacity.

There was a discussion of whether or not the buy-outs would still produce the desired effect if only a portion of structure owners agreed to the buy-out. As this is a long-term strategy, not all of the buy-outs would need to happen all at once to gain long-term benefit. The first few structures removed would contribute to restoring the floodplain, and the community could continue planning for future buy-outs to improve the situation over time.

## General Discussion

After learning about projects and strategies that are recommended by the VERI Team, the audience continued general discussion about reducing flood risk in Barre Town and Barre City. The following points were made:

- Buying and converting a vacant building in the floodplain into a parking lot for a business would help to restore flood storage space. Without well designed stormwater management, the lot would contribute to stormwater run-off volumes because pavement does not allow rainwater to filter into the ground. This would not make a big difference during the largest flooding events, but would contribute to cumulative stormwater impacts.
- One resident has been flooded four times at his house and always responded to the damage using his own resources rather than relying on the City.
- Flooding in Barre Town and Barre City has been increasing for the last 15 years and this trend is also occurring throughout the state.

## Project Prioritization

Sticky dots were handed out for people to place on the charts to prioritize project recommendations in Barre City and Barre Town. The community's ranking of the high priority projects can act as a road map for the community to follow moving ahead. The results of the project prioritization are below, in order of popularity - with number of sticky dots received in parenthesis.

1. Replace undersized bridge on Upper Brook Street (23)
2. Consider buyouts for 6-9 of the most at-risk buildings between upper Brook Street Bridge and Dix Place (14)
3. Remove the now closed Harrington Avenue Bridge (12)
4. Replace undersized bridge on North Main Street (8)
5. Consider buyouts for 3-4 at-risk buildings on right bank above upper Brook Street Bridge (7)
6. Consider buyouts for 8-10 of the most at-risk buildings between Dix Place and Main Street (6)
7. Develop and implement a Debris Management Plan (4)
8. Repair failed channel walls throughout City using the Flood Resilient Design Standard (3)
9. Update policies allowing fill in flood hazard areas (2)
10. Emphasize watershed-wide stormwater planning to reduce flooding impacts (2)
11. Replace undersized culvert on Mitchell Road (2)
12. Develop a Flood Resilient Design Standard for channel walls throughout the City (2)
13. Preserve floodplain near the Barre City/Barre Town line (2)
14. Educate business owners, landlords and contractors about flood resilience (1)
15. Educate people about the causes, risks and warning signs of floods (1)
16. Require repaired and rebuilt structures to be built higher (1)
17. Document damages from flood events (1)
18. Document road, sewer, and water infrastructure vulnerabilities in municipal and capital plans (1)
19. Floodproof multiple buildings in floodplain from upper Brook Street Bridge down to the Stevens Branch (1)
20. Remove multiple unused outbuildings adjacent to channel from upper Brook Street bridge to Stevens Branch (1)

## Next Steps and Where to Get Help

Barre City and Barre Town have already taken steps to make the town safer, and continuing with this effort is in everyone's best interest. The Barre community can become more flood resilient by understanding the risks and developing bylaws, policies, plans, and projects which address those risks. Community members can help the municipalities to:

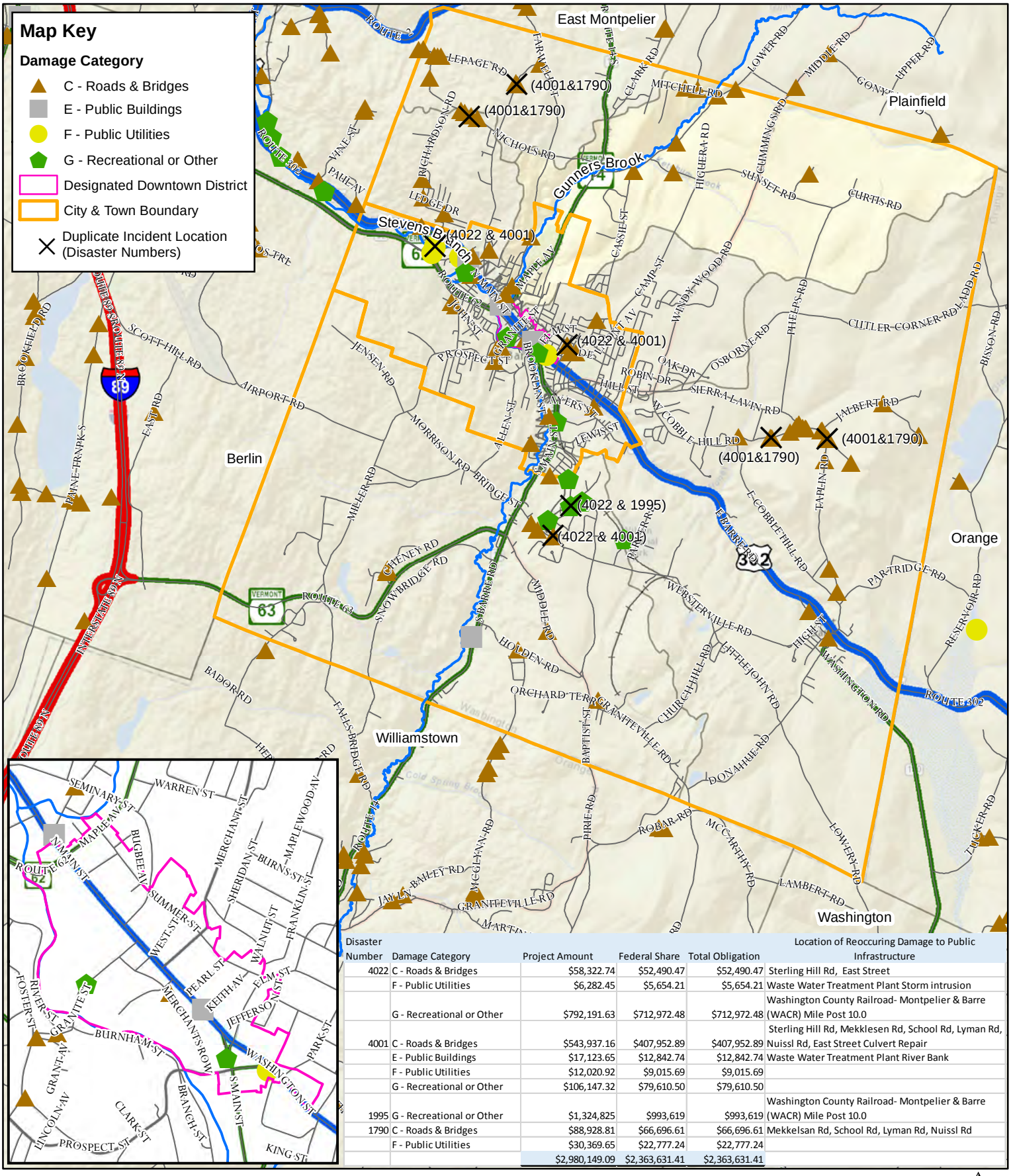
- Prioritize projects to better secure funding.
- Prioritize projects that have support across multiple sectors, municipal government, business, real estate & banking, service and non-profit organizations.

- Try to do a couple of projects per year, not all at once, to better identify resources and to build momentum.
- Know who owns your town's work plan- City Council, Planning Commission, Fire Department or others.

Any comments or suggestions on the draft report can still be sent to Wendy Rice via the VERI website. The final report will be ready for distribution in late May.

# Appendix M:
# Maps of Repetitive Damage for Barre City and Town

# Gunners Brook and Stevens Branch, Barre City & Barre Town, VT




| Disaster Number | Damage Category | Project Amount | Federal Share | Total Obligation | Location of Reoccuring Damage to Public Infrastructure |
|---|---|---|---|---|---|
| 4022 | C - Roads & Bridges | $58,322.74 | $52,490.47 | $52,490.47 | Sterling Hill Rd, East Street |
| | F - Public Utilities | $6,282.45 | $5,654.21 | $5,654.21 | Waste Water Treatment Plant Storm intrusion |
| | G - Recreational or Other | $792,191.63 | $712,972.48 | $712,972.48 | Washington County Railroad- Montpelier & Barre (WACR) Mile Post 10.0 |
| 4001 | C - Roads & Bridges | $543,937.16 | $407,952.89 | $407,952.89 | Sterling Hill Rd, Mekklesen Rd, School Rd, Lyman Rd, Nuissl Rd, East Street Culvert Repair |
| | E - Public Buildings | $17,123.65 | $12,842.74 | $12,842.74 | Waste Water Treatment Plant River Bank |
| | F - Public Utilities | $12,020.92 | $9,015.69 | $9,015.69 | |
| | G - Recreational or Other | $106,147.32 | $79,610.50 | $79,610.50 | |
| 1995 | G - Recreational or Other | $1,324,825 | $993,619 | $993,619 | Washington County Railroad- Montpelier & Barre (WACR) Mile Post 10.0 |
| 1790 | C - Roads & Bridges | $88,928.81 | $66,696.61 | $66,696.61 | Mekkelsan Rd, School Rd, Lyman Rd, Nuissl Rd |
| | F - Public Utilities | $30,369.65 | $22,777.24 | $22,777.24 | |
| | | $2,980,149.09 | $2,363,631.41 | $2,363,631.41 | |



Author: Map provided by the Department of Housing & Community Development (DHCD).
FEMA Data.Gov Map created 1/22/2015.

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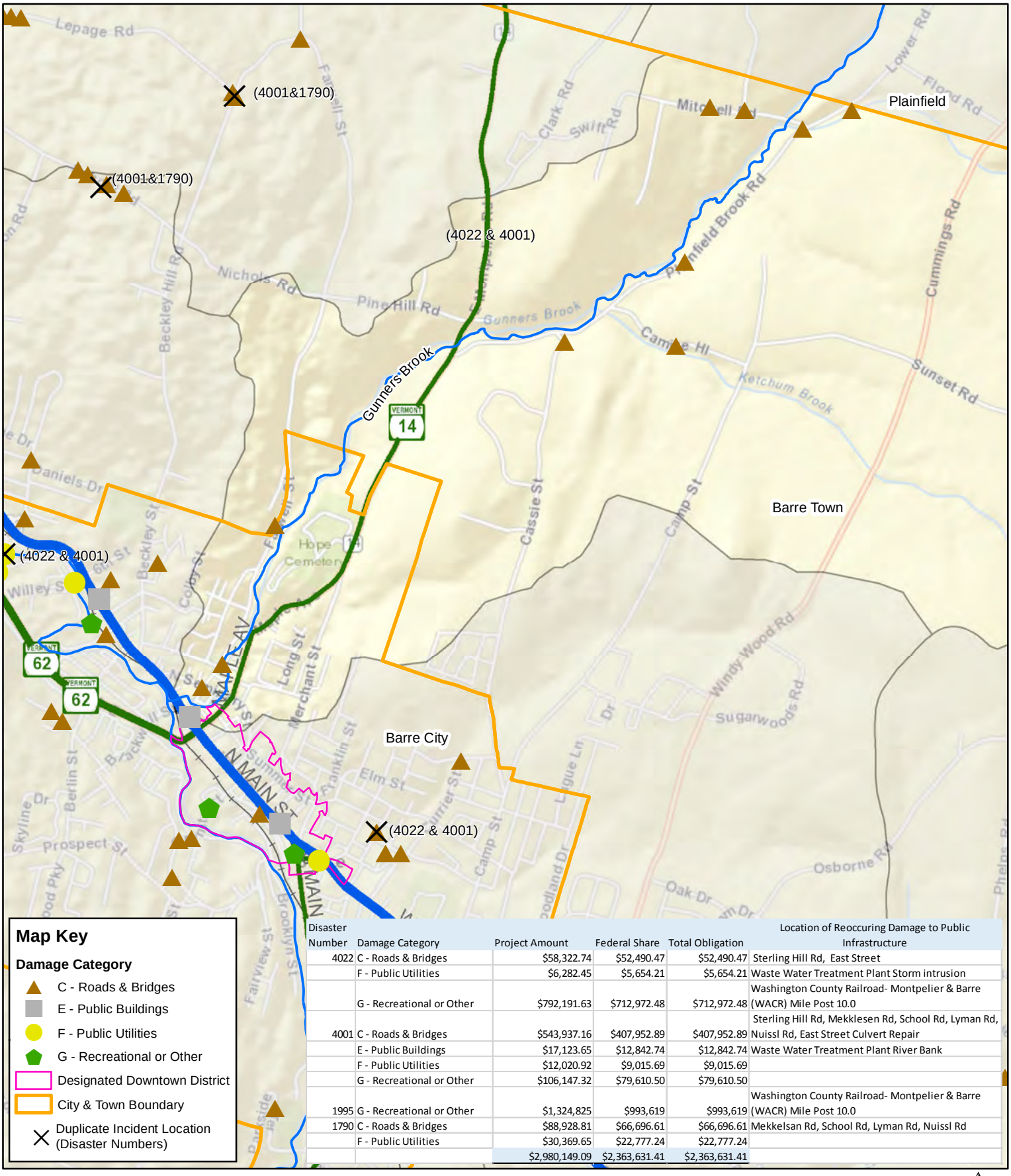
# Gunners Brook, Barre City & Barre Town, VT




**Map Key**

**Damage Category**

- C - Roads & Bridges
- E - Public Buildings
- F - Public Utilities
- G - Recreational or Other
- Designated Downtown District
- City & Town Boundary
- Duplicate Incident Location (Disaster Numbers)

| Disaster Number | Damage Category | Project Amount | Federal Share | Total Obligation | Location of Reoccuring Damage to Public Infrastructure |
|---|---|---|---|---|---|
| 4022 | C - Roads & Bridges | $58,322.74 | $52,490.47 | $52,490.47 | Sterling Hill Rd, East Street |
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Author: Map provided by the Department of Housing & Community Development (DHCD).
FEMA Data.Gov Map created 1/22/2015.

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# Vermont Economic Resiliency Initiative [VERI]

## Consultant Team

DuBois & King inc.

Landslide
Linking people to their landscape
Natural Resource Planning
Community Involvement
Watershed Assessment
Project Coordination
GIS Mapping
Facilitation

Bear Creek Environmental

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MILONE & MACBROOM

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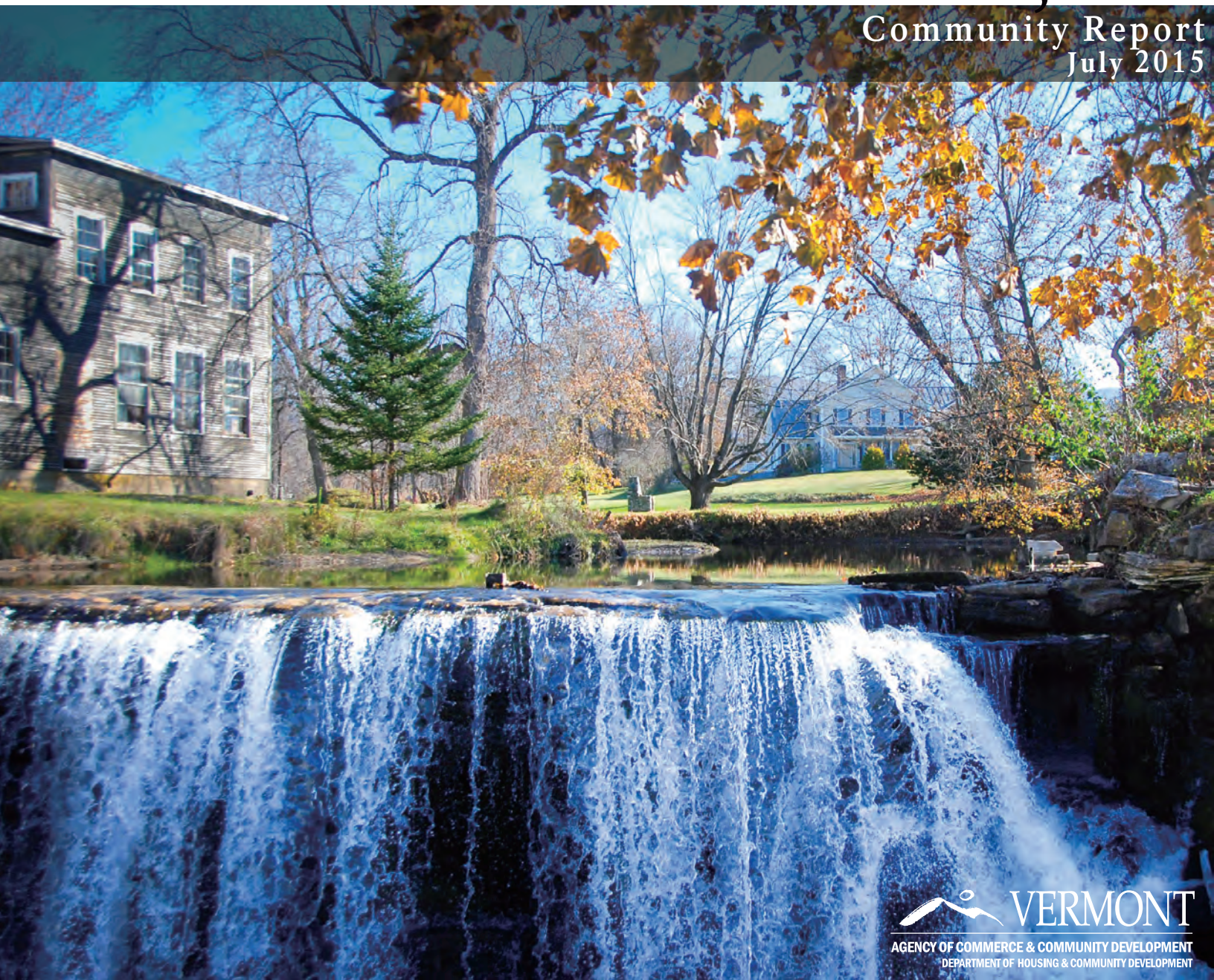
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

# Vermont Economic Resiliency Initiative [VERI]

## Brandon, VT

Community Report
July 2015



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DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

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- Jeff Nugent
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- Peter Gregory
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Central Vermont Regional Planning Commission

- Daniel Currier
- Gail Aloisio

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- Bethany Remmers
- Taylor Newton

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- Bear Creek Environmental, LLC: Mary Nealon
- DuBois & King, Inc.: Matt Murawski
- Fitzgerald Environmental Associates, LLC: Evan Fitzgerald
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Noelle MacKay, Commissioner of Housing and Community Development

# Table of Contents


Vermont Economic Resiliency Initiative (VERI): Brandon Executive Summary ..... i
List of Acronyms ..... v
Glossary of Terms ..... vi
Project Overview ..... 1
  Why was Brandon Selected? ..... 2
  Study Area ..... 2
  Research and Outreach ..... 4
Flood History and Town Accomplishments ..... 6
  Flood History and Risk ..... 6
  Town Accomplishments ..... 9
    Town Wide Flood Policy ..... 9
    Site Specific ..... 10
Strategies and Projects to Protect Brandon ..... 12
  Municipal Policy and Program Recommendations ..... 12
  Specific Project Recommendations ..... 14
    Building and Site Improvements ..... 16
    Channel and Floodplain Management ..... 16
    Infrastructure Improvements ..... 17
Conceptual Project Designs to Protect Brandon ..... 19
  Remove Newton Road Berm ..... 19
    Overview and Objectives ..... 19
    Data Analysis and Results ..... 20
    Conceptual Design ..... 20
    Steps for Project Implementation ..... 21
    Project Benefits ..... 21
  Stabilize Bank at Wheeler Road ..... 21
    Overview and Objectives ..... 21
    Conceptual Design ..... 23
    Steps for Project Implementation ..... 24
    Project Benefits ..... 24
Next Steps ..... 25
  Education and Outreach ..... 26
  What Can Individuals Do to Reduce their Risks? ..... 27
    Steps to Reduce Risks ..... 28
  What Can Businesses Do to Reduce their Risks? ..... 29
    Steps to Reduce Risks ..... 30
References ..... 32

## Figures and Tables

Figure 1: Study area ..... 2
Figure 2: Neshobe River in Forest Dale ..... 3
Figure 3: Neshobe River in downtown Brandon ..... 3
Figure 4: Community forum ..... 4
Figure 5: Flooding in downtown Brandon during Tropical Storm Irene ..... 6
Table 1: Description of Neshobe River flood events and damage ..... 6
Table 2: Businesses in Flood Hazard Zones in VERI study area ..... 7
Figure 6: Flood recovery in downtown Brandon following Tropical Storm Irene ..... 7
Table 3: How Brandon Met its ERAF Match ..... 10
Figure 7: River corridor easement for parcels (shaded green) prone to flooding and erosion along the Neshobe River. Red arrows show the flow of water during extreme storms. ..... 11
Table 4. Categories of Municipal Policies and Programs ..... 13
Table 5: Mitigation Project Types ..... 15
Figure 8: Newton Road berm looking upstream ..... 19
Figure 9: Top of bank failure along Wheeler Road ..... 22
Figure 10: Bank failure site from the upstream right bank floodplain ..... 22
Figure 11: Rootwad installation diagram ..... 23
Figure 12: Log crib diagram ..... 24

## Appendices

Appendix A: Town of Brandon and Neshobe River Data Resources
Appendix B: Town of Brandon Flood Hazards and Flood Damage Maps and Tables
Appendix C: V-DAT One-Page Visual Summary of the Top Recommendations for Brandon
Appendix D: Results of EPA's Flood Resilience Checklist for Brandon
Appendix E: Table of Municipal Policy and Program Recommendations
Appendix F: Maps and Tables of Projects to Protect Brandon
Appendix G: Conceptual Project Designs to Protect Brandon
Appendix H: Community Forum Meeting Notes
Appendix I: Maps of Repetitive Damage to Brandon

# Vermont Economic Resiliency Initiative (VERI): Brandon Executive Summary

In communities around Vermont, rapidly melting snow and torrential downpours bring nightmares of washed out bridges, closed roads, flooded basements and shuttered businesses. To calm these fears, Vermonters have been working to better understand the flood risks they face and identify and implement projects that reduce, avoid or minimize these risks. The goal: to protect lives, help businesses remain open and reduce costs to taxpayers for repetitive repair to infrastructure.

After Tropical Storm Irene, Governor Shumlin challenged us to "build back stronger than Irene found us." This project, the Vermont Economic Resiliency Initiative (VERI), is designed to help meet that challenge. It is modeled after a successful project in Bennington, Vermont that minimized business interruption and saved tax payers money by substantially reducing flood recovery costs (DHCD, 2015 a). With funding from the US Department of Commerce, Economic Development Administration, the Agency of Commerce and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched VERI to help ensure Vermont recovers quickly and remains open for business after disaster strikes.

In the first phase of the project, the VERI team evaluated and ranked areas where economic activity and associated infrastructure are at high risk of flooding. Based on this state-wide assessment, input from the team's economic steering committee and interest from local municipalities, five areas in seven communities (Barre City and Town, Brandon, Brattleboro, Enosburg Village and Town, and Woodstock) were selected for a more detailed analysis of the local flood risks to the community and businesses.

Brandon was selected because it has a densely developed downtown area with significant economic activity and critical transportation infrastructure and commercial buildings at risk of flooding. Brandon also has a history of strong local support of initiatives to reduce flood risks, including past efforts to identify and prevent flood risks throughout the town. For example, Brandon is one of a handful of towns in Vermont that have adopted flood hazard regulations above and beyond the minimum National Flood Insurance Program (NFIP) requirement. As a result of its proactive regulations, Brandon qualifies for the highest level for federal and state reimbursement (75% federal and an additional 17.5% state) of federally-declared disasters through the Emergency Relief Assistance Fund (ERAF). The town has also encouraged the permanent conservation of key floodplains upstream of the downtown to help protect downstream properties and infrastructure during future floods by allowing flood waters to spread out over a large area and slow down the energy and speed of flood waters.

The team hosted two community forums, as well as smaller group meetings and worked directly with local leaders, municipal staff, local businesses and interested citizens to determine the locations of greatest risk and cost, identified potential projects and highlighted the work Brandon has

accomplished to date to reduce the impact of floods. Based on this community insight, along with data collection and analysis, the team evaluated local flood risk to business and infrastructure and identified strategies and projects Brandon can implement to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining the local economy.

This report summarizes the team's work and identifies municipal policy and program recommendations and 13 site-specific projects in Brandon, including the following 10 projects deemed high priority by the team.

## Municipal Policy and Program Recommendations

Top recommendations include the following:

- **Document Road, Sewer, and Water Infrastructure Vulnerabilities in Municipal and Capital Plans:** Specific areas that were damaged or have known vulnerabilities such as those identified in this report should be documented so the community can plan for their replacement in long-term budgets, easing the impact on taxpayers. While capital programs and budgets are not common in smaller towns, the town of Brandon has begun this process. With help from the Rutland Regional Planning Commission (RRPC) and financial advisors, the town should develop a priority project list and process to allocate funds and make these improvements over time.
- **Identify Areas for Conservation:** The Neshobe River Corridor Plan identifies potential riparian easement sites. The town can identify and work with willing landowners to establish conservation sites along the river to prevent future development in flood-prone locations.
- **Identify VERI Project Recommendations in Brandon's Hazard Mitigation Plan:** Once the community has chosen the top recommendations for further action, include these in the town's Hazard Mitigation Plan (HMP). This will help when applying for future Hazard Mitigation Grant Program funding.

## High Priority Specific Project Recommendations

**Building and Site Improvements:** These are projects which lower the risk of flooding and/or erosion to specific properties through improvements to the building and/or surroundings.

- **Floodproof Downtown Businesses:** Multiple buildings in downtown Brandon were flooded during Tropical Storm Irene and one was destroyed. Flood risk may be lowered with the completion of the overflow culvert project, however some risk of flood damage will likely remain during extreme floods. Floodproofing projects (e.g., sealing off buildings to prevent water infiltration) would protect nine businesses and the town offices with a total of 83 employees.

**Channel and Floodplain Improvements:** These types of projects lower the risk of flooding and/or erosion to properties along the river through the improvement of natural river and floodplain functions.

- **Remove Berms Downstream of Route 53 in Forest Dale:** Historic berms along the south bank of the Neshobe River downstream of VT Route 53 in Forest Dale restrict the river's access to a forested floodplain in an area of major flood flow and sediment transport. Berm removal would allow the river to access an undeveloped floodplain upstream of an area along Newton Road where homes were flooded in Tropical Storm Irene, thereby reducing flooding and erosion risks and helping protect several homes and one business with five employees.

**Infrastructure Improvements:** These are projects which lower the risk of flooding and/or erosion to utilities, roadways and other municipal or state-owned infrastructure.

- **Install Downtown Brandon Overflow Culvert:** The Town of Brandon has received a FEMA Hazard Mitigation Grant (Phase 1; $250,000) to design an overflow box culvert in the Village to prevent or reduce flood damage to Route 7 and downtown businesses.
- **Stabilize Bank at Wheeler Road:** An eroding slope along the west bank of the Neshobe River was likely initiated by river erosion on the lower bank. Wheeler Road and a town water main are at-risk if the erosion continues.
- **Replace Route 53 Bridge:** The Route 53 bridge over the Neshobe River in Forest Dale is undersized (i.e., does not accommodate all floods) and should be replaced with a larger span to reduce risk for bridge closure, damage to surrounding property and impacts to local businesses due to bridge closure. This project will significantly reduce flood and erosion risks affecting two businesses with nine employees, a state highway that is a major connector, and several private residences.
- **Replace Wheeler Road Bridge:** The abutments for the Wheeler Road Bridge over the Neshobe River are in poor condition and the bridge is undersized (i.e., does not accommodate all floods). This project will significantly reduce flood and erosion risks along Wheeler Road and VT Route 73, helping to ensure this critical throughway is kept open during floods.
- **Stabilize or Relocate Wastewater Treatment Facility:** Brandon's businesses are highly dependent on a functioning Wastewater Treatment Facility (WWTF), however flooding and erosion have negatively affected Brandon's WWTF for years. The WWTF is aging and major upgrades will be required in the near future, at which point steps to reduce flood risks should be considered in any proposed upgrades or planning of a new facility. This could include the reconnection of adjacent floodplains to take the pressure off of the existing WWTF location, or the planning of a new facility in a different location outside flood hazard zones. This will ensure that the WWTF remains up and running after an event, ensuring businesses can remain open for employees and customers as this facility services over 1,000 residential and commercial connections.

Two of these high-priority projects (berm removal/floodplain restoration in Forest Dale along Newton Road and bank stabilization along Wheeler Road) are further detailed in the report to

help Brandon take the next steps and to create model project designs to help other communities learn from this project.

## Next Steps

As part of the ongoing community discussion regarding the VERI effort, the team recommends the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization.
- Prioritize one to two projects to pursue each year with assistance from the Vermont Department of Environmental Conservation and Rutland Regional Planning Commission staff to identify appropriate funding sources and partners.
- Apply for one to two grants each year to advance project development and/or designs.
- Implement projects as funding allows.
- Monitor project success.

Irene taught us many lessons -- a key one was that no one individual, business, organization, town or state agency can address and tackle large and complicated projects alone. Reducing the risk of future floods in Brandon will require partnerships, funding and time implement. The Agency of Commerce and Community Development, its sister agencies and the Rutland Regional Planning Commission are committed to help Brandon take the steps outlined in this report to save lives and protect jobs and its economy from future storms and floods.

Flooding due to severe storms will happen again, the question is how can we best reduce the recovery costs to communities and ensure businesses remain open.

# List of Acronyms

**ACCD** – Vermont Agency of Commerce and Community Development

**ANR** – Vermont Agency of Natural Resources

**CDBG** – Community Development Block Grant

**CRS** – Community Rating System

**DEC** – Vermont Department of Environmental Conservation

**DHCD** – Vermont Department of Housing and Community Development

**EDA** – US Economic Development Administration

**ELJ** – Engineered Log Jam

**EPA** – United States Environmental Protection Agency

**ERAF** – Emergency Relief Assistance Fund

**FEMA** – Federal Emergency Management Agency

**HMP** – Hazard Mitigation Plan

**NFIP** – National Flood Insurance Program

**RCP** – River Corridor Plan

**RRPC** – Rutland Regional Planning Commission

**SFHA** – Special Flood Hazard Area

**USGS** – United States Geological Survey

**VERI** – Vermont Economic Resiliency Initiative

**VTrans** – Vermont Agency of Transportation

**WWTF** – Waste Water Treatment Facility

# Glossary of Terms

Terms are bolded the first time they appear in the text.

**100-Year Floodplain** – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Flood Zone or 100-Year Flood Hazard Area.

**500-Year Floodplain** – The area that will be inundated by the flood event having a 0.2% chance of being equaled or exceeded in any given year. Also called 500-Year Flood Zone or 500-Year Flood Hazard Area.

**Base Flood Elevation** – The computed elevation to which floodwater is anticipated to rise during a 100-year flood.

**Berm** – An artificial ridge or embankment, e.g., a raised bank bordering a river that prevents flow out of the main channel.

**Community Rating System (CRS)** – Program that provides a flood insurance premium rate reduction based on a community's floodplain management activities. CRS recognizes community floodplain management activities that exceed the minimum NFIP standards. Besides the benefit of reduced insurance rates, CRS floodplain management activities enhance public safety, reduce damages to property and infrastructure, avoid economic disruption and losses, and protect the environment.

**Culvert** – A pipe or tunnel underground, usually under roads, that transports flowing water, sediment, debris and ice from one side to the other.

**Emergency Relief Assistance Fund** – This program allows towns in Vermont to increase the amount of state aid money they could receive as a match to federal aid for post-disaster recovery.

**Erosion** – The wearing away of rock or soil by flowing water.

**Flash Flooding** – Rapid, short-term flooding often caused by severe rain and/or rapid snowmelt.

**Floodplain** – Area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge.

**Floodway** – The area within and immediately adjacent to the channel containing the highest velocity flows that must remain open to allow floodwaters to pass.

**Flood Chute** – A short cut taken by a river or similar waterway during high water, rather than following the normal meandering route.

**Flood Resiliency** – The ability of individuals, communities, organizations and states to adapt to and recover from flooding without compromising long-term prospects for development.

**Fluvial Erosion** – The erosion caused by rivers and streams that ranges from gradual bank erosion to catastrophic changes in river channel location and size during flood events.

**Hamlet** – A small rural community.

**Hazard Mitigation Plan** – A document and planning process that provides actions to reduce the long-term risk to human life, property, and the economy from natural disasters.

**Mitigation** – Any sustained action taken to reduce or eliminate the long-term risk to life and property from hazard events. It is an on-going process that occurs before, during, and after disasters and serves to break the cycle of repetitive damage and repair.

**National Flood Insurance Program** – A federally funded and locally implemented program to reduce the impacts of flooding through individual insurance policies and incentives for floodplain regulations.

**Riparian Buffer** – Mixed composition, vegetated land adjacent to a stream separating it from other land uses.

**Riprap** – The application of rocks to reduce erosion and protect nearby infrastructure or private property. Also known as rock armoring.

**Special Flood Hazard Area** – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Flood Zone or 100-Year Flood Hazard Area.

# Project Overview

In May 2013, the Vermont Agency of Commerce and Community Development (ACCD) received disaster recovery funding from the US Economic Development Administration (EDA) for the Vermont Economic Resiliency Initiative (VERI). The objectives of VERI are to:

1. Analyze threats to areas of economic activity and their associated infrastructure;
2. Develop plans to reduce impacts and avoid future losses and costs; and
3. Identify projects that communities and businesses can implement that avoid, minimize or reduce the risk and thus, ensure businesses stay open, and communities save money in repair costs.

The overarching goal is to ensure that businesses and communities bounce back quickly when disaster strikes, saving time and money in recovery costs.

**The primary objective of the focus area assessments is to develop strategies and projects to make businesses and the communities more resilient to floods and other disasters.**

VERI is led by ACCD's Department of Housing and Community Development (DHCD) in partnership with the Agency of Natural Resources (ANR), Agency of Transportation (VTrans), and Vermont's Regional Planning Commissions, which in Brandon is the Rutland Regional Planning Commission (RRPC). Early in the process, these agencies mapped places where flood hazard risks intersect with areas of economic activity and infrastructure. Five priority communities were selected for a detailed assessment of those risks. These five areas include: Barre City and Town, Brandon, Brattleboro, Enosburg Village and Town, and Woodstock. A river scientist and engineering team consisting of five consulting companies - Bear Creek Environmental, LLC, DuBois & King, Inc., Fitzgerald Environmental Associates, LLC, Landslide Natural Resource Planning, Inc., and Milone & MacBroom, Inc. - were hired to analyze the rivers in each community and assist in developing recommendations to reduce the vulnerability of infrastructure and businesses to flood damage.

A number of factors played a role in the selection of the five communities for more detailed assessments. First, the project team ranked towns across the state by flood risk, economic activity and infrastructure at-risk. Then the team looked at the 20 highest ranking communities and removed any that had undergone or had funding for similar analysis (e.g., Bennington and Waterbury). Next, the team selected five pilot communities that represented different economic profiles (e.g., agriculture, tourism, downtowns) as well as different sizes. Other considerations included risk of future damage, economic factors, and level of community engagement and interest. Together, these factors helped determine the five pilot communities selected.

## Why was Brandon Selected?

Brandon was selected as one of the pilot communities for the following reasons:

- The community has significant economic activity and it is a state-designated downtown;
- Critical transportation infrastructure was identified to be at-risk that, if closed, would impact employees and customers trying to get to businesses and the flow of goods and services;
- Commercial buildings were identified to be at-risk;
- Brandon has strong local support for **flood resiliency** initiatives; and
- Previous efforts have been made to identify flood and **erosion** risks in Brandon and mitigate the risk.

## Study Area

Approximately six miles of the Neshobe River are included in the study area for this project. The area begins approximately one tenth of a mile upstream (east) of the North Street (VT Route 53) bridge in the **hamlet** of Forest Dale, and continues downstream to Brandon's Wastewater Treatment Facility (WWTF) on Union Street. The study area includes the hamlet of Forest Dale and Brandon's downtown. Figure 1 is a map of the VERI study area, shown in red, in relation to roads and populated areas.

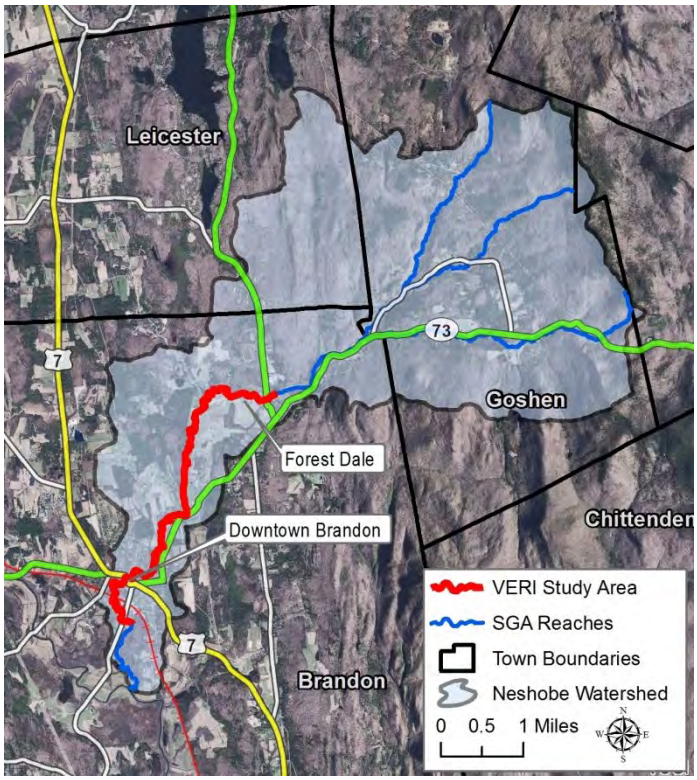


**Figure 1:** Study area

The Town of Brandon is located in Rutland County in central Vermont. The town was founded in 1761, originally named the Town of Neshobe, and was changed to its current namesake in 1784. The 2010 census population was approximately 4,000 people, making Brandon the fourth largest town within Rutland County (Brandon Town Website, 2015). The downtown was built around two churches and now contains a wide range of businesses including restaurants and retail. Commercial and residential development continues along the roads radiating out from the town center. Two additional areas of concentrated development are located within the town: Forest Dale, and an actively developing mixed use area at the historic Brandon Training School. The major economic assets within the town are primarily located within these three areas of development (RRPC, 2011). The remainder of the 40 square mile town is predominantly agriculture along the valley bottoms and forests climbing the slopes of the Taconic Mountains to the west and

the Green Mountains to the east. The downtown contains several important transportation corridors including the Vermont Railway line, US Route 7, a major north-south arterial highway, and VT Route 73, an important connector to central Vermont.

**Figure 2:** Neshobe River in Forest Dale

The Neshobe River is a significant natural feature in the town, passing through Forest Dale and downtown. The river drains a 20 square mile watershed and empties into the Otter Creek west of downtown Brandon. The headwaters flow from the western slopes of the Green Mountains in Goshen. The North Branch and the mainstem converge as the two streams enter the town. The river valley transitions from steep and narrow to very wide and flat near Forest Dale at the intersection of VT Route 73 and VT Route 53 (North Street).

**Figure 3:** Neshobe River in downtown Brandon

Upstream of this transition in Forest Dale, the Neshobe River is a steeper river channel with a rocky stream bed and is typically lined by steep, wooded banks (Figure 2). Below this transition, the river has a lower slope and winds across the valley (RNRCD, 2011). Not including downtown Brandon, land use in the Neshobe River corridor is predominantly agriculture and forest, with small pockets of development along the banks in Forest Dale. The Neshobe Golf Course is located along the east bank of the river for approximately 2,500 feet along Town Farm Road. Dense development fills the river corridor through downtown Brandon, which was built around and over the Neshobe River. Several buildings span or overhang the river (Figure 3) before it enters the twin stone arches under US Route 7 (Center Street) and plunges over a large waterfall. Downstream of downtown the river continues through a broad, flat, and predominantly forested valley to meet the Otter Creek.

## Research and Outreach

The team initiated efforts to gather information about Brandon's flood risks with a kick-off meeting in August 2014 in Brandon. Several community members representing the downtown business association and the Selectboard were present to share information about completed and ongoing flood resiliency efforts initiated by the town. Following this meeting, the team reviewed existing information about the town, the Neshobe River, and associated community hazard planning (see table of data sources in Appendix A). Following the kick-off meeting, DHCD and the Rutland Regional Planning Commission (RRPC) hosted a community forum at the Brandon Town Hall on October 16, 2014 (Figure 4). Community members, business owners, and homeowners attended the forum. DHCD Commissioner Noelle MacKay and Evan Fitzgerald of Fitzgerald Environmental Associates, LLC, provided background about the VERI study and then the floor was open for ideas and questions from community members, and discussion with the group.

**Figure 4:** Community forum

Brandon community members highlighted successfully completed and ongoing flood resiliency projects carried out by the Town along the Neshobe River, including:

- Restoration of **riparian buffers** and **floodplains** following Tropical Storm Irene;
- Adopting more stringent flood hazard regulations, including restriction of development in the **100-year floodplain** and the **fluvial erosion** hazard zone;
- Beginning a study of an "overflow **culvert**" in downtown Brandon to reduce flood risks in future floods; and
- Creating river corridor easements to protect areas vulnerable to flooding.

Participants also highlighted areas vulnerable to flooding and erosion, including:

- Flooding and drainage problems along Newton Road and Furnace Road in Forest Dale, and along Route 7 (Center Street) and Pearl Street in the downtown;
- Risks to the Forest Dale Mobile Home Park and the Town Hall (and other buildings downtown) located in the **floodway**; and
- Vulnerability of the wastewater infrastructure along Maple Street and Briggs Lane.

The river scientists on the team also completed field surveys of the Neshobe River to gain a first-hand understanding of the state of the river following flooding caused by Tropical Storm Irene in 2011. Local community insight gained at the community forum helped guide this fieldwork. The

river scientists visited the watershed on several occasions between August and December 2014 and walked the entire length of the Neshobe River within the study area (see maps in Appendix E). The team made the following observations:

- Locations and dimensions of bank erosion and armoring;
- Locations of significant wood debris accumulation in the channel;
- Historic and recent **berms** that restrict or prevent floodplain access;
- Bridge and culvert dimensions and conditions;
- Riparian buffer conditions;
- Areas of severe river channel instability; and
- Areas of high quality aquatic habitat.

Input gathered at the workshops and meetings, along with the research completed by the VERI team, were used to develop the recommendations to help the community prepare for, manage, decrease risk, and reduce the economic costs of future losses due to flooding. In the sections that follow, the team has outlined specific projects as well as plan and bylaw updates that can help ensure businesses remain open and infrastructure continues to function. Estimated costs, funding sources and benefits associated with implementing the recommendations are included.

# Flood History and Town Accomplishments

The Town of Brandon has experienced severe property and infrastructure damage from flooding along the Neshobe River since the 1920's. Severe and widespread damage occurred during Tropical Storm Irene throughout Brandon. With input from RRPC and the community, the team has identified key flood risks in Brandon.

**Figure 5:** Flooding in downtown Brandon during Tropical Storm Irene (Janet Mondlak, 2011)

## Flood History and Risk

Major flooding damage along the Neshobe occurred during three very large storm events in 1927, 1938, and 2011 (Figure 5). It is likely that each of these three floods equaled or exceeded the 100-year flood events. Photographs and descriptions of damage in the downtown area during the 1938 flood are very similar to impacts from Tropical Storm Irene in 2011 (The Reporter, 2011). The Town **Hazard Mitigation Plan** (HMP) also lists several repeat flood damage areas along the Neshobe River including: the Wastewater Treatment Facility, Newton Road, Union Street, and the downtown area (Center Street and Conant Square). Damage during recent and historic flooding events, and associated recovery costs, are summarized below in Table 1 (RRPC, 2011). Smaller scale **flash flooding** events over the last decade have typically affected smaller areas within the watershed, such as Newton Road in Forest Dale.

**Table 1: Description of Neshobe River Flood Events and Damage**

| Flood Date | Damage Description | Estimated Recovery Cost |
|---|---|---|
| November, 1927 | Major flooding damage to downtown | Unknown |
| September, 1938 | Major flooding damage to downtown | Unknown |
| April, 1996 | Flooding affects Brandon | $10,000 |
| June, 1996 | Flash flooding | $10,000 |
| July, 2003 | Flash flooding in Brandon and Forest Dale | $25,000 |
| February, 2008 | Flash flooding affects Forest Dale | $100,000 |
| August, 2011 | Major damage throughout Town | >$800,000 |

The team analyzed maps to identify at-risk businesses and facilities in the flood hazard zones (Appendix B). The businesses at highest risk have at least a portion of their building in the designated Federal Emergency Management Agency (FEMA) floodway. During a flood event, the floodway typically conveys the highest velocity waters. The team also identified businesses and

important facilities and utilities in the 100-year floodplain (also known as the **Special Flood Hazard Area**) and the Fluvial Erosion Hazard (FEH) Zone adopted by the Town of Brandon. Within these three flood zones, over 25 businesses with over 100 employees are at-risk.

| Table 2: Businesses in Flood Hazard Zones in VERI Study Area | | | |
|---|---|---|---|
| **Measure** | **Floodway** | **100-Year Flood Zone** | **FEH** |
| Number of Businesses | 2 | 14 | 14 |
| Number of Employees | 5 | 40 | 86 |

These data only show if buildings are within the flood zone and do not show the elevation of the building relative to the flood zone elevation.

The flood hazard summary report for the town lists 67 properties within the FEMA-mapped Special Flood Hazard Area (SFHA), of which only 18 (27%) have flood insurance (Flood Ready Vermont, 2015). Four critical public facilities are located in the SFHA. The team's mapping analysis also showed that only 6% of the 100-year flood zone is currently developed in the Town of Brandon. This is significant as undeveloped areas do not have structures or infrastructure that would be impacted and thus keeping development in these areas at a minimum helps eliminate the potential for impacts. These areas often help slow or sink flood water and reduce the risk to developed areas.

Many significant property and infrastructure concerns were also identified in the Neshobe River Corridor Plan (RCP) (Bear Creek Environmental, 2011) and during subsequent field visits and mapping exercises in 2014 and 2015 as part of our analysis. A summary of significant flood risks to business, residential and municipal property and infrastructure is provided below.

## *Business Property Risks*

In downtown Brandon there are over two dozen business properties located within flood and erosion hazard areas. At least 26 businesses sustained damages during Tropical Storm Irene flooding in 2011 (see damage maps and table in Appendix B). During this storm, floodwaters spilled out of the Neshobe River's banks and flowed through downtown along Center Street (US Route 7), causing extensive damage to businesses and forcing the closure of US Route 7 for several days (Figure 6). Three business locations were destroyed in downtown during this flood.

**Figure 6:** Flood recovery in downtown Brandon following Tropical Storm Irene (wingsovermont.com, 2011)

The Neshobe Golf Club, upstream from the downtown along Neshobe River, is located in the 100-year flood zone and the Town's fluvial erosion hazard zone. This business has experienced $100,000 in damages during recent floods. During Tropical Storm Irene, floodwaters were

approximately eight feet deep and two feet of sediment was deposited on the course close to the river.

Agricultural lands located along Town Farm Road and Newton Road are susceptible to flooding and bank erosion. Flooding and erosion risks are especially severe in the vicinity of the Town Farm Road Bridge, where floodwaters spilled out of the river's banks during Tropical Storm Irene and caused extensive damage to crop fields.

In Forest Dale, two private businesses and a US Postal Service building are located in the 100-year flood zone. Both of these buildings were damaged by floodwaters and mud/debris during the 2011 flood.

The damages noted above impact the individual business, those working at those businesses, customers and the broader local and regional economy.

### *Municipal Property and Infrastructure Risks*

The Brandon Wastewater Treatment Facility (WWTF) is adjacent to the Neshobe River at the intersection of Maple Street and Union Street, south of downtown. The facility was threatened by flooding and erosion and nearly lost a critical utility pole during Tropical Storm Irene. At the WWTF the river channel is severely undersized and confined. Barlow Road and associated residential properties to the north further confine the river and flood waters at this location, putting greater flood risk on the WWTF. River bank erosion along the south bank adjacent to the WWTF appears to have worsened since 2010 when the town installed stone armor (i.e., **riprap**) as a protection. In addition, WWTF infrastructure in the downtown area (e.g., Maple Street and Briggs Lane) is susceptible to flood damage, resulting in repetitive damage to these public utilities (DHCD, 2015 b). If this infrastructure is damaged during a flood, businesses may have to close for health and safety reasons even if their building is not damaged.

**What is the Floodway?**

The floodway is the area within and immediately adjacent to the channel that must remain open to allow floodwaters to pass.

**What is the 100-year Floodplain?**

The 100-year floodplain is also called the Special Flood Hazard Area, and is the base floodplain shown on FEMA maps.

A total of eight bridges along the Neshobe are too narrow to accommodate the predicted width of the spring flow (i.e., "bankfull width") resulting in floodwaters going around and impacting surrounding landowners. An additional four bridges confine the river during large floods, but are appropriately sized to accommodate the bankfull width. Several of these structures are linked to known areas of repeat flooding. The concrete support piers under the Route 7 and 73 Bridges and under several buildings upstream of the bridge in downtown Brandon are known to be at-risk for the accumulation of large debris. Debris catching on these piers could temporarily block a portion of the river during a flood, exacerbating the rise of flood waters and potentially causing structural

failure of the piers. If it failed and a portion of a building fell into the river, major flooding damage could occur downstream (RRPC, 2011).

The town water main runs along Wheeler Road in an area susceptible to flooding and erosion hazards. A large landslide along Wheeler Road threatens both the road and the water main to the west. In addition, Wheeler Road has been damaged repeatedly by Neshobe River flooding (DHCD, 2015 b).

### *Residential Property Risks*

Near downtown Brandon there are several residential properties located within flood and erosion hazard areas. There are approximately 10 homes along River Street east of downtown that are at-risk for flood damages. Two homes are within the 100-year flood zone near the intersection of Wheeler Road and Forest Dale Road (VT Route 73). One of these properties was badly flooded during Tropical Storm Irene, and was purchased by the town with state and federal disaster recovery funds.

In Forest Dale, approximately 35 homes are located in the 100-year flood zone or the town's fluvial erosion hazard zone. Along Furnace Road, 25 homes are located in the 100-year flood zone, and a berm protects additional homes upstream from flooding. Along Newton Road, approximately 10 homes are located within flood hazard zones. Several homes along Newton Road that are located outside of the 100-year flood zone had their basements flooded during Tropical Storm Irene.

## Town Accomplishments

The Town of Brandon has been working over the past several years to reduce the risk of flooding to businesses, farms, residences and local infrastructure. As described below, these efforts have addressed both town-wide policies and site specific initiatives to reduce flood risks.

### *Town Wide Flood Policy*

In conjunction with RRPC and ANR, the town has conducted several studies of the river (BCE, 2011; CLD, 2013) and worked to implement recommendations outlined in these studies, such as river corridor conservation easements in areas prone to flooding. In addition, following Tropical Storm Irene, the town took a critical step toward reducing flood risks and recovery costs by adopting bylaws that restrict development in flood prone areas. This will help keep new structures out of harm's way and protect existing development.

The Town of Brandon's land use ordinance includes flood hazard regulations for the purpose of avoiding and minimizing "the loss of life and property, the disruption of commerce, the impairment of the tax base, and the extraordinary public expenditures and demands on public services that result from flooding related inundation and erosion" (Brandon, 2012). Brandon is one of a handful of towns in Vermont that have adopted flood hazard regulations above and beyond the minimum **National Flood Insurance Program** (NFIP) requirements. Its ordinance restricts future development within the entire FEMA-mapped floodplain (including the floodway and the floodplain fringe) and the Fluvial Erosion Hazard zone.

As a result of its proactive regulations, Brandon qualifies for the highest level of federal and state reimbursement (75% federal and an additional 17.5% state) of federally-declared disasters through the **Emergency Relief Assistance Fund** (ERAF) (Flood Ready Vermont, 2015). In 2014, the State of Vermont established an ERAF to provide matching funding for federal assistance after federally-declared disasters. This program allows towns in Vermont to increase the amount of state aid money they can receive as a match to federal aid for post-disaster recovery. Because Brandon has taken steps to be prepared and resilient, the town is eligible for the highest match (17.5%). Table 3 outlines the steps Brandon has taken to qualify. Maps included in Appendix B show the locations of buildings within the different flood hazard zones.

| **Table 3: How Brandon Met its ERAF Match** | |
|---|---|
| **Steps to increase State aid to 12.5%** | |
| Participate in the National Flood Insurance Program | Yes |
| Adopt 2013 State Road & Bridge Standards | Yes |
| Adopt Local Emergency Operations Plan | Yes |
| Adopt Local Hazard Mitigation Plan | Yes |
| **Step to increase State aid to 17.5% (one needed to qualify)** | |
| Adopt no new development in a River Corridor | Yes |
| Adopt no new development in Flood Hazard areas and participate in the Federal **Community Rating System** | No |
| **ERAF Match** | **17.5%** |

## *Site Specific*

The Neshobe RCP recommended the conservation of key floodplain areas along the Neshobe River to enhance their functionality and reduce downstream flooding. One of these critical areas, encompassing two properties to the northeast of the intersection of Newton Road and Town Farm Road was conserved in 2013 (Figure 7). This easement protected approximately 34 acres of river corridor from future channel and floodplain manipulation (e.g., gravel dredging, berming). This critical floodplain protection project will help protect downstream properties and infrastructure during future floods by allowing flood waters to slow and spread out over a large area.

The Town of Brandon is pursuing two projects in the lower watershed that will reduce flood risk. A bridge crossing over the Neshobe River on Wheeler Road is undersized and exacerbates flooding to nearby properties. Following the 2011 flooding, the town completed a buyout of a house adjacent to this bridge. This buyout will allow for more flexibility in the design of a properly sized bridge crossing. The town also recently approved matching funds for a VTrans structures grant to develop a design to increase the bridge span. For the downtown, Brandon received a FEMA Hazard Mitigation Grant to design an overflow box culvert to prevent or reduce flood damage to US Route 7 and downtown businesses.

In 2013-2014, with support from a Community Development Block Grant for disaster recovery (CDBG-DR), the DHCD hired a team of experts in community design and economic development and partnered with eight communities, including Brandon, to help speed recovery from Tropical Storm Irene. The Vermont-Downtown Action Team (V-DAT) visited Brandon on a number of occasions to gather input, develop projects and build consensus on the recommendations. The final report included short, mid and long-term recommendations to support local economic development efforts. Brandon's complete report and supporting documents are available at: http://accd.vermont.gov/strong_communities/opportunities/revitalization/vdat.

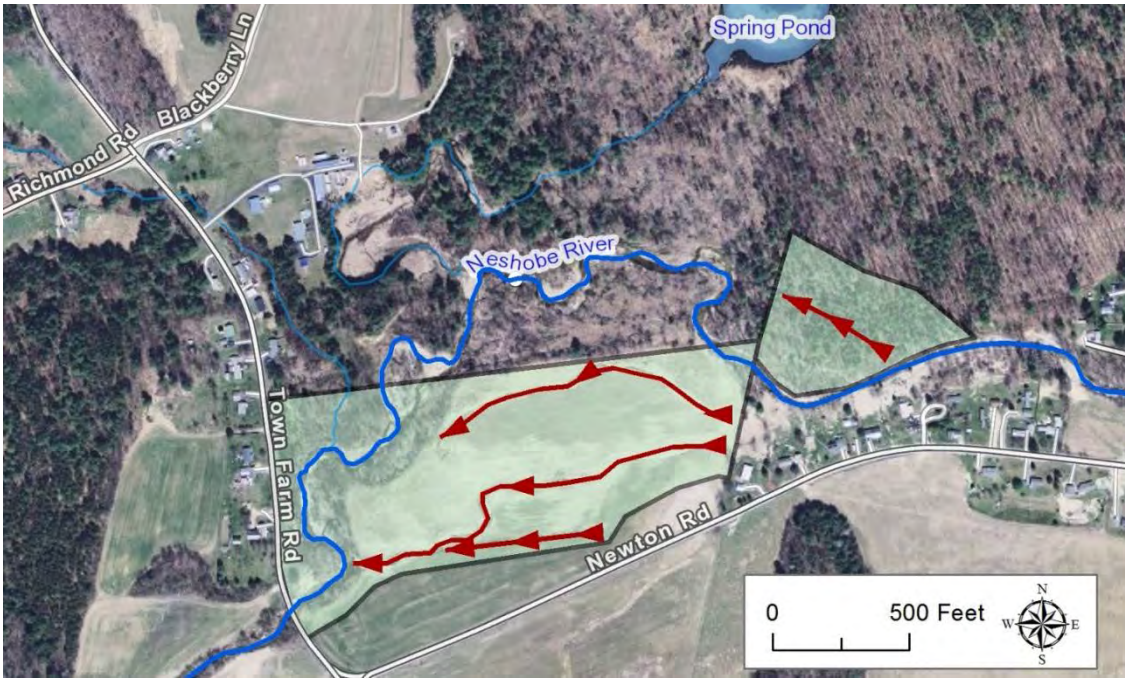


**Figure 7:** River corridor easement for parcels (shaded green) prone to flooding and erosion along the Neshobe River. Red arrows show the flow of water during extreme storms.

A one-page visual summary of the top recommendations is included in Appendix C. Several of the V-DAT recommendations have been completed in Brandon, including:

- Initiating the Community Branding and Marketing Package – including: updated town office sign, new town website, updated town letterhead/material and brand implemented on town vehicles.
- Receiving a $500,000 CDBG-DR grant award to repair and rehabilitate the historic town office building which was severely damaged by Tropical Storm Irene.

# Strategies and Projects to Protect Brandon

The team has developed a list of recommended strategies and projects to protect Brandon's businesses and infrastructure during future floods. Based on data collection and analysis, review of the town plan and bylaws, hazard mitigation plan, previous reports and community input, the team developed a list of flood **mitigation** objectives for the Neshobe River in Brandon to address town-specific flood damages. These objectives include:

1. Reduce flood risks in downtown Brandon and Forest Dale;
2. Keep major roadways (e.g., US Route 7 and US Route 73) open during floods;
3. Protect businesses and residences from flooding and erosion; and
4. Improve flood resiliency of town-owned infrastructure (e.g., WWTF, bridges) to better withstand flooding.

Using the objectives outlined above, the team developed a list of recommended flood mitigation strategies and projects for the Town of Brandon and the Neshobe River. To complement input from the community, maps were developed to guide the development of project ideas and highlight specific areas with elevated flood risk (see maps in Appendix B). These maps summarize:

1. Land development and buildings located in flood hazard areas; and
2. Business damage sustained during Tropical Storm Irene in 2011.

Strategies and projects for the Town of Brandon are summarized below, including municipal policy and program recommendations and site specific project recommendations.

## Municipal Policy and Program Recommendations

Reducing the impacts of floods involves an ongoing process of evaluating and adjusting policies to minimize risks through protection, prevention and education. Accordingly, the VERI team first reviewed Brandon's Municipal Plan, Hazard Mitigation Plans and land use regulations to identify the policies they contain and those that are absent. The team also reviewed related plans for capital improvements, conservation, emergency and preparedness and continuity of operations. These documents were reviewed with the goal of identifying gaps and opportunities to improve the flood preparedness, safety and resilience of residents, visitors, businesses and local government.

The team then used the US Environmental Protection Agency's (EPA) flood resiliency checklist that was developed from a study in the Mad River Valley in Vermont (US EPA, 2014). This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

The checklist review found that Brandon currently employs 28 of 56 items on the checklist including buyouts for frequently flooded property, regulatory measures to limit development in flood prone areas, and utilizing steep slope development regulations (RRPC, Appendix D).

The results of both reviews identified 16 planning or policy opportunities that were then organized into four groups: Regulations, Community Planning, Emergency Planning, and Education and Outreach. The distribution of opportunities to improve policy and programs is shown in Table 4.

**Table 4. Categories of Municipal Policies and Programs**

| Category | Description | Policies or Programs |
|---|---|---|
| Land Use Regulations | Avoid and minimize land use conflicts around watershed resources that help lower the risk of flooding and/or erosion to properties. | 4 |
| Community Planning | Develop long term goals, recommendations and budgets to improve flood resilience. | 4 |
| Emergency Planning | Specific projects for supporting mitigation and recovery actions for flooding and other hazards. | 5 |
| Education and Outreach | Programs targeted at critical businesses and vulnerable populations to educate them about flood risk, mitigation and recovery. | 3 |

The results of the plan and policy reviews were then combined and scored with either a one (ineffective), three (limited) or five (effective) using the following three objectives:

1. Reduces flood risk (proposed project lowers the flood level);
2. Reduces erosion risk (proposed project lessens the vulnerability to erosion); and
3. Protects businesses, infrastructure and property.

The three scores were added to provide a total score. Cost and ease of implementation, political realities and limitations as well as input from the community were also considered. To assist the town with implementation, potential partners and funding sources were identified. Each recommendation was further explained and next steps were identified. This information was compiled into easy to read charts found in Appendix E

The highest ranked regulatory changes included two to minimize river and land use conflicts and improve public safety. Recommended town plan updates included documenting damage to infrastructure and updating the capital and hazard mitigation plan to make these and other improvements were implemented to reduce threats to infrastructure over time. A lower cost recommendation included continuing efforts to conserve floodplain to protect downstream properties.

The top priority policy and program recommendations were presented at the community forum and local feedback was incorporated into the final prioritization, below.

- **Document road, sewer, and water infrastructure vulnerabilities in municipal and capital plans:** Specific areas that were damaged or have known vulnerabilities such as those identified in this report should be documented so the community can plan for their replacement in long-term budgets, easing the impact on taxpayers. While capital programs and budgets are not common in smaller towns, the town of Brandon has begun this process. With help from the RRPC and financial advisors, the town should develop a priority project list and process to allocate funds and make these improvements over time.
- **Identify areas for conservation:** The Neshobe RCP identifies potential riparian easement sites. The town can identify and work with willing landowners to establish conservation sites along the river to prevent future development in flood-prone locations.
- **Identify VERI project recommendations in Brandon's Hazard Mitigation Plan:** Once the community has chosen the top recommendations for further action, include these in Brandon's Hazard Mitigation Plan. This will help when applying for future Hazard Mitigation Grant Program funding.

Local stakeholders (residents, businesses, planning commission, Selectboard, etc.) are encouraged to review these recommendations and seek assistance from the identified partners and programs and take these steps to reduce flood risk over time.

## Specific Project Recommendations

The Neshobe River Geomorphic Assessments and RCP (BCE, 2011) were instrumental in the development of site specific flood mitigation project ideas. In many cases project ideas conceived in the RCP prior to the 2011 flooding are still valid today. These RCP project locations were evaluated in the field during 2014 to determine if river conditions had changed significantly since the development of the plan in 2011, and whether or how the project concept should be adapted to account for these changes. Additional project ideas were developed through the course of discussions with stakeholders and additional data analysis and field visits. Projects identified to meet town-specific objectives were organized by the project types outlined in Table 5. A table summarizing projects to protect businesses and infrastructure from flooding is included in Appendix F. Maps depicting the location of each project site in Brandon, along with other relevant economic asset and flood hazard information, are also included in Appendix F.

| Table 5: Mitigation Project Types | | |
|---|---|---|
| **Category** | **Description** | **Number of Projects** |
| Building and Site Improvements | Lowers the risk of flooding and/or erosion to specific properties through improvements to the building and/or surroundings, e.g., sealing off buildings to prevent water infiltration. | 2 |
| Channel and Floodplain Management | Lowers the risk of flooding and/or erosion to properties along the river through the improvement of natural river and floodplain functions, e.g., tree plantings along unstable river banks. | 4 |
| Infrastructure Improvements | Lowers the risk of flooding and/or erosion to roadways and other municipal or state-owned infrastructure, e.g., increasing the size of bridges and culverts to pass more flood waters. | 6 |
| Public Safety Improvements | Lowers the risk of flooding and/or erosion to properties through the avoidance of future flood risks, e.g., FEMA buyouts of improved properties highly vulnerable to flooding. | 1 |

To begin, the team screened and prioritized each project. Each project received a score of one (ineffective), three (limited) or five (effective) for the three objectives:

1. Reduces flood risk (proposed project lowers the flood level);
2. Reduces erosion risk (proposed project lessens the vulnerability to erosion); and
3. Protects businesses, infrastructure and property.

The three scores were added to provide a total score, which was then weighted based on the importance of the project in the region. Projects that would result in a regional economic boost and help keep businesses open were given the greatest weight, while projects that would offer minimal economic benefit to the business economy were assigned a lesser weight. Many of the high priority projects are from the Infrastructure Improvements category, as those at-risk areas potentially affect the greatest number of community members and businesses.

Project partners and stakeholders, including representatives from DHCD, ANR, RRPC, and the Town of Brandon, provided feedback on a draft list of mitigation strategies and their priorities in November 2014. The feedback was incorporated into the final prioritization of projects. Below are brief descriptions of the high priority projects from each of the project categories described in Table 5. A summary of efforts to develop conceptual designs for two of the high priority projects follows, with additional supporting information provided in Appendix G.

## *Building and Site Improvements*

**Floodproof Downtown Businesses:** Multiple buildings in downtown Brandon were flooded during Tropical Storm Irene, and one was destroyed (Brandon House of Pizza). Flood risk may be lowered with the completion of the overflow culvert project; however some risk of flood damage will likely remain during extreme floods. While selection of a specific floodproofing strategy is building specific, several are widely applicable:

- **Elevate buildings and utilities:** For buildings prone to first floor flooding, raising the structure (by temporarily jacking it up and replacing it on top of an elevated foundation) can reduce flood damages. Utilities such as furnaces and electrical panels are also relocated to a higher floor, above the flood elevation, as part of the project.
- **Fill in Basements**: Filling basements with clean fill material, along with the relocation of utilities to higher floors above the flood elevation, can also reduce damages and save money.
- **Dry floodproofing:** When elevation is not possible or feasible walls can be made watertight. Openings are in-filled and the walls and floors covered with waterproof materials. Typically the foundation and walls must be strengthened to withstand pressure and energy of the water on the building. This approach likely has limited applicability due to the age and construction methods of many buildings in the floodplain. However, it may be suitable for heavy masonry buildings constructed of block, brick or reinforced concrete.
- **Wet floodproofing:** This option is used in situations where elevation and dry floodproofing are not viable. Floodwaters are allowed into the building with combination of flood vents/openings. Durable building materials that can withstand water, mud, and other pollutants are installed and cleaned up after the flood. This, along with the relocation of furnaces and electrical panels out of harm's way, can reduce losses and recovery costs.
- **Retrofitting flood vents in outbuildings:** Particularly in buildings with limited use, installing flood vents that allow water to readily enter and exit the structure can significantly reduce flood damages.

The method of floodproofing selected depends upon the structure, size, age and location of the building. Each building requires a site specific assessment by a structural engineer. In all cases, outdoor fuel tanks servicing buildings in special flood hazard areas should be anchored and elevated.

Floodproofing projects (e.g., sealing off buildings to prevent water infiltration) would protect nine businesses and the town offices with a total of 83 employees. In most cases these projects would be relatively straightforward to design and implement. Typical floodproofing costs are approximately $10,000 per building.

## *Channel and Floodplain Management*

**Remove Berms Downstream of Route 53:** Historic berms exist along the south bank of the Neshobe River downstream of VT Route 53 in Forest Dale. The berms restrict the river's access to a

forested floodplain in an area of major flood flow and sediment transport. Berm removal would allow the river to access an undeveloped floodplain upstream of an area along Newton Road where homes were flooded in Tropical Storm Irene. Removal of the berm would reduce flooding and erosion risks and help protect several homes and one business with five employees. Design and implementation of the project will be moderately challenging, likely requiring one to two years, and are estimated to cost between $5,000 and $10,000. A conceptual design was developed for this project and is summarized in the next section of the report.

### *Infrastructure Improvements*

**Install Downtown Brandon Overflow Culvert:** The Town of Brandon has received a FEMA Hazard Mitigation Grant (Phase 1; $250,000) to design an overflow box culvert in the downtown to prevent or reduce flood damage to Route 7 and downtown businesses. During Tropical Storm Irene, the river overflowed its banks in the downtown, causing extensive damage to businesses and closing US Route 7 for several days. This project will significantly reduce flood and erosion risks and will have a major local and regional impact due to increased protection of Route 7 during floods. Given the complexity of the project in the downtown area (e.g., utilities), the design and implementation of the overflow culvert will be challenging and take several years to carry out. Initial cost estimates for this project are approximately $650,000 (CLD, 2013). Town officials and downtown businesses are concerned about coordination of this project with the VTrans Route 7, Segment 6 construction project, as both projects will result in significant disruptions to downtown traffic.

**Stabilize Bank along Wheeler Road:** An eroding bank adjacent to the river (i.e., mass failure) along the west bank of the Neshobe River was likely initiated by river erosion on the lower bank. Wheeler Road and a town water main are at-risk if the erosion continues. In order to stabilize the bank, the original source of the problem at the bottom of the slope will need to be addressed and the upper bank will also need to be stabilized. This project will reduce a major erosion risk and sediment source, and protect both transportation and utilities infrastructure used by over a dozen residences along Wheeler Road and Stone Mill Dam Road. Design and implementation of the project will be moderately challenging, likely requiring one to two years, and are estimated to cost in the ballpark of $25,000. A conceptual design was developed for this project and is summarized below.

**Replace Route 53 Bridge:** The Route 53 Bridge over the Neshobe River in Forest Dale is undersized (56% of the bankfull channel width) and should be replaced with a larger span. Floodplain mapping and data from FEMA indicates that the bridge is undersized to accommodate the 100-year flood. The river characteristics in the area upstream and downstream of this bridge suggest that a span greater than the standard ANR recommended width may be appropriate for this site. This project will significantly reduce flood and erosion risks affecting two

**Tip: Bridges and culverts should be at least the width of the "bankfull channel" to allow floodwaters, sediment, and woody debris to pass downstream without putting the structure at-risk.**

businesses with nine employees, a state highway, and several private residences. Design and implementation of the project will be moderately challenging, likely requiring two to five years, and will cost in excess of $200,000.

**Replace Wheeler Road Bridge:** The abutments for the Wheeler Road Bridge over the Neshobe River are in poor condition and the bridge is undersized, with a span 61% of the bankfull channel width. The Town of Brandon recently approved match for a VTrans structures grant to move forward with a design to increase the bridge span and realign the roadway; the realignment is now possible following the buy-out of an adjacent property impacted by Tropical Storm Irene flooding. This project will significantly reduce flood and erosion risks along Wheeler Road and VT Route 73, helping to ensure this critical throughway is kept open during floods. Design and implementation of the bridge replacement will likely require two to three years and will cost greater than $200,000.

**Stabilize or Relocate Wastewater Treatment Facility:** Flooding and erosion have negatively affected Brandon's Wastewater Treatment Facility (WWTF) for years. Brandon's businesses are highly dependent on a functioning WWTF. If the WWTF were severely damaged and temporarily closed during a flood, businesses downtown would also need to close even if they escaped direct flooding damage. The town installed riprap along the bank in 2010, but the area is still prone to erosion and a Green Mountain Power utility pole servicing the facility is also at-risk. The WWTF is aging and major upgrades will be required in the near future, at which point flood resilience should be considered. This could include the reconnection of adjacent floodplains to take the pressure off the existing WWTF location, or the planning of a new facility in a different location outside flood hazard zones. This will ensure that the WWTF remains up and running after an event ensuring businesses can remain open for employees and customers as this facility services over 1,000 residential and commercial connections. Design and implementation of stabilization measures would be moderately challenging, likely requiring one to two years and would cost between $50,000 and $100,000.

# Conceptual Project Designs to Protect Brandon

Using input from the community and the team's professional judgment of priority flood mitigation projects that would provide multiple benefits to the community, the team selected two projects to advance to a conceptual design stage. These projects include a floodplain reconnection through the removal of an old berm in Forest Dale, and the stabilization of a tall bank along Wheeler Road. Both project areas are representative of other sites in Brandon where site specific designs are recommended, and therefore can be used as a template for future work. The conceptual designs require additional design and engineering work to advance toward implementation. Should the community wish to advance the projects, the designs include sufficient detail for grant applications.

## Remove Newton Road Berm

### *Overview and Objectives*

This project is representative of countless floodplains across Vermont that have restricted access due to historic or recent berms, typically constructed following flood events. Many of these berms are ineffective and unnecessarily increase downstream flooding risks.

**Figure 8**: Newton Road berm looking upstream

The Newton Road berm project area is located approximately 800 feet downstream of the North Street bridge (see map in Appendix G). This area represents a transition zone in the watershed where the slope decreases and the valley opens to wide floodplains. This transition leads to increased sediment deposition and lateral channel migration as described in the Neshobe RCP (BCE, 2011). The historic berm begins immediately downstream of the former Tubbs furniture manufacturing buildings (Figure 8). During Tropical Storm Irene, the river spilled over its banks where the channel is constricted by the old buildings and berms. Major overbank flow continued to the west along and over Newton Road, flooding both sides of the road and eventually rejoining the river approximately 1,200 feet downstream (see map in Appendix G). The river also overtopped the south bank farther downstream causing significant property damage and basement flooding to several homes along Newton Road.

A forested floodplain with several large **flood chutes** is located on the river bend between the old manufacturing buildings and the downstream houses along Newton Road. The river's access to this floodplain is very limited due to the 220 foot long berm. The middle portion of the berm is four to

five feet tall and it gradually tapers upstream and downstream to approximately two to three feet tall. Based on sediment and debris left during Tropical Strom Irene, there is minimal access to this floodplain.

## *Data Analysis and Results*

The team surveyed four cross-sections of the channel, berm, and the floodplain to the south of the river. These cross-sections were located between the AA and AB cross-sections included in the FEMA Flood Insurance Study data (see map in Appendix G). The team modeled the channel and floodplain responses to removing the berm using a steady flow one-dimensional Hydrologic Engineering Centers River Analysis System (HEC-RAS) hydraulic model (ACOE, 2010). Then, estimated the 100-year storm discharge (approximately 1,700 cubic feet squared) based on United States Geological Survey (USGS) Stream Statistics and an area-normalized flow based on the 100-year flood calculations in the Route 7 bridge hydraulics report for downtown Brandon (CLD, 2013). The team also estimated the Tropical Storm Irene flow (3,000 cubic feet squared) based on the elevation of flood deposits visible during the field survey and from aerial photos.

Both flows are completely contained within the channel under existing conditions with the berm in place. Removing the berm allows the river access to the forested floodplain during large floods, which will reduce floodwater velocity. The analysis shows that berm removal will lower the peak water surface elevation by approximately one and a half feet for the 100-year flood in this area. Floodwaters that spill on to this floodplain with reduced velocity will allow for greater sediment and debris deposition, and will likely decrease downstream flood peaks and reduce impacts to downstream homes and property along Newton Road.

The topography of the forested floodplain and the upper grassed floodplain would direct all overbank flow through the project area back towards the channel during a 100-year flood or larger event; berm removal is not expected to cause additional floodwaters to be redirected towards the downstream houses along Newton Road. In addition, removal of this berm will not likely affect overbank flow along Newton Road; however it would reduce the severity of downstream flooding by better distributing sediment deposition along this river segment.

## *Conceptual Design*

The Newton Road berm removal project is relatively straightforward due to direct site access and the small scale of the project. An excavator and dump truck could access the berm area through the cleared lot immediately west of the former Tubbs manufacturing facility. Minimal tree and brush clearing would be necessary to access the forested floodplain along the berm. A medium sized excavator and dump truck would be required for one to two days to remove approximately 300 cubic yards of berm material. Several maple trees are growing on the berm and would need to be removed. (Some of these trees may be large enough to re-use at the Wheeler Road bank stabilization site.) The new top of bank would be reshaped to a stable slope (1V:2H --slope width: slope height) at the elevation of the forested floodplain. A layer of topsoil would be spread over the disturbed area and covered with straw matting following seeding. Conservation planting mix would be spread and

watered to help hold the disturbed soils. Additional tree plantings are recommended along the disturbed bank to stabilize the bank and floodplain and provide shading along the river edge. This project is estimated to cost between $5,000 and $10,000:

- Contractor labor, excavator, and trucking: $5,000
- Conservation seed and erosion fabric: $640
- Tree planting: $2,400

### *Steps for Project Implementation*

Landowner outreach would be the logical first step to move this project forward. Depending on landowner willingness, grant funding could be secured through the Vermont Department of Environmental Conservation (DEC) Ecosystem Restoration Program (ERP) and/or other funding sources. All necessary state and federal permits must be explored and/or secured. DEC and US Army Corps of Engineers may have jurisdiction given the proximity to the stream channel. In addition, amendments to the FEMA mapping (e.g., Letter of Map Amendment or LOMA) may be required due to changes in the floodwater and hydraulics with berm removal. The LOMA may help reduce insurance costs downstream.

### *Project Benefits*

The implementation of this project would help reduce flood risks in Forest Dale. Specific benefits include:

- Increased floodplain access resulting in slower flowing flood waters, and settling of sediment and debris in an area upstream of residences along Newton Road.
- Reduced risk of flood damage to one business with five employees on upper Newton Road.
- Less build-up of sediment and debris in the Neshobe River along lower Newton Road, and therefore lower floodwaters with lower risk of basement flooding, and lower costs for channel dredging in this area.
- Reduced risk of Newton Road being washed out and closed during floods, allowing for greater public safety by keeping this important connector road open during emergencies.

## Stabilize Bank at Wheeler Road

### *Overview and Objectives*

This project represents common conflicts between slope failures and adjacent roads and buildings throughout Vermont. The challenging access at this site is also common. Slope failures contribute huge volumes of sediment to streams and rivers and can cause catastrophic infrastructure damage during large events, or slowly progress and over time undermine and damage infrastructure and utilities.

The Wheeler Road bank failure site is located along the east side of Wheeler Road approximately 800 feet south of the intersection with Stone Mill Dam Road (see map in Appendix G). The bank is failing along approximately 60 feet of the Neshobe River and extends up the valley wall to the edge of the road (Figure 9). A cluster of small elm trees is partially stabilizing the middle of the bank failure (Figure 10). The soil along the bank is a combination of erodible silty-sand (lower) and fine to coarse sand (upper). A 2011 report recommended monitoring the slope for further failure, and evaluating the slope for a combination of standard slope stabilization techniques and measures to deflect the river away from the slope (BCE, 2011). No stabilization efforts have occurred since and the bank failure has moved approximately three feet closer to Wheeler Road. It will likely undermine the road in the near future.

**Figure 9:** Top of bank failure along Wheeler Road

The River has very low slope and access to a large floodplain along the left bank, however the site is located at a sharp bend in the channel and higher velocity flows are likely during storm events. A fallen tree across the channel immediately downstream of the mass failure may create a current that is exacerbating erosion along the toe of the slope.

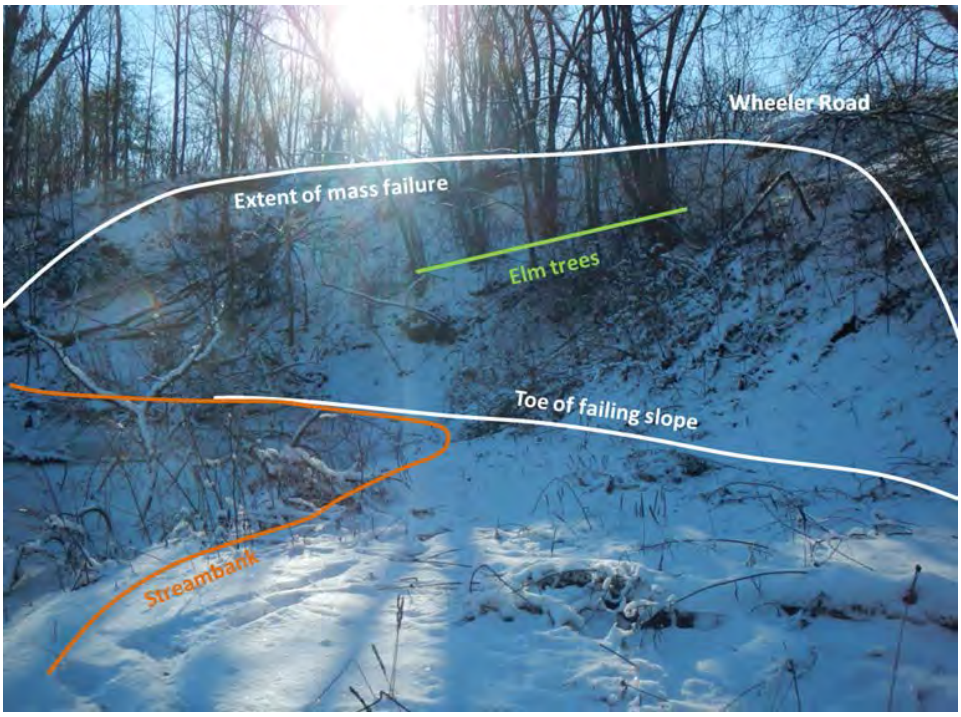


**Figure 10:** Bank failure site from the upstream right bank floodplain

The bank failure is located along the western edge of a 43 acre parcel owned by Rosemary Hunt. This

parcel was under consideration for purchase by the town or for purchase as a river corridor easement in 2011 (BCE, 2011), however these efforts are no longer ongoing. Due to the steep banks along Wheeler Road, direct equipment access will not be possible from the west. Access through the cornfield on the Hunt property is most direct, however it will require crossing the channel. Alternatively, an excavator could access from Stone Mill Dam Road, requiring disturbance of the floodplain and a significant wetland to the north. Truck access will be restricted to Wheeler Road. A partnership with Vermont Youth Conservation Corps (VYCC) or a similar group could provide the labor required to spread topsoil, install coir logs, and seed/plant the project area, as described further below.

## *Conceptual Design*

The team recommends a combination of stabilization measures along the upper and lower slopes and the construction of natural armoring along the edge of the river. Rootwad revetments or an engineered log jam (ELJ) along the base of the slope are cost-effective erosion protection measures for this site. These structures maintain a more natural bank and improve in-stream habitat (VDCR, 2004). To build a rootwad revetment, a tree with an intact rootwad is placed on top of a footer log and trenched or pushed into the bank (Figure 11). Heavy boulders and soil are filled over the log to anchor it in place. Additional logs may be placed on top of this structure to link multiple rootwads together. An ELJ is a similar toe protection structure constructed out of a grid of logs and filled with native rock material (Figure 12).

The installation of approximately three to five rootwads or log jams would help center the thalweg (i.e., deepest, strongest part of river current) away from the bank and reduce erosional forces along the bank failure. At this site, the ELJ would be constructed below the current channel bed to reduce the risk of scour and will tie into the bank with stakes or earth anchors. Steel cabling or pins are used to hold the ELJ together and geotextile or erosion control fabric may line the ELJ to limit the washout of material from the middle of the structure. Above the stabilization structure, the bank would be graded and filled with a compost/topsoil mix to a more stable slope (see conceptual drawing in Appendix G). Erosion

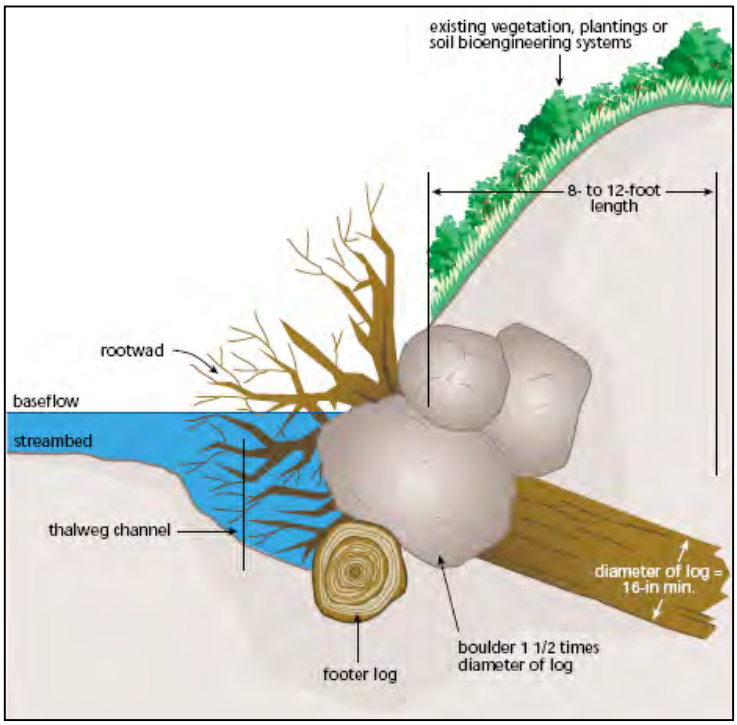


Figure 11: Rootwad installation diagram

control fabric would be draped and pinned over the filled slope. Coir logs would be installed along the slope approximately every four vertical feet to terrace the slope and reduce erosion along the planted slope. The slope would be planted with shrub plugs (e.g., dogwoods) or other native container plants and a conservation/slope seed mix. The existing trees on the middle of the slope would be stabilized using steel cables attached to earth anchors. The anchors will be driven in as deep as possible to tie into stable soil and protect the trees. An approximate budget for this project is estimated at $25,000 (see details in Appendix G).

## *Steps for Project Implementation*

Grants are available from DEC ERP (Ecosystem Restoration Program) and other funding sources. All necessary state and federal permits must be secured, potentially including additional assessment of disturbance to wetlands or the river channel to access the site. Stream alteration and wetlands permits from DEC and US Army Corps of Engineers are likely needed. Landowner permission through the Hunt property is required for site access and for project implementation. Appropriate materials for rootwad or ELJ structures will need to be gathered or purchased.

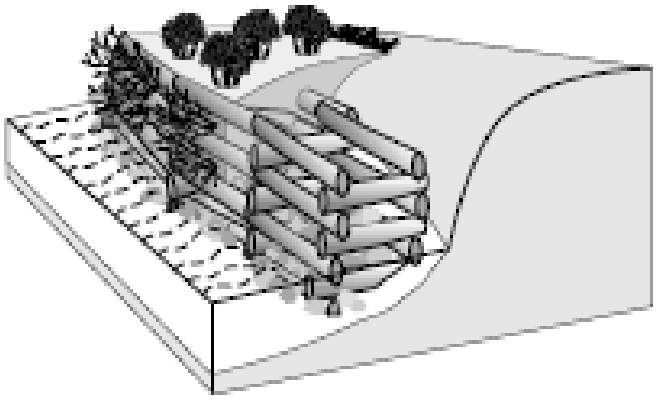

**Figure 12:** Log crib diagram (FISWRG, 2001)

## *Project Benefits*

The implementation of this project is anticipated to provide benefits for reducing flood risks in Brandon. These benefits include:

- Reduced risk of Wheeler Road being washed out and closed during floods, allowing for greater public safety by keeping this connector road open during emergencies.
- Reduced risk of the water line being damaged and service lost to over a dozen residences along Wheeler Road.
- Reduced input of sediment and woody debris into the channel which exacerbates flooding at downstream road crossings.

# Next Steps

On April 6, 2015 the team hosted the second community forum to share the list of policy and project recommendations to decrease flood risk for Brandon. At the forum, Community members asked questions, provided input and helped rank the proposed list of priority recommendations.

The team shared the list of policy and project recommendations to significantly decrease flood risk in Brandon. Community members were given the opportunity to ask questions, provide input and rank the proposed list of priority recommendations. The projects that the community most supported included the installation of an overflow culvert on US Route 7, the removal of a berm in Forest Dale and floodproofing downtown businesses.

The town is currently pursuing funding for design and engineering of the overflow culvert and hopes to coordinate it with the work to improve US Route 7. Participants noted successful floodplain conservation work to date and that continued efforts to protect undeveloped floodplain between Forest Dale and downtown area would help alleviate downstream flooding issues. It was also noted that floodproofing costs vary depending on the location and design of the building, but the approximate cost is $10,000 per business. Business owners can find additional information on construction floodproofing techniques here
http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

See Appendix H for the complete meeting notes from the first and second community forums.

The tables included in Appendices E and F provide a comprehensive list of recommended high priority projects for the Town of Brandon to further discuss, explore, and advance as resources permit. The conceptual designs summarized above and in Appendix G are intended to provide examples for how to advance high priority projects to the next level and acquire funding for final design and implementation. As part of the ongoing community discussion regarding the VERI effort, the team recommends the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization.
- Prioritize one to two projects to pursue each year with assistance from DEC and RRPC staff to identify appropriate funding sources and partners.
- Apply for one to two grants each year to advance project development and/or designs.
- Implement projects as funding allows.
- Monitor project success.

Implementing these projects and updating related flood policies will, over time, help Brandon become safer and more resilient to future floods and there are a number of organizations and programs that can help. For example, the RRPC can help gather and review sample bylaws, capital plans and hazard mitigation plans and help draft town specific language for review and local

adoption. DHCD's Municipal Planning Grants, http://accd.vermont.gov/strong_communities/opportunities/funding/overview/municipal_planning_grants , the Vermont Rivers Program http://www.anr.state.vt.us/dec/waterq/rivers.htm and www.floodready.vermont.gov can help support these efforts. The Vermont Land Trust http://www.vlt.org/ can assist landowner's protection of critical floodplain with easements. The State's Hazard Mitigation Grant Program http://vem.vermont.gov/mitigation can help implement projects identified in Brandon's Hazard Mitigation Plan. The Vermont Small Business Development Center http://www.vtsbdc.org/ has offered extensive disaster assistance to businesses as well as compiling a great guide for owners to navigate these programs. And several federal and state programs can assist in funding the recommendations outlined in the report. Working together we can reduce the risk and financial burden of future flooding events.

## Education and Outreach

Vermont has a long tradition of managing its rivers to limit or prevent flood damage including armoring riverbanks with rocks, moving or straightening river channels and building dams and berms. Despite these efforts, flooding is the most common natural disaster in Vermont (ANR). Tropical Storm Irene showed Vermonters that rivers and streams are powerful and tend to make their own way during a flood. Because we cannot reliably control flooding, educating citizens, business and property owners about rivers and potential flood risks within their communities is critical.

> *"We all have short memories when it comes to flooding. It's just human nature to think it couldn't happen here again anytime soon."*
>
> Chris Campany, Executive Director
> Windham Regional Commission

Ongoing community education and outreach is an important part of any effort to promote flood safety and to protect local business and economies. Ultimately, the better informed everyone in the community is about the behavior of local rivers and streams, the more likely it is that they will make sound decisions.

**Make Information Readily Available:** Easy access to river and floodplain information is an essential way to help citizens and businesses incorporate flood risks into decisions they make. Most communities offer printed information at the town office or library as well as on town webpages.

**Common Handouts or Webpage Information Includes:**

- Maps of the local flood hazard areas and the permitting requirements in the floodplain.
- Information about flood insurance and floodproofing buildings.
- Information about how rivers, streams and watersheds work.
- Benefits of green infrastructure and conservation of existing floodplain.

**Actively Engage:** Many communities work to increase the understanding of rivers and risks via email or by posting information on their local Front Porch Forum. Communities often include

flood maps and permitting information in their town meeting reports and other municipal mailings like sewer and water bills. Others promote awareness of flood history and risk by placing high water lines on prominent buildings in the community.

However, education and outreach efforts should not be the sole responsibility of local governments, and community groups like chambers of commerce, downtown business associations, neighborhood groups, and watershed organizations are encouraged to partner with state, regional and local groups to offer local workshops and education sessions.

**Potential Workshop Topics and Partners and Presenters:**

- Flood Insurance and What You Need to Know (Department of Finance Regulation, Division of Emergency Management and Homeland Security, Vermont League of Cities and Towns )
- Developing a Continuity of Operations Plan (Small Business Development Centers, Regional Planning Commissions, Regional Development Corporations )
- Resilient Road Designs to Reduce Recurring Damage and Improve Water Quality (Agency of Natural Resources, Agency of Transportation)
- Planning for Resilience (Regional Planning Commissions)
- Flood Risk, Preparedness and Safety (Division of Emergency Management and Homeland Security, Regional Planning Commissions)
- Extreme Weather and Climate Change (Agency of Natural Resources, Vermont Natural Recourses Council )
- How Rivers, Streams and Watersheds Work (Agency of Natural Resources, Vermont Natural Resources Council, Vermont Land Trust )
- Low Cost Techniques to Reduce Flooding and Improve Water Quality (Agency of Natural Resources, Vermont Natural Resources Council, Regional Planning Commissions, Vermont League of Cities and Towns)

**Invest in Staff Training and Certification:** In many of Vermont's cities and towns, floodplain management is just one of many responsibilities of the local planning office or zoning administrator. Yet, administration of a floodplain ordinance is quite complex and the consequences of limited staff time and understanding of the regulations can easily allow inappropriate development in dangerous areas. The consequences of granting improper variances and not enforcing against violations may preclude the community from participating in the federal flood insurance program. Therefore, local government officials are strongly encouraged to support staff training and certification in floodplain management.

## What Can Individuals Do to Reduce their Risks?

Most of us remember to annually change the batteries in our smoke alarms to reduce the risk of fire, but few of us prepare for floods or disasters. Since 2000, Vermont has had more than one federally-declared disaster per year and floods have occurred nearly everywhere in the state (ANR, 2015).

Buildings located in a 100-year floodplain have 1% chance of being flooded every year. In other words, over a 30 year period (length of most home mortgages), there is a 26% chance of a 100-year flood (USGS, 2015).

The good news is that there are many steps that individuals can take to reduce the risks, loss, disruption and costs associated with flooding. Understanding what the risks of flooding are for your home and family will help you:

- Make sure that you have the right amount of insurance coverage.
- Protect your home and take steps to limit potential damage.
- Prepare plans detailing how your family will respond if flooding looks likely.
- Practice so family members know what actions to take in the event of a flood or upon receiving a flood warning.

## *Steps to Reduce Risks*

- **Identify Flood Risk.** The first step is to identify your risk so you can plan appropriately. Floodplain maps are available at most town offices or click this link http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your home or apartment is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** Homeowners' or renters' insurance helps pay to repair or rebuild your home and replace personal property due to a covered loss, however it does not cover any damages caused by floods or your rent and living expenses while your home is rebuilt. All insurance policies have overall policy limits and specific limits for different types of coverage. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Fill Gaps in Your Insurance Coverage.** If your home is underinsured at the time of a loss, there is frequently a penalty or reduction in the amount the insurance company will pay for the loss. Property insurance also does not cover flood damages or your expenses if you cannot live in your home due to flood damages. All homeowners who live in flood-prone areas should carry flood insurance. Flood insurance is available for your home and personal property and can be obtained from your local agent.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

- **Plan Ahead.** Draft an emergency response and communications plan (family phone numbers) for your home and family. Use the process as an opportunity to bring family members together to discuss the roles needed during an emergency and how best to assign responsibilities. Make sure you have a designated place to meet other family members in the event of an emergency. Also, don't forget to plan for individuals with special needs like prescription medication and for your pets as many public shelters or hotels do not allow animals.
    - Pack an emergency kit and make sure family members know where it is located.
    - Keep copies of your insurance policy, computer data and other important documents like tax returns and financial information safe from flooding on upper floors or stored offsite.
    - Document your home and possessions with photos or video to help simplify the insurance claims process. Generally, the more detailed documentation (receipts, serial numbers, etc.) you can supply during the claims process, the fewer problems you will experience.

- **Train and Practice.** Many of us participate in fire drills at work or school, but few of us practice at home for disasters. Training and practicing your emergency response and communications plan will help assure the plan is workable and family members understand their roles and responsibilities.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. If you know a storm is headed your way, fill up your gas tank in case you must evacuate. (If the power is out, it is not always easy to find an operating gas station.) If you must evacuate, try to contact your employer and let them know your plans. Having a plan and a few extra minutes to evacuate can make a difference.

FEMA http://www.ready.gov/make-a-plan and the Vermont Division of Emergency Management and Homeland Security http://vem.vermont.gov/preparedness/hazards/floods both provide more detailed information on how to prepare and protect your home and family from disasters and floods.

## What Can Businesses Do to Reduce their Risks?

According to FEMA, nearly 40% of businesses do not reopen after a disaster and data from the US Small Business Administration indicates that over 90% of businesses fail within two years after being struck by a disaster.

It can take years to repair the damage to the building, furnishings, equipment and inventory. Disasters can also require businesses to relocate or cease operation temporarily, which may lead to canceled contracts and customers going elsewhere for goods or services. Even if the event does not impact the business directly, severe weather from snow or rain or even extended power outages can strand employees at home and complicate deliveries.

Identifying your risk can significantly reduce potential damages and business recovery costs. Understanding what the risks of flooding are for your business will help you:

- Make sure that you have the right insurance coverage for business interruption.
- Plan ahead and take steps like developing a continuity of operations plan to limit potential damage.
- Train employees so they know what actions to take in the event of a disaster or after receiving a flood warning.

## *Steps to Reduce Risks*

- **Identify Flood Risk.** Since 2000, Vermont has had more than one federally-declared disaster per year and floods have occurred nearly everywhere in the state (ANR). Identifying your risk is a good place to start. Floodplain maps are available at most town offices or click here http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your business is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** Many types of disasters are not covered under normal insurance policies and funding or loans from government agencies is often too little and too late. All insurance policies have overall policy limits and specific limits for different types of coverage and any business located in a flood-prone area should carry flood insurance. Also check to make sure your insurance includes business interruption coverage and that it reimburses other unexpected costs (like service interruptions from lost power or Internet access, law suits and unemployment compensation claims filed by employees). Business interruption insurance compensates a business for lost income, expenses and profits if a disaster, such as a flood, closes your doors. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

- **Plan Ahead.** There are also a number of low-cost steps you can take to reduce the impacts of a flood. At a minimum, regularly back up computer data and store important tax and financial records and information such as your insurance policy details in a flood safe place. Documenting your building, furnishings, equipment and inventory with photos or video can speed the insurance claims process.

All businesses should have a continuity of operations plan. A continuity of operations plan is a written document that outlines how your business will respond and recover from a flood or other disaster. At a minimum, your plan should include:

- A list of important contacts including your insurance company, key customers and vendors and evacuation contacts for staff.
- A map showing locations of important equipment to relocate (computers and servers) and where to shut off electricity, gas and other services.
- Procedures to protect your property and minimize business disruption – e.g. remote back up of computer files, a plan to relocate inventory or livestock.
- A back up location to conduct business while the building is being repaired.

Having a continuity of operations plan will help you identify and assign essential tasks that will help minimize the damage caused by flooding. Training and practice will help assure the plan is workable and employees are properly trained.

The Vermont Small Business Development Center http://www.vtsbdc.org and many of Vermont's Regional Development Corporations http://accd.vermont.gov/business/partners/rdc and Regional Planning Commissions http://www.vapda.org can also provide training and one-on-one assistance to help your business develop a continuity of operations plan.

CERF+ (Craft Emergency Relief Fund + Artists' Emergency Resources) offers tailored disaster guidance and recourses for artists (http://studioprotector.org/OnlineGuide/DisasterPlanning/DisasterSpecificPlanningResources.aspx ).

- **Train and Practice.** Employees need to understand flood warnings and what to do when they get one. This includes understanding the dangers of flooding and how to evacuate the building safely. Train all staff on procedures to shut down the business and how to deploy loss reduction measures like relocating equipment and inventory to upper floors and deploying door and window dams reduce flooding. Finally, remember that flooding can also affect employees' ability to work, as their priority may be to protect their home and family first.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. Having a continuity of operations plan and a few extra minutes to evacuate can save lives and your business.

The US Small Business Administration https://www.sba.gov/content/disaster-preparedness offers more detailed information on how to prepare and protect your employees and business and from disasters and floods.

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# Appendix A:

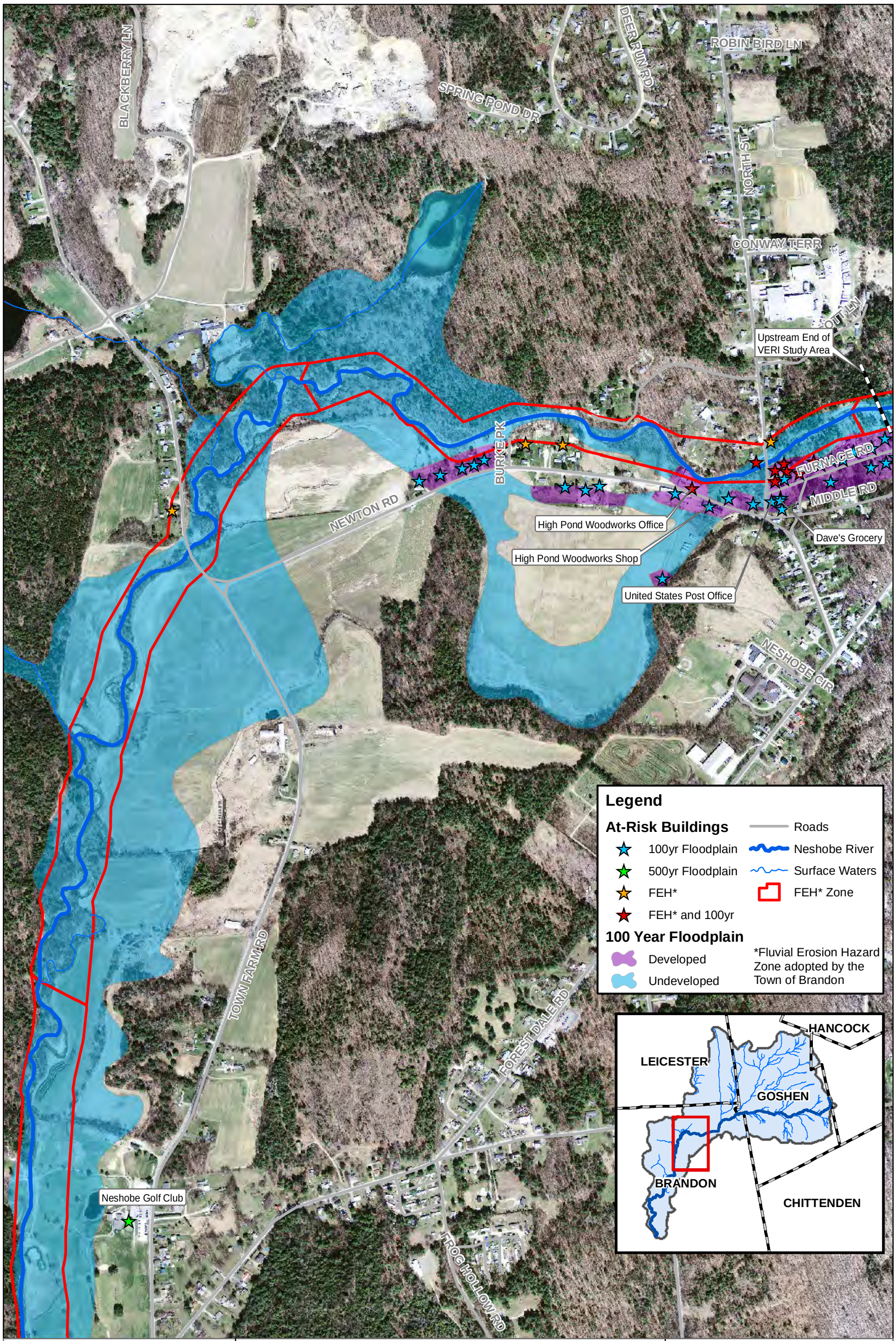
## Town of Brandon and Neshobe River Data Sources

## Town of Brandon and Neshobe River Data Sources

| Name | Description | Source |
|---|---|---|
| Brandon Economic Assets and T.S. Irene Flood Damage | Critical town-owned infrastructure including water lines, sewer lines, stormwater lines, and public/private wells; T.S. Irene business flood damage data. | Rutland Regional Planning Commission (RRPC) |
| Brandon Hazard Mitigation Plan | All-hazards local mitigation strategy to make the community more disaster resistant and resilient. | RRPC |
| Brandon Land Use Ordinance | Land use regulations to encourage appropriate development of lands in Brandon, including those located in flood hazard areas. | Town of Brandon |
| Nesbobe River Geomorphic Assessments and River Corridor Plan (RCP) | Data and maps of channel stability and aquatic habitat, and recommended actions to improve river stability and reduce flood hazards. | RRPC; Bear Creek Environmental (BCE) |
| Flood Hazard Areas | Mapping of 100 and 500-year flood zones and fluvial erosion hazard zones. | VTANR |
| Bridge and Culvert Data | Neshobe River crossing structure dimensions | VTrans; VTANR |
| Geospatial data for Rutland County | Aerial photography and GIS layers for contour lines, surface waters, wetlands, soils, roadways, and parcel boundaries. | VTANR; VCGI; RRPC |
| Flood Resiliency Projects | Information about completed and flood resiliency efforts initiated by the town | VTANR; Town of Brandon |

# Appendix B:

## Town of Brandon Flood Hazards and Flood Damage Maps and Table

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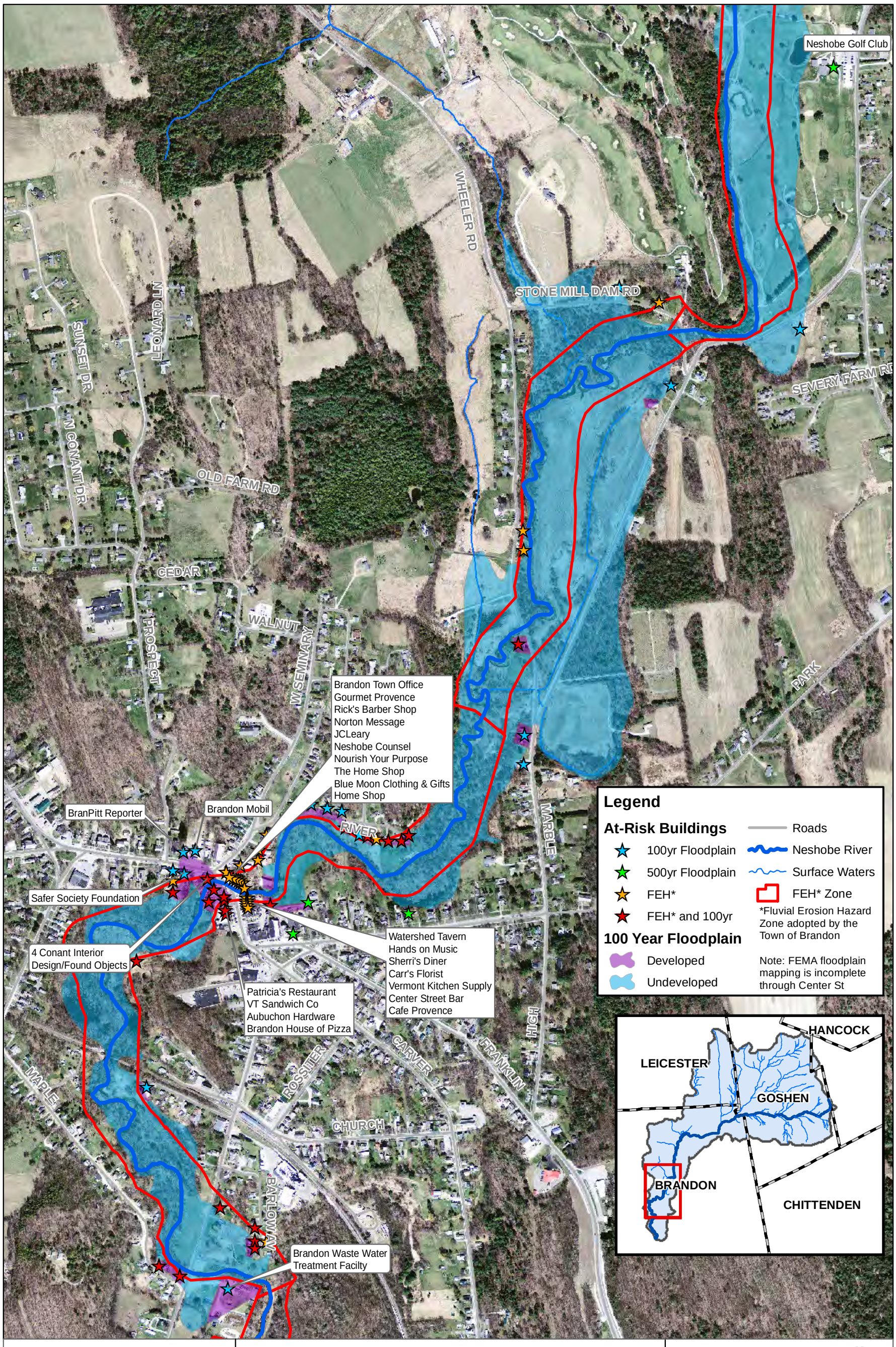
# Flood Hazards and Floodplain Development Brandon, Vermont

Vermont Economic Resiliency Initiative
Agency of Commerce & Community Development

0 350 700 Feet
1 in = 700 feet

Map 1 of 2

Drawn: JHB & EPF
Date: Feb 18, 2015

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# Flood Hazards and Floodplain Development Brandon, Vermont

Vermont Economic Resiliency Initiative
Agency of Commerce & Community Development

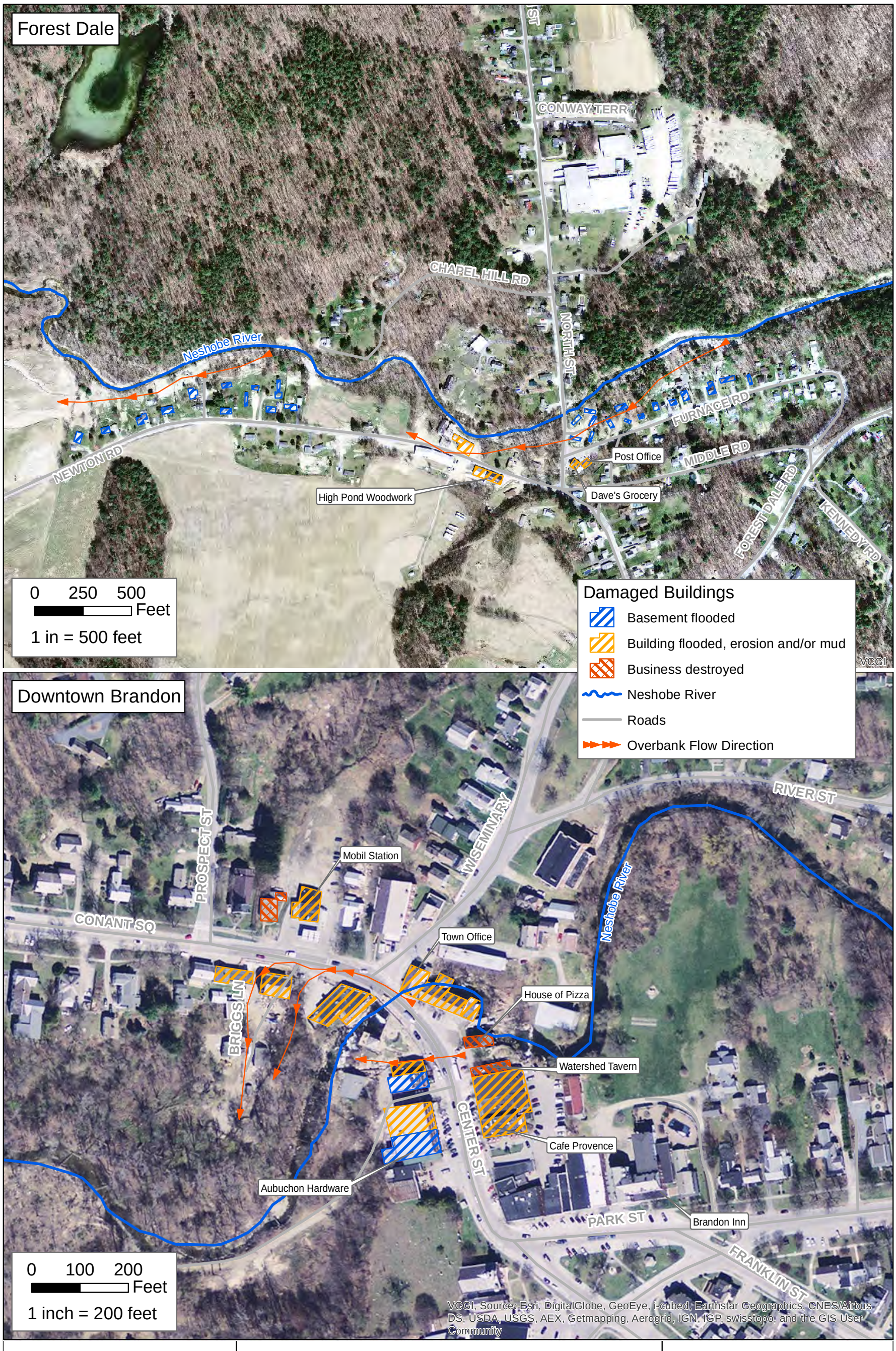
0 350 700 Feet
1 in = 700 feet

Map 2 of 2

Drawn: JHB & EPF
Date: Feb 18, 2015

| Business Name | E911 Business Address | Number of Employees | Brandon FEH | FEMA Floodway | FEMA 100yr Flood Zone | FEMA 500 Year Flood Zone | TSI Inundation Area |
|---|---|---|---|---|---|---|---|
| 4 Conant Interior Design/Found Objects | 4 Conant Sq | 2 | | | X | | X |
| Apartment House | 14 Conant Sq | -- | | | X | | X |
| Aubuchon Hardware | 10 Center St | 5 | | | | | X |
| Blue Moon Clothing & Gifts | 43 Center St | 2 | X | * | * | * | X |
| Brandon House of Pizza (New Location) | 16 Center St | 7 | | | X | | X |
| Brandon House of Pizza (Old Location) | 33 Center St | 7 | X | | | | X |
| Brandon Inn | 20 Park St | 15 | | | | X | |
| Brandon Mobil | 9 Conant Sq | -- | | | X | | X |
| Brandon Town Office | 49 Center St | 37 | X | * | * | * | X |
| Brandon Waste Water Treatment Facilty | 500 Union St | -- | | X | X | X | X |
| Cafe Provence | 11 Center St | 30 | | * | * | * | X |
| Carr's Florist & Gifts | 21 Center St | 5 | X | * | * | * | X |
| Center Street Bar | 15 Center St | -- | | * | * | * | X |
| Century 21 | 30 Marble St | 7 | | | X | X | |
| Dave's Grocery | 15 Furnace Rd | 4 | | | X | | X |
| Gourmet Provence | 37 Center St | 6 | X | * | * | * | X |
| Hands On Music | 27 Center St | -- | X | * | * | * | X |
| High Pond Woodworks Office | 107 Newton Rd | 5 | X | X | X | | X |
| High Pond Woodworks Shop | 106 Newton Rd | -- | | | | | X |
| Home Shop | 47 Center St | 1 | X | * | * | * | X |
| Neshobe Golf Club | 224 Town Farm Rc | 25 | | | | X | X |
| NortonMessage/JCLeary/NeshobeCounsel/NourishYrPurp | 39 Center St | 7 | X | * | * | * | X |
| Patricia's Restaurant (Sully's Place) | 18 Center St | 10 | X | | X | | X |
| Rick's Barber Shop | 35 Center St | -- | X | * | * | * | X |
| Safer Society Foundation | 8 Conant Sq | -- | | | X | | X |
| Sheri's Diner | 25 Center St | 6 | X | * | * | * | X |
| The Watershed Tavern | 31 Center St | -- | X | * | * | * | X |
| United States Post Office | 233 North St | 5 | | | X | | X |
| Vacant | 14 Center St | -- | | | X | | X |
| Vermont Kitchen Supply | 17 Center St | 2 | | * | * | * | X |
| VT Sandwich Co (New Location) | 22 Center St | -- | X | | X | | X |
| VT Sandwich Co (Old Location)/BranPitt Reporter | 11 Conant Sq | -- | | | X | | X |

* Denotes businesses that are located along Center St and Conant Sqare where FEMA floodplain mapping was not conducted

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# Tropical Storm Irene Flood Damage
# Brandon, Vermont

Vermont Economic Resiliency Initiative
Agency of Commerce & Community Development

Drawn: JHB & EPF
Date: Feb18, 2015

N W E S

Building damage data provided by
Rutland Regional Planning Commission

# Appendix C:

## V-DAT One-Page Visual Summary of the Top Recommendations for Brandon

DOWNTOWN BRANDON
*Unhurried. Unspoiled. Unforgettable.*

# Conceptual Vision Plan for **Our Community**

Brandon, VT is an intimate, warm and walkable small town with a strong sense of place and significant community and historic assets, including a compact and full-service downtown. Brandon's downtown is unusual in that it still provides the essential goods and services that have moved to the outskirts of many Vermont towns. Brandon provides the local populace and residents of surrounding towns with opportunities for jobs, retail goods and services, and the social and civic benefits of an active and diverse community. The things that make Brandon special include its natural resources, historic streetscape and community character.

On August 28, 2011, Tropical Storm Irene brought over one foot of rain to Brandon, VT causing flooding and overflow of the Neshobe River that runs through downtown. When the rain and rising waters were over, one business was off its foundation and left in the middle of the street. Multiple other businesses were flooded and the question of the integrity of several buildings was an issue.

Brandon has a dedicated and highly skilled volunteer corps that has enabled the city to jump-start the recovery process. One of the key historic buildings whose back is on the river has been saved. An overflow system will be put in place during the section 6-highway work that should alleviate future flooding.

The Vermont Downtown Action Team (V-DAT) was selected by the State of Vermont, Department of Housing and Community Development, Vermont Downtown Program in May 2013 to conduct a community planning and economic development charrette in Wilmington. The V-DAT was comprised of experts in architecture, planning, landscape architecture, historic preservation, economic development, organizational structure, landscape architecture, engineering and community branding.

The V-DAT planning charrette operates on three key tenants: utilizing an asset based approach, addressing the community in a holistic manner, and conducting the exercise in a public forum.

The market study findings for Brandon show that there is room for additional retail and restaurant growth in the market. This information coupled with the excellent collection of buildings with strong architectural character point to a great opportunity for infill development.

The architectural stock of Brandon is remarkable. It is also a community where many of the key traditional uses remain in downtown alongside more specialty shops. Upper floor renovation for future uses, maintenance of existing buildings, and façade restoration opportunities will dramatically enhance Brandon's already charming appearance while encouraging economic health.

Telling Brandon's story: The community has cultivated a well-known identity as a place of innovation and creativity. This story should continue in innovative ways. The following brand statement provides insight into the tagline for the community: Unhurried, Unspoiled, Unforgettable.

**Uncover the art of being Unhurried.**
Ours is a place where the Vermont that everyone yearns for still exists. A place where our neighbors are our friends, and we treat visitors like neighbors. A place where the lunch hour can go a little longer, and morning coffee isn't standing in line for a paper cup. A place where our shopkeepers greet us with a smile, understand the value of true service, and the connection of being known by name. Come discover our town at your pace.

**Uncover the beauty of life Unspoiled.**
Ours is a place called Brandon. A place where you won't find flashing lights or strip malls. A place where 200 years of architectures frame a river that cascades through the heart of our downtown. A place where the majesty of our woods and fields, parks and trails is crowned by historic church spires. A place where historic houses still make warm homes.

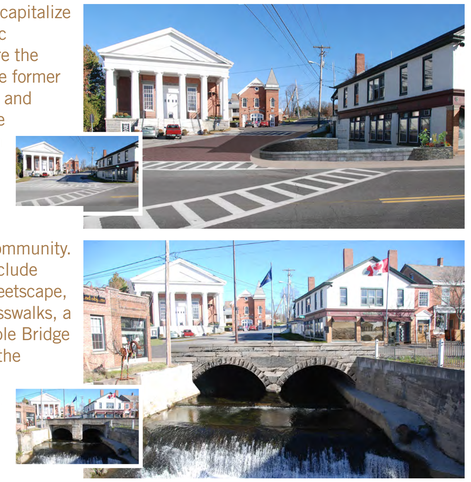
**Uncover memories that are Unforgettable.**
Ours is a place we call downtown. A place where memories are made around every turn. It's the heaping scoop of ice cream. It's marching to the beat of your own drum. It's the fine art and the art of fine cuisine. It's family time. Its finding exactly what you need. It's finding what you never knew existed. It's being surrounded by friends. It's saying I do.

**We are Brandon, Vermont.**
**Unhurried, Unspoiled, Unforgettable..**



## **Enhance** the Heart

Brandon can capitalize on the historic crossing where the Town Hall, the former Town Offices, and Marble Bridge intersect with Seminary Street to create a vibrant civic core of the community. This could include enhanced streetscape, improved crosswalks, a restored Marble Bridge and reuse of the former Town Office once it is restored.





MAIN STREET
DOWNTOWN BRANDON, VT


## **Connecting** the Core

The reconfiguration of Route 7 creates an opportunity for Brandon to create improvements to Central Park by enhancing pedestrian connections, creating a more logical traffic pattern through the area, and calming traffic so that it does not speed through the heart of town. Brandon can continue to foster its connections to the Neshobe River as the river creates a remarkable attraction in downtown Brandon. Flood remediation efforts should combine with amenities and attractions to bring people to the river.


V-DAT
VERMONT DOWNTOWN ACTION TEAM

VERMONT
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

**Project Funding and Support**
This project was supported by funding from the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant – Disaster Recovery. The plan was prepared as a cooperative effort of the State of Vermont Department of Housing and Community Development, the Division of Community Planning and Revitalization and the Town of Wilmington. The contents of this document do not necessarily reflect the official views or policy of HUD or the State of Vermont. For more information on the Vermont Downtown Action Team [V-DAT] program and links to the detailed presentation and report for Wilmington please visit http://accd.vermont.gov/strong_communities or call (802) 828-5229.

# Appendix D:

## Results of EPA's Flood Resilience Checklist for Brandon

# Flood Resilience Checklist

Is your community prepared for a possible flood? Completing this flood resilience checklist can help you begin to answer that question. This checklist was developed as part of the U.S. Environmental Protection Agency's Smart Growth Implementation Assistance project in the state of Vermont. More information about the project can be found by reading the full report, *Planning for Flood Recovery and Long-Term Resilience in Vermont*, found online at www.epa.gov/smartgrowth/sgia_communities.htm#rec1.

## What is the Flood Resilience Checklist?

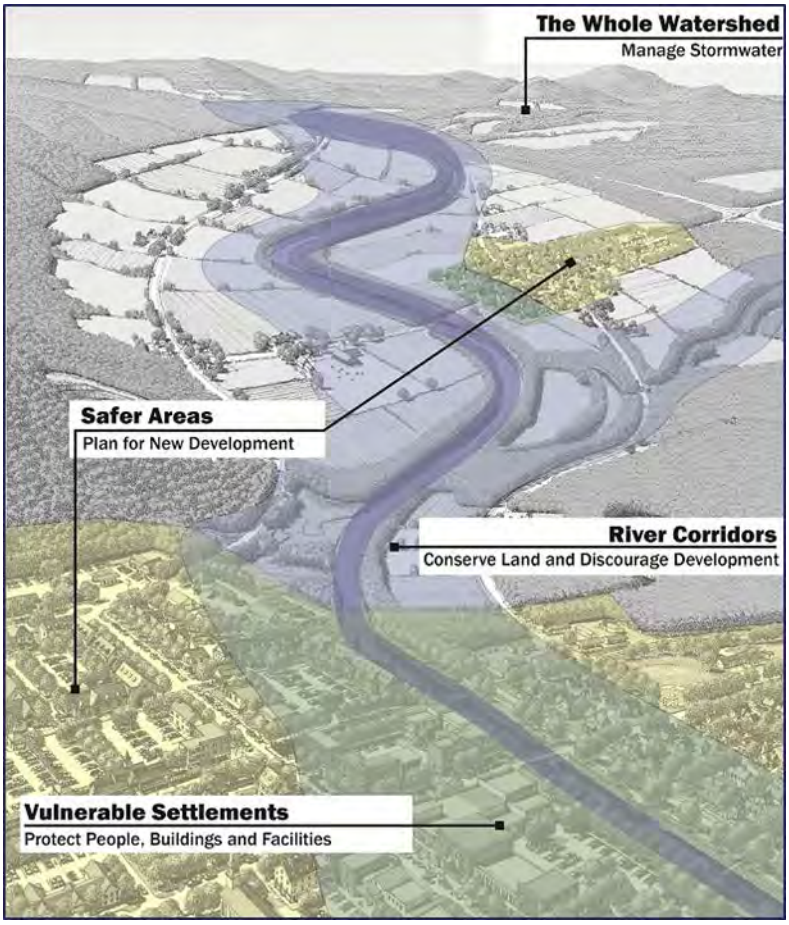
This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

## Who should use it?

This checklist can help communities identify opportunities to improve their resilience to future floods through policy and regulatory tools, including comprehensive plans, Hazard Mitigation Plans, local land use codes and regulations, and non-regulatory programs implemented at the local level. Local government departments such as community planning, public works, and emergency services; elected and appointed local officials; and other community organizations and nonprofits can use the checklist to assess their community's readiness to prepare for, deal with, and recover from floods.

## Why is it important?

Completing this checklist is the first step in assessing how well a community is positioned to avoid and/or reduce flood damage and to recover from floods. If a community is not yet using some of the strategies listed in the checklist and would like to, the policy options and resources listed in the *Planning for Flood Recovery and Long-Term Resilience in Vermont* report can provide ideas for how to begin implementing these approaches.




*This graphic illustrates the four categories of approaches to enhance resilience to future floods. Credit: Vermont Agency of Commerce and Community Development.*

# BRANDON FLOOD RESILIENCE CHECKLIST

**Overall Strategies to Enhance Flood Resilience**
(Learn more in Section 2, pp. 9-11 of
*Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Does the community's comprehensive plan have a hazard element or flood planning section? | ■ Yes | ☐ No |
| a. Does the comprehensive plan cross-reference the local Hazard Mitigation Plan and any disaster recovery plans? | ■ Yes | ☐ No |
| b. Does the comprehensive plan identify flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas, if applicable? | ■ Yes | ☐ No |
| c. Did the local government emergency response personnel, flood plain manager, and department of public works participate in developing/updating the comprehensive plan? | ■ Yes | ☐ No |
| 2. Does the community have a local Hazard Mitigation Plan approved by the Federal Emergency Management Agency (FEMA) and the state emergency management agency? | ■ Yes | ☐ No |
| a. Does the Hazard Mitigation Plan cross-reference the local comprehensive plan? | ■ Yes | ☐ No |
| b. Was the local government planner or zoning administrator involved in developing/updating the Hazard Mitigation Plan? | ■ Yes | ☐ No |
| c. Were groups such as local businesses, schools, hospitals/medical facilities, agricultural landowners, and others who could be affected by floods involved in the Hazard Mitigation Plan drafting process? | ■ Yes | ☐ No |
| d. Were other local governments in the watershed involved to coordinate responses and strategies? | ☐ Yes | ■ No |
| e. Does the Hazard Mitigation Plan emphasize non-structural pre-disaster mitigation measures such as acquiring flood-prone lands and adopting No Adverse Impact flood plain regulations? | ■ Yes | ☐ No |
| f. Does the Hazard Mitigation Plan encourage using green infrastructure techniques to help prevent flooding? | ■ Yes | ☐ No |
| g. Does the Hazard Mitigation Plan identify projects that could be included in pre-disaster grant applications and does it expedite the application process for post-disaster Hazard Mitigation Grant Program acquisitions? | ■ Yes | ☐ No |
| 3. Do other community plans (e.g., open space or parks plans) require or encourage green infrastructure techniques? | ☐ Yes | ■ No |

| BRANDON FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Do all community plans consider possible impacts of climate change on areas that are likely to be flooded? | ☐ Yes | ■ No |
| 5. Are structural flood mitigation approaches (such as repairing bridges, culverts, and levees) and non-structural approaches (such as green infrastructure) that require significant investment of resources coordinated with local capital improvement plans and prioritized in the budget? | ■ Yes | ☐ No |
| 6. Does the community participate in the National Flood Insurance Program Community Rating System? | ☐ Yes | ■ No |
| **Conserve Land and Discourage Development in River Corridors**<br>(Learn more in Section 3.A, pp. 14-19 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Has the community implemented non-regulatory strategies to conserve land in river corridors, such as: | | |
| a. Acquisition of land (or conservation easements on land) to allow for stormwater absorption, river channel adjustment, or other flood resilience benefits? | ■ Yes | ☐ No |
| b. Buyouts of properties that are frequently flooded? | ■ Yes | ☐ No |
| c. Transfer of development rights program that targets flood-prone areas as sending areas and safer areas as receiving areas? | ☐ Yes | ■ No |
| d. Tax incentives for conserving vulnerable land? | ☐ Yes | ■ No |
| e. Incentives for restoring riparian and wetland vegetation in areas subject to erosion and flooding? | ☐ Yes | ■ No |
| 2. Has the community encouraged agricultural and other landowners to implement pre-disaster mitigation measures, such as: | | |
| a. Storing hay bales and equipment in areas less likely to be flooded? | ☐ Yes | ■ No |
| b. Installing ponds or swales to capture stormwater? | ☐ Yes | ■ No |
| c. Planting vegetation that can tolerate inundation? | ☐ Yes | ■ No |
| d. Using land management practices to improve the capability of the soil on their lands to retain water? | ☐ Yes | ■ No |
| 3. Has the community adopted flood plain development limits that go beyond FEMA's minimum standards for Special Flood Hazard Areas and also prohibit or reduce any new encroachment and fill in river corridors and Fluvial Erosion Hazard areas? | ☐ Yes | ■ No |

| BRANDON FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Has the community implemented development regulations that incorporate approaches and standards to protect land in vulnerable areas, including: | | |
| a. Fluvial erosion hazard zoning? | ■ Yes | ☐ No |
| b. Agricultural or open space zoning? | ■ Yes | ☐ No |
| c. Conservation or cluster subdivision ordinances, where appropriate? | ☐ Yes | ■ No |
| d. Other zoning or regulatory tools that limit development in areas subject to flooding, including river corridors and Special Flood Hazard Areas? | ■ Yes | ☐ No |
| **Protect People, Buildings, and Facilities in Vulnerable Settlements**<br>(Learn more in Section 3.B, pp. 19-26 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Do the local comprehensive plan and Hazard Mitigation Plan identify developed areas that have been or are likely to be flooded? | ■ Yes | ☐ No |
| a. If so, does the comprehensive plan discourage development in those areas or require strategies to reduce damage to buildings during floods (such as elevating heating, ventilation, and air conditioning (HVAC) systems and flood-proofing basements)? | ■ Yes | ☐ No |
| b. Does the Hazard Mitigation Plan identify critical facilities and infrastructure that are located in vulnerable areas and should be protected, repaired, or relocated (e.g., town facilities, bridges, roads, and wastewater facilities)? | ■ Yes | ☐ No |
| 2. Do land development regulations and building codes promote safer building and rebuilding in flood-prone areas? Specifically: | | |
| a. Do zoning or flood plain regulations require elevation of two or more feet above base flood elevation? | ■ Yes | ☐ No |
| b. Does the community have the ability to establish a temporary post-disaster building moratorium on all new development? | ■ Yes | ☐ No |
| c. Have non-conforming use and structure standards been revised to encourage safer rebuilding in flood-prone areas? | ■ Yes | ☐ No |
| d. Has the community adopted the International Building Code or American Society of Civil Engineers (ASCE) standards that promote flood-resistant building? | ☐ Yes | ■ No |
| e. Does the community plan for costs associated with follow-up inspection and enforcement of land development regulations and building codes? | ☐ Yes | ■ No |

| BRANDON FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 3. Does the community require developers who are rebuilding in flood-prone locations to add additional flood storage capacity in any new redevelopment projects such as adding new parks and open space and allowing space along the river's edge for the river to move during high-water events? | ■ Yes | ☐ No |
| 4. Is the community planning for development (e.g., parks, river-based recreation) along the river's edge that will help connect people to the river AND accommodate water during floods? | ■ Yes | ☐ No |
| 5. Does the comprehensive plan or Hazard Mitigation Plan discuss strategies to determine whether to relocate structures that have been repeatedly flooded, including identifying an equitable approach for community involvement in relocation decisions and potential funding sources (e.g., funds from FEMA, stormwater utility, or special assessment district)? | ☐ Yes | ■ No |
| **Plan for and Encourage New Development in Safer Areas**<br>(Learn more in Section 3.C, pp. 26-27 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Does the local comprehensive plan or Hazard Mitigation Plan clearly identify safer growth areas in the community? | ☐ Yes | ■ No |
| 2. Has the community adopted policies to encourage development in these areas? | ☐ Yes | ■ No |
| 3. Has the community planned for new development in safer areas to ensure that it is compact, walkable, and has a variety of uses? | ☐ Yes | ■ No |
| 4. Has the community changed their land use codes and regulations to allow for this type of development? | ☐ Yes | ■ No |
| 5. Have land development regulations been audited to ensure that development in safer areas meets the community's needs for off-street parking requirements, building height and density, front-yard setbacks and that these regulations do not unintentionally inhibit development in these areas? | ☐ Yes | ■ No |
| 6. Do capital improvement plans and budgets support development in preferred safer growth areas (e.g., through investment in wastewater treatment facilities and roads)? | ■ Yes | ☐ No |
| 7. Have building codes been upgraded to promote more flood-resistant building in safer locations? | ■ Yes | ☐ No |

# BRANDON FLOOD RESILIENCE CHECKLIST

**Implement Stormwater Management Techniques throughout the Whole Watershed**
(Learn more in Section 3.D, pp. 27-31 of *Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Has the community coordinated with neighboring jurisdictions to explore a watershed-wide approach to stormwater management? | ☐ Yes | ■ No |
| 2. Has the community developed a stormwater utility to serve as a funding source for stormwater management activities? | ☐ Yes | ■ No |
| 3. Has the community implemented strategies to reduce stormwater runoff from roads, driveways, and parking lots? | ☐ Yes | ■ No |
| 4. Do stormwater management regulations apply to areas beyond those that are regulated by federal or state stormwater regulations? | ☐ Yes | ■ No |
| 5. Do stormwater management regulations encourage the use of green infrastructure techniques? | ☐ Yes | ■ No |
| 6. Has the community adopted tree protection measures? | ☐ Yes | ■ No |
| 7. Has the community adopted steep slope development regulations? | ■ Yes | ☐ No |
| 8. Has the community adopted riparian and wetland buffer requirements? | ☐ Yes | ■ No |

# Appendix E:

## Table of Municipal Policy and Program Recommendations

# Brandon

**Town-wide Policy and Program Options**
**Vermont Economic Resiliency Initiative**



**Legend**
● Effective ◒ Limited ○ Ineffective

* Priority rating based on degree of community benefit

| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Land Use Regulations** | | | | | | | | | | |
| Require repaired and rebuilt structures to be built higher above base flood elevation. | **Medium** | ● | ○ | ● | Moderate | < $10K | RPC, VLCT, Consultant | MPG | Owners rebuilding should raise the lowest floor 2 to 3 feet higher than the most recently recorded flood elevation in high-risk areas. These requirements can be added to the development standards portion of the flood hazard section of the town zoning bylaw. | Work with Planning Commission. |
| Update policies to prevent fill and require conditional use review for other activities in the special flood hazard area. | **High** | ● | ○ | ● | Moderate | < $10K | DEC River Management Program, RPC, VLCT, Consultant | MPG | Allowing landowners to fill low lying areas may help protect an individual property, but it can reduce the land's ability to slow and store extra flood waters and increase flood hazards downstream. Other activities in flood hazarda areas such as improvements to existing structures should be required to undergo conditional use review. These policies can be added to the development standards portion of the flood hazard section of the town and zoning bylaw. | Work with Planning Commission. |
| Remove the special flood hazard area from developable land calculations. | **Medium** | ● | ● | ● | Moderate | < $10K | RPC, VLCT, Consultant | MPG | Removing the special flood hazard area from developable land calculations reduces the potential for too many structures to be built near hazardous areas. | Work with Planning Commission. |
| Create benchmarks for rebuilding after a disaster. | **High** | ◒ | ◒ | ● | Moderate | < $10K | DEMHS, VLCT, FEMA | | People want to return to normal as quickly as possible after a disaster but local officials need to monitor rebuilding work and create benchmarks to ensure that rebuilding does not violate town and federal regulations. Without close monitoring, improper rebuilding may result in future federal disaster funding being unavailable for the town and its residences and businesses. | Work with Zoning Administrator. |
| **Town Plan** | | | | | | | | | | |
| Document damages from flood events. | **High** | ○ | ○ | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | Disasters are easily forgotten over time and damages from the 2011 floods as well as other smaller recent rain and flood events should be documented. This will help the community consider the implications of new investments in areas damaged by floods including businesses along the Neshobe River, mobile homes, and municipal infrastructure. Town officials such as the emergency management director, zoning administrator, and public works should be involved in this work. | Incorporate into current Planning Commission work on Town Plan update. |
| Document road, sewer, and water infrastructure vulnerabilities in municipal and capital plans. | **High** | ○ | ○ | ● | Moderate | < $10K | RPC, VLCT, Consultant | MPG | Specific areas that were damaged or have known vulnerabilities should be documented so the community can plan for their replacement in their long-term budgets, easing the impact on taxpayers. Capital programs and budgets are not common in smaller towns but the local Selectboard may start this process with a list and a capital reserve fund. | Continue Planning Commission work on capital improvement planning. |
| Encourage agricultural uses in flood hazard areas. | **Medium** | ● | ● | ◒ | Easy | < $10K | RPC, VLCT, Consultant | MPG | Farming that is done according to best management practicies and in consideration of the river should be encouraged in flood hazard areas. By encouraging agricultural uses, other risky activities such as building improvements will be further discouraged. | Incorporate into current Planning Commission work on Town Plan update. |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

# Brandon

**Town-wide Policy and Program Options**
**Vermont Economic Resiliency Initiative**



**Legend**
● Effective ◓ Limited ○ Ineffective

* Priority rating based on degree of community benefit

| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| Identify areas for conservation. | **High** | ● | ● | ● | Moderate | ?? | VT River Conservancy, DEC River Management Program, VT Land Trust | | The Neshobe River Corridor Plan identifies potential riparian easement sites. The town can identify and work with willing landowners to establish conservation sites along the river to prevent future development in flood-prone locations. | Identify high priority land for conservation. |
| **Emergency Planning** | | | | | | | | | | |
| Develop a local recovery fund. | **Medium** | ○ | ○ | ● | Difficult | ?? | VLCT, DEMHS | | Towns will recover much more quickly after a disaster if they create a local fund to address urgent needs. Federal and state money will come, but these funds are slow to arrive. Establishing a local household and business small grant or loan fund is proven to speed recovery efforts. | Work with Selectboard. |
| Develop a local building retrofit fund. | **Medium** | ○ | ○ | ● | Difficult | ?? | VLCT, DEMHS | | Again state and federal grants take time and may not be available for small projects. As part of the recovery or pre-disaster mitigation plan and fund, towns could offer mini grants for retrofits such as backflow preventers (that keep stormwater and sewage from flooding buildings via the drainage system), elevation of exterior utilities, and flood barriers for doors. | Work with Selectboard. |
| Develop evacuation plans. | **High** | ○ | ○ | ● | Easy | < $10K | RPC,D EMHS | | Municipal facilities and schools as well as private facilities such as mobile home parks, senior centers, nursing homes and workplaces should all have evacuation plans. | Work with Emergency Management Director. |
| Educate people about the causes, risks and warning signs of floods. | **Medium** | ○ | ○ | ● | Moderate | < $10K | RPC, DEMHS, DEC River Management Program, FEMA | | Schools can include flood awareness and preparedness in spring and fall science and history programs. Schools and towns and other local groups can publicize flood risk areas, warning signs and evacuation plans. Working with the state and the RPCs, these groups can distribute flood hazard maps so that people know where there is a risk of flooding. | Reach out to schools and community groups. |
| Identify VERI project recommendations in Brandon's Hazard Mitigation Plan. | **High** | ○ | ○ | ● | Easy | < $10K | RPC, Consultant | HMGP | Once the community has chosen the top recommendations for further implementation, include these in the town's Hazard Mitigation Plan. This will help when applying for future Hazard Mitigation Grant Program (HMGP) funding. | Work with town Emergency Management Director. |
| **Education and Outreach** | | | | | | | | | | |
| Promote and educate property owners on the value of flood insurance. | **Medium** | ○ | ○ | ● | Easy | < $10K | RPC, DEMHS, FEMA | | Homeowners' insurance does not pay for any flood related damage. Only flood insurance through the National Flood Insurance Program does. In Brandon, only 27% of buildings in the flood hazard area have flood insurance. | Gather NFIP informational materials for distribution, and reach out to real estate agents. |
| Help businesses plan for disasters. | **Medium** | ○ | ○ | ● | Moderate | < $10K | SBDC, FEMA, RPC | | If a home is damaged or washed away, occupants can go stay in a hotel, with friend or family, or find a rental. When a business is flooded, it is much harder or impossible to relocate. Continuity of operations plans outlines the steps business can take during and after a disaster to reduce disruption and losses. | Offer continuity of operations planning training for businesses. |

[1] **Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2] **Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

## Brandon

**Town-wide Policy and Program Options**
**Vermont Economic Resiliency Initiative**

**Legend**
● Effective ◒ Limited ○ Ineffective

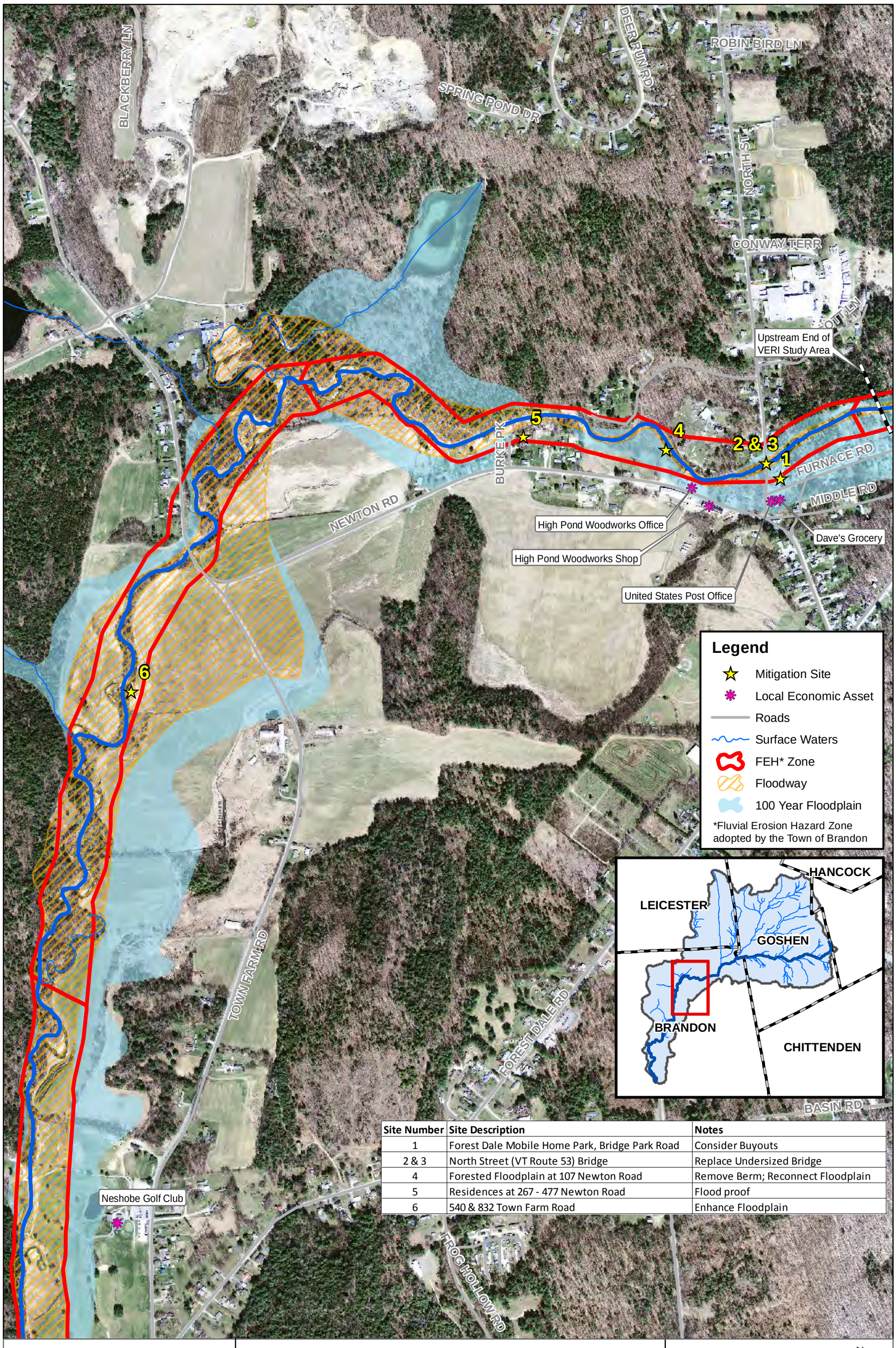
* Priority rating based on degree of community benefit

| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| Educate landlords and contractors about local regulations. | **Medium** | ○ | ○ | ● | Moderate | < $10K | | | Many landlords and contractors may not understand the requirements for rebuilding after a flood. Specific standards must be met to maintain eligibility for flood insurance and other federal grants. | Reach out to landlords and contractors. |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

# Appendix F:

## Maps and Tables of Projects to Protect Brandon




| Site Number | Site Description | Notes |
|---|---|---|
| 1 | Forest Dale Mobile Home Park, Bridge Park Road | Consider Buyouts |
| 2 & 3 | North Street (VT Route 53) Bridge | Replace Undersized Bridge |
| 4 | Forested Floodplain at 107 Newton Road | Remove Berm; Reconnect Floodplain |
| 5 | Residences at 267 - 477 Newton Road | Flood proof |
| 6 | 540 & 832 Town Farm Road | Enhance Floodplain |

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# Projects to Protect Businesses and Infrastructure Brandon, Vermont

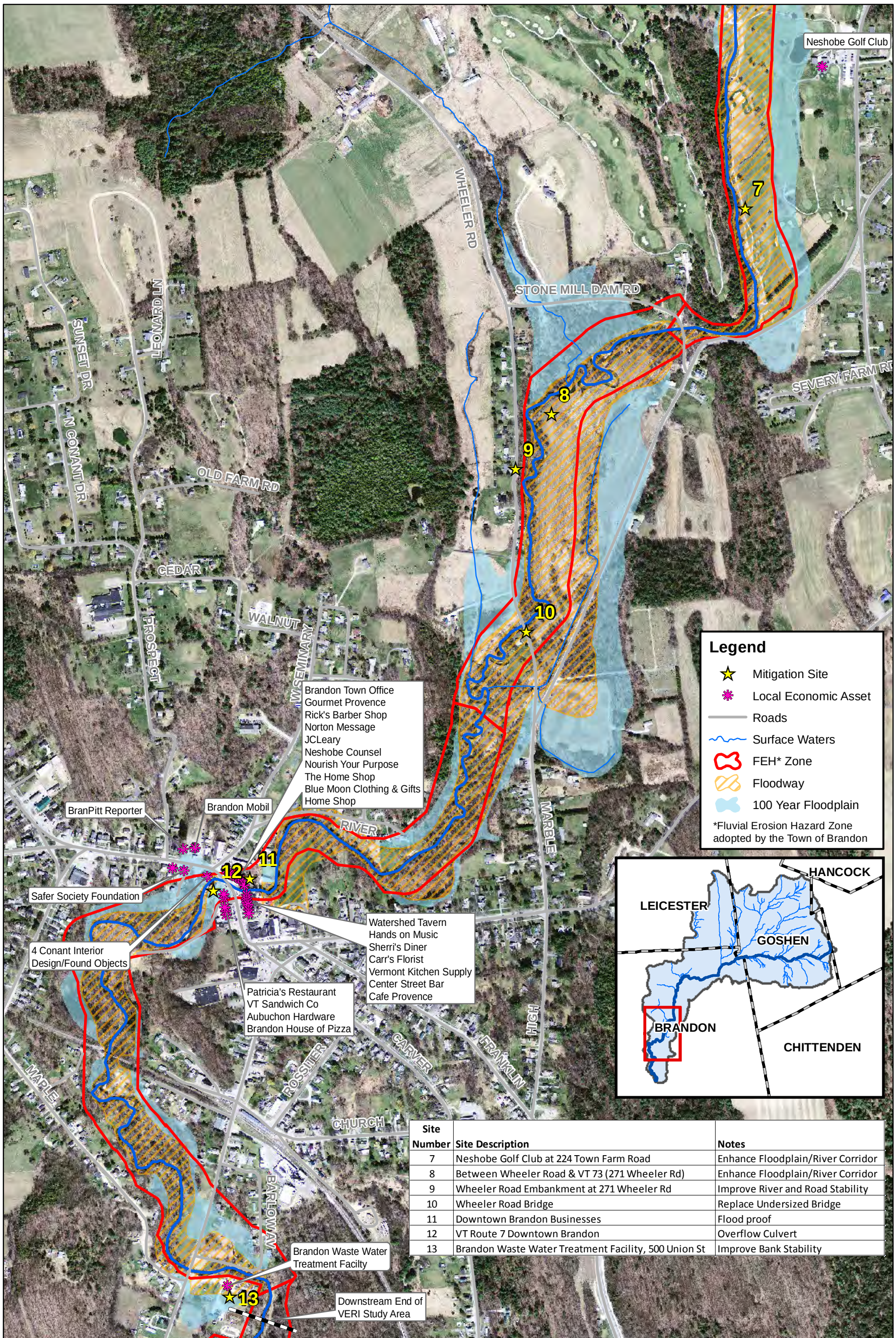
Vermont Economic Resiliency Initiative
Agency of Commerce & Community Development

0 350 700 Feet
1 in = 700 feet

Map 1 of 2

Drawn: JHB & EPF
Date: Feb 18, 2015

Please see project detail table for more information about project sites




| Site Number | Site Description | Notes |
|---|---|---|
| 7 | Neshobe Golf Club at 224 Town Farm Road | Enhance Floodplain/River Corridor |
| 8 | Between Wheeler Road & VT 73 (271 Wheeler Rd) | Enhance Floodplain/River Corridor |
| 9 | Wheeler Road Embankment at 271 Wheeler Rd | Improve River and Road Stability |
| 10 | Wheeler Road Bridge | Replace Undersized Bridge |
| 11 | Downtown Brandon Businesses | Flood proof |
| 12 | VT Route 7 Downtown Brandon | Overflow Culvert |
| 13 | Brandon Waste Water Treatment Facility, 500 Union St | Improve Bank Stability |

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# Projects to Protect Businesses and Infrastructure
# Brandon, Vermont

Vermont Economic Resiliency Initiative
Agency of Commerce & Community Development

0 350 700 Feet
1 in = 700 feet

Map 2 of 2

Drawn: JHB & EPF
Date: Feb 18, 2015

Please see project detail table for more information about project sites

# Brandon

**Recommended Projects to Protect Businesses and Infrastructure**
**Vermont Economic Resiliency Initiative (VERI)**
**July 26, 2015**

**Legend**
● Effective ◒ Limited ○ Ineffective

* Priority rating based on objectives and potential business impact (refer to Section X of report for explanation)



| | | | | OBJECTIVES | | | FEASIBILITY | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| **Building and Site Improvements** | | | | | | | | | | |
| Flood proof businesses in Downtown Brandon **(see site 11 on map 2)** | Businesses | 9 businesses and Town Offices with a total of 83 employees | High | ○ | ○ | ● | Moderate | $10K per building | 1-2 years | Multiple buildings were flooded and one was destroyed (Brandon House of Pizza) during Tropical Storm Irene. Flood risk may be lowered with future overflow culvert project, but risk of flood damage will likely remain during large floods. |
| Flood proof homes along Newton Road **(see site 5 on map 1)** | Residences | Residential | Low | ○ | ○ | ● | Moderate | $10K per building | 1-2 years | Approximately 10 homes to the north of Newton Road are vulnerable to flooding. Flooding did not reach the first floor on most homes, but many basements were flooded during Tropical Storm Irene. Since homes are not likely eligible for buyouts, floodproofing is an option to prevent basement damage. |
| | | | | | | | | | | |
| **Channel and Floodplain Management** | | | | | | | | | | |
| Remove berms downstream of VT Route 53 to store floodwaters and sediments in floodplain **(see site 4 on map 1)** | Town Road; Residences; 1 Business | 1 business with 5 employees | High | ● | ● | ● | Moderate | $20K-$50K | 1-2 years | Old berms exist along the south (left) bank downstream of VT Route 53. Berms restrict the river's access to floodplains in an area of major flood flow and sediment movement. Berm removal would allow access to undeveloped, forested floodplains upstream of an area where homes were flooded along Newton Road. |
| Neshobe Golf Club Floodplain/Corridor Improvements **(see site 7 on map 2)** | Golf Course | 1 business with 25 employees | Medium | ○ | ◒ | ◒ | Easy | $100-$200K | >5 years | Neshobe Golf Club has experienced $100,000 in damages during recent floods. During Tropical Storm Irene, floodwaters were approximately 10 feet deep and 2 feet of sediment was deposited on the course close to river. Could the golf course consider relocating some holes to allow the river to migrate and deposit sediment in the channel (versus floodplain) and reduce damage over the long-term? |
| Revegetate floodplain and river corridor between Wheeler Road and VT Route 73; Consider conservation easements for long-term, permanent protection **(see site 8 on map 2)** | Town Road; Residences; Farm fields | Residential and Agricultural lands | Medium | ○ | ◒ | ◒ | Moderate | $10K-$50K | 2-5 years | Upper end of river reach M03 has good floodplain access and large wetlands in the floodplain. The floodplain and river corridor are protected from development by town zoning. Consider enhancement of floodplain and wetlands with buffer tree plantings (e.g., NRCS CREP program) to slow floodwaters and store sediment and debris during large floods. Permanent protection of river from dredging (an accepted agricultural practice) would require purchase of channel management rights through an easement. |
| Revegetate floodplain and river corridor west of Town Farm Road; Consider conservation easements for long-term, permanent protection **(see site 6 on map 1)** | Farm fields; Golf Course | Agricultural lands and downstream Golf Course | Medium | ○ | ◒ | ◒ | Moderate | $10K-$50K | 2-5 years | Extensive floodplains exist from the Neshobe Golf Course up to conserved Nop property east of Town Farm Road. This area of the floodplain has major flood flow during large events (floodway width nearly = floodplain width). Consider enhancement of floodplain and wetlands with buffer tree plantings (e.g., NRCS CREP program) to slow floodwaters and store sediment and debris during large floods, and reduce long-term bank erosion along farm fields. Permanent protection of river from dredging (an accepted agricultural practice) would require purchase of channel management rights through an easement. |

[1]**Reduces Flood Risk** - The proposed project/strategy lowers the flood level.
[2]**Reduces Erosion Risk** - The proposed project/strategy lessens the vulnerability of a location to erosion.

## Brandon

**Recommended Projects to Protect Businesses and Infrastructure**
**Vermont Economic Resiliency Initiative (VERI)**
**July 26, 2015**

**Legend**
● Effective ◒ Limited ○ Ineffective

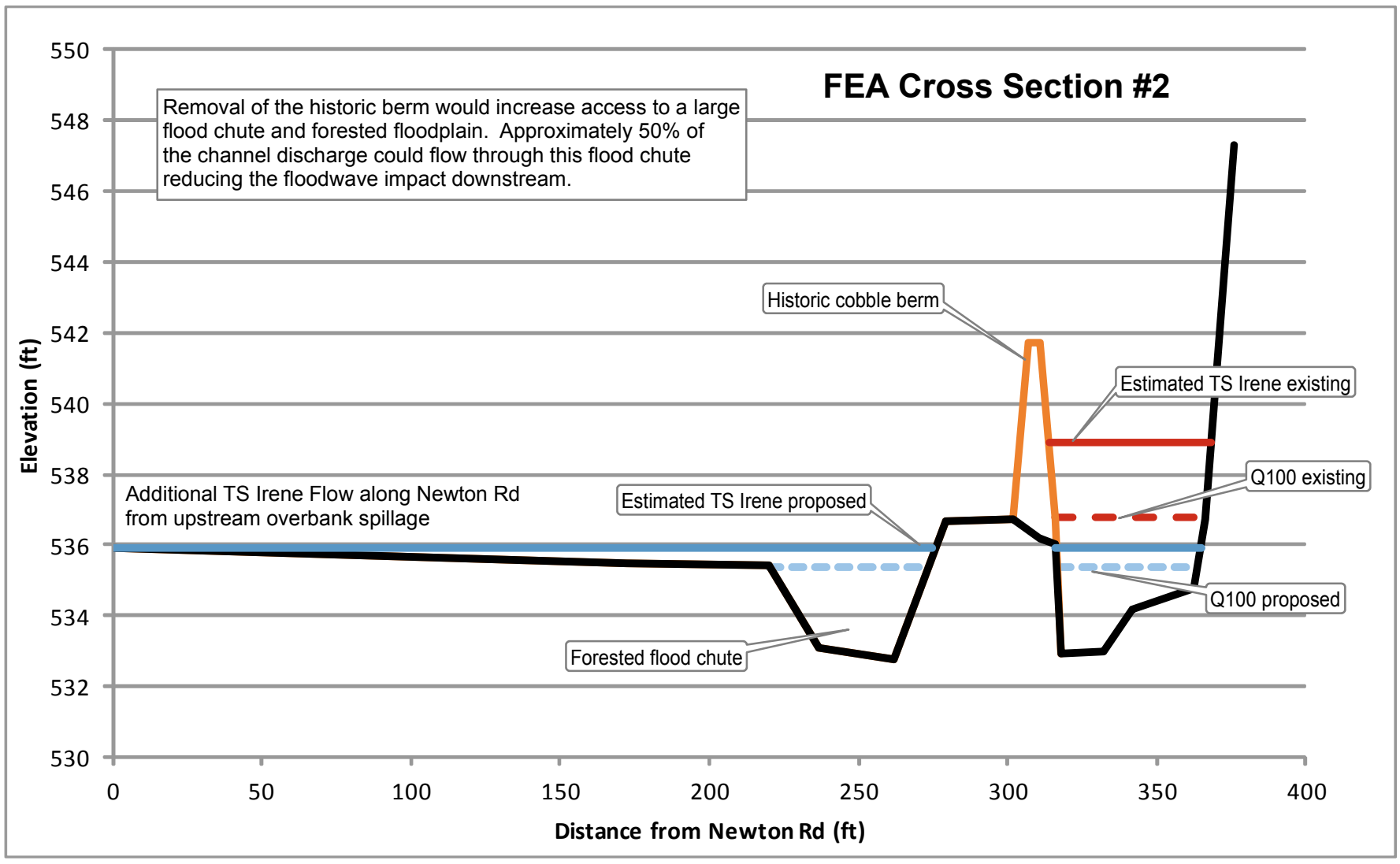
* Priority rating based on objectives and potential business impact (refer to Section X of report for explanation)

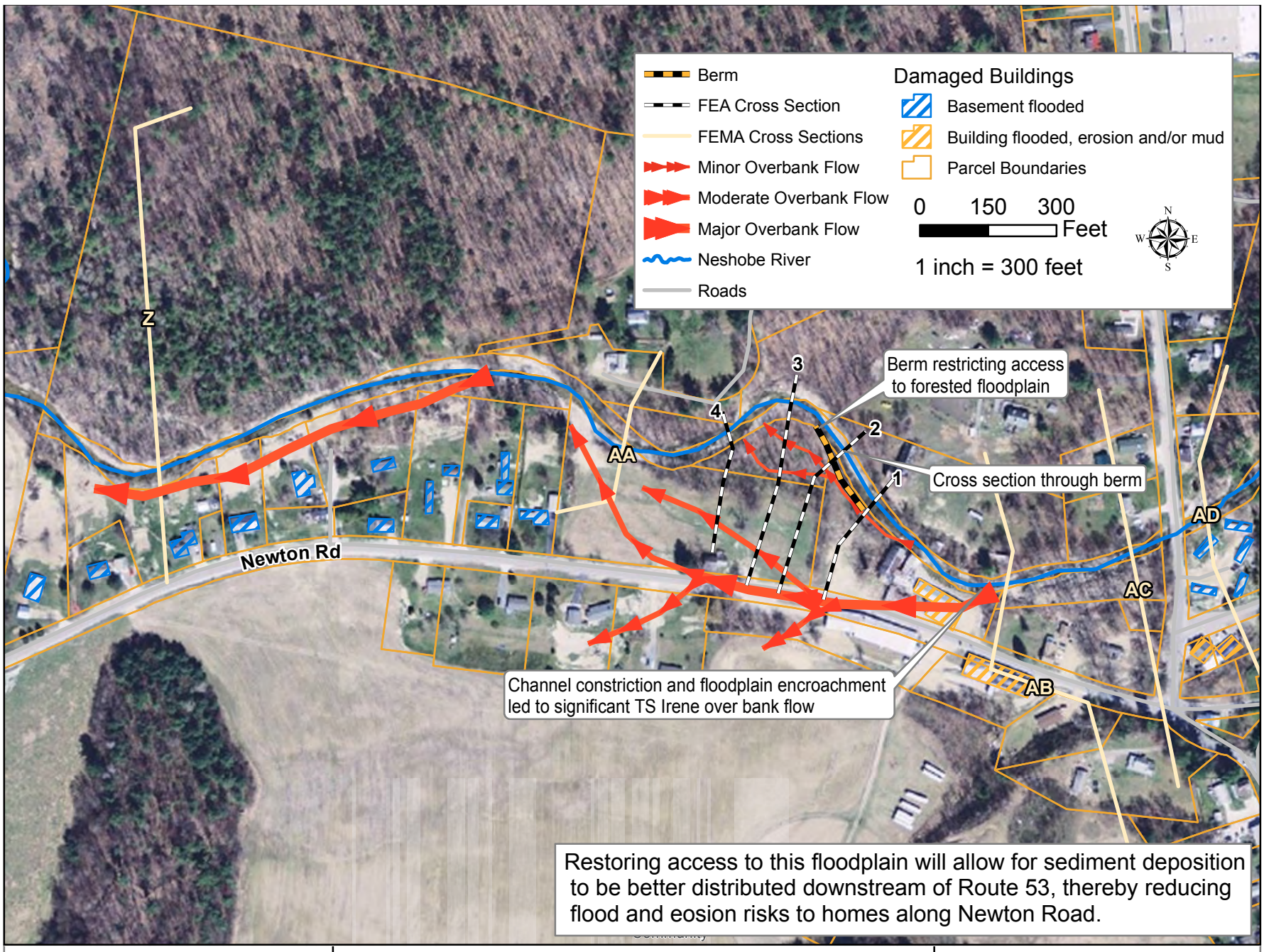
| | | | | OBJECTIVES | | | FEASIBILITY | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| **Infrastructure Improvements** | | | | | | | | | | |
| Overflow culvert in Downtown Brandon to prevent/reduce flood flows out of river channel and along Route 7 **(see site 12 on map 2)** | Downtown Brandon businesses and residences; Federal Highway | Local: >25 business and 200 employees; Significant regional impact | High | ● | ● | ● | Difficult | >$200K | 2-5 years | Town of Brandon has received a FEMA Hazard Mitigation Grant (Phase 1; $250K) to design an overflow box culvert in the Village to prevent or reduce flood damage to Route 7 and downtown businesses. Town and businesses are concerned about coordination of this project with VTrans Route 7 Segment 6 construction project. |
| Stabilize embankment along Wheeler Road approx. 800 ft south of Stone Mill Dam Road **(see site 9 on map 2)** | Town Road and Water Main | >25 business and 200 employees | High | ○ | ● | ● | Moderate | $20K-$50K | 1-2 years | A mass failure (i.e., eroded valley wall) along the west bank of the river was caused by river erosion on the lower bank. Wheeler Road and a Town water main are at risk. Recommend treating the source of the problem at the bottom of the slope (i.e., rock protection) and stabilizing the upper bank with soil, natural fabrics, and vegetation. |
| Replace VT Route 53 bridge with larger span **(see site 2 on map 1)** | State Highway; Businesses; Residences | 2 businesses with a total of 9 employees | High | ● | ● | ● | Moderate | >$200K | 2-5 years | The bridge is undersized (56% of channel width) and should be replaced with a larger span. Floodplain mapping and profiles suggest that the bridge is hydraulically undersized for the 100-year flood. River characteristics suggest a span greater than the standard VTDEC-recommended width may be needed. |
| Replace Wheeler Road Bridge with a larger span **(see site 10 on map 2)** | Town Road; Residences | Residential | High | ● | ● | ● | Moderate | >$200K | 2-5 years | The abutments are in poor condition and the span is 61% of the channel width. The Town of Brandon recently approved match for a VTrans structures grant to move forward with a design to increase span and realign roadway now that an adjacent property was bought out following Tropical Storm Irene flooding. |
| Long-term stabilization and/or relocation of Waste Water Treatment Facility (WWTF) on Union Street, South of Village **(see site 13 on map 2)** | Town WWTF | >25 business and 200 employees | High | ○ | ◒ | ● | Moderate | $50K-$100K | 1-2 years | Flooding and erosion have been a problem at the WWTF. The Town installed rock armor (i.e., rip rap) on the bank in 2010, but the area is still prone to erosion and there is a Green Mountain Power utility pole at risk. The WWTF is aging and major upgrades will be needed in the near future, at which point flood resiliency should be considered. Evaluation of objectives and feasibility reflects the intermediate step of addressing current erosion risks. |
| Retain overflow structure next to VT Route 53 bridge **(see site 3 on map 1)** | State Highway; Residences | Residential | Low | ◒ | ◒ | ◒ | Easy | <$10K | 1-2 years | A historic overflow culvert was uncovered following Tropical Storm Irene south of the bridge. This structure conveyed floodwaters during the flood and took pressure off the bridge, but was filled by the mobile home park owners following the flood. |
| **Public Safety Improvements** | | | | | | | | | | |
| Consider buyouts for at-risk properties in flood and erosion hazard area **(see site 1 on map 1)** | Forest Dale Mobile Home Park | Residential | Medium | ○ | ○ | ● | Difficult | $100-$200K | >5 years | Five mobile homes are located in the 100-year floodplain and Fluvial Erosion Hazard (FEH) zone and were flooded during Tropical Storm Irene. Buyouts would reduce future risk of losses. |

[1]**Reduces Flood Risk** - The proposed project/strategy lowers the flood level.
[2]**Reduces Erosion Risk** - The proposed project/strategy lessens the vulnerability of a location to erosion.

# Appendix G:

## Conceptual Project Designs to Protect Brandon

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# Newton Rd Berm Removal Analysis
# Brandon, Vermont

Vermont Economic Resiliency Initiative
Agency of Commerce & Community Development

Drawn: JHB & EPF
Date: Feb 18, 2015

Post-Irene background imagery from VCGI

HEC-RAS model results for the simulated 100-year flood in Forest Dale. Removal of the historic berm increases floodplain access, lowering flood elevation and velocity.

| Cross-section | Bed Elevation (ft) | Q100 Elevation (ft) | | Top Width (ft) | | Total Velocity (ft/sec) | |
|---|---|---|---|---|---|---|---|
| | | Existing | Berm Removed | Existing | Berm Removed | Existing | Berm Removed |
| FEMA AB | 544.00 | 549.78 | 549.78 | 38.27 | 38.27 | 11.27 | 11.27 |
| FEA 1 | 536.29 | 540.67 | 540.67 | 48.56 | 48.56 | 10.39 | 10.39 |
| FEA 2 | 532.91 | 536.82 | 535.41 | 50.22 | 100.21 | 11.99 | 9.96 |
| FEA 3 | 531.01 | 533.99 | 533.10 | 130.20 | 264.69 | 7.12 | 5.82 |
| FEA 4 | 526.07 | 529.99 | 529.99 | 141.54 | 141.54 | 4.79 | 4.79 |
| FEMA AA | 522.40 | 527.33 | 527.33 | 94.28 | 94.28 | 8.01 | 8.01 |

HEC-RAS model results for an estimated Tropical Storm Irene sized event. Removal of the historic berm increases floodplain access, lowering flood elevation and velocity.

| Cross-section | Bed Elevation (ft) | TSI Elevation (ft) | | Top Width (ft) | | Total Velocity (ft/sec) | |
|---|---|---|---|---|---|---|---|
| | | Existing | Berm Removed | Existing | Berm Removed | Existing | Berm Removed |
| FEMA AB | 544.00 | 551.74 | 551.74 | 44.13 | 44.13 | 12.99 | 12.99 |
| FEA 1 | 536.29 | 541.93 | 541.06 | 360.35 | 325.21 | 3.65 | 5.74 |
| FEA 2 | 532.91 | 538.85 | 535.94 | 54.16 | 324.08 | 12.15 | 10.32 |
| FEA 3 | 531.01 | 534.12 | 533.70 | 131.46 | 378.58 | 11.77 | 6.22 |
| FEA 4 | 526.07 | 531.11 | 531.11 | 259.93 | 259.93 | 5.17 | 5.17 |
| FEMA AA | 522.40 | 529.06 | 529.06 | 203.70 | 203.70 | 6.86 | 6.86 |

A budget of approximately $8,000 was estimated to cover the materials and excavator time to remove the Newton Road berm.

| Item | Cost/Unit | Quantity | Estimated Total Cost |
|---|---|---|---|
| Contractor | --- | 2 - 3 days | $5,000 |
| Erosion Control Fabric | $0.99/yd | 400 yd | $400 |
| BioStakes | $70/box | 2 | $140 |
| Conservation Seed Mix | --- | 60lb | $100 |
| Tree Planting | $60/tree | 40 | $2,400 |
| | | **Approximate Total Cost:** | **$8,040** |

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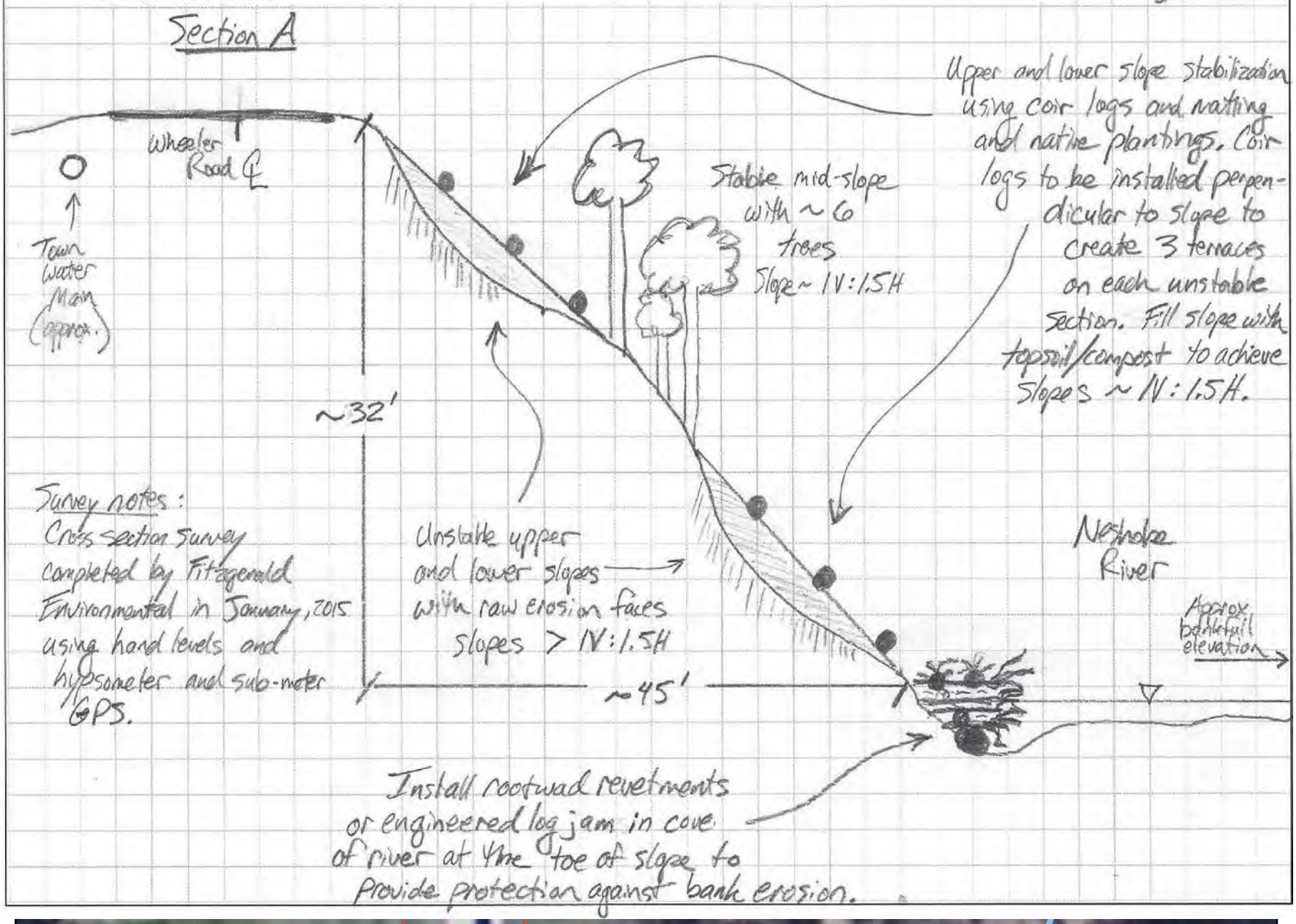
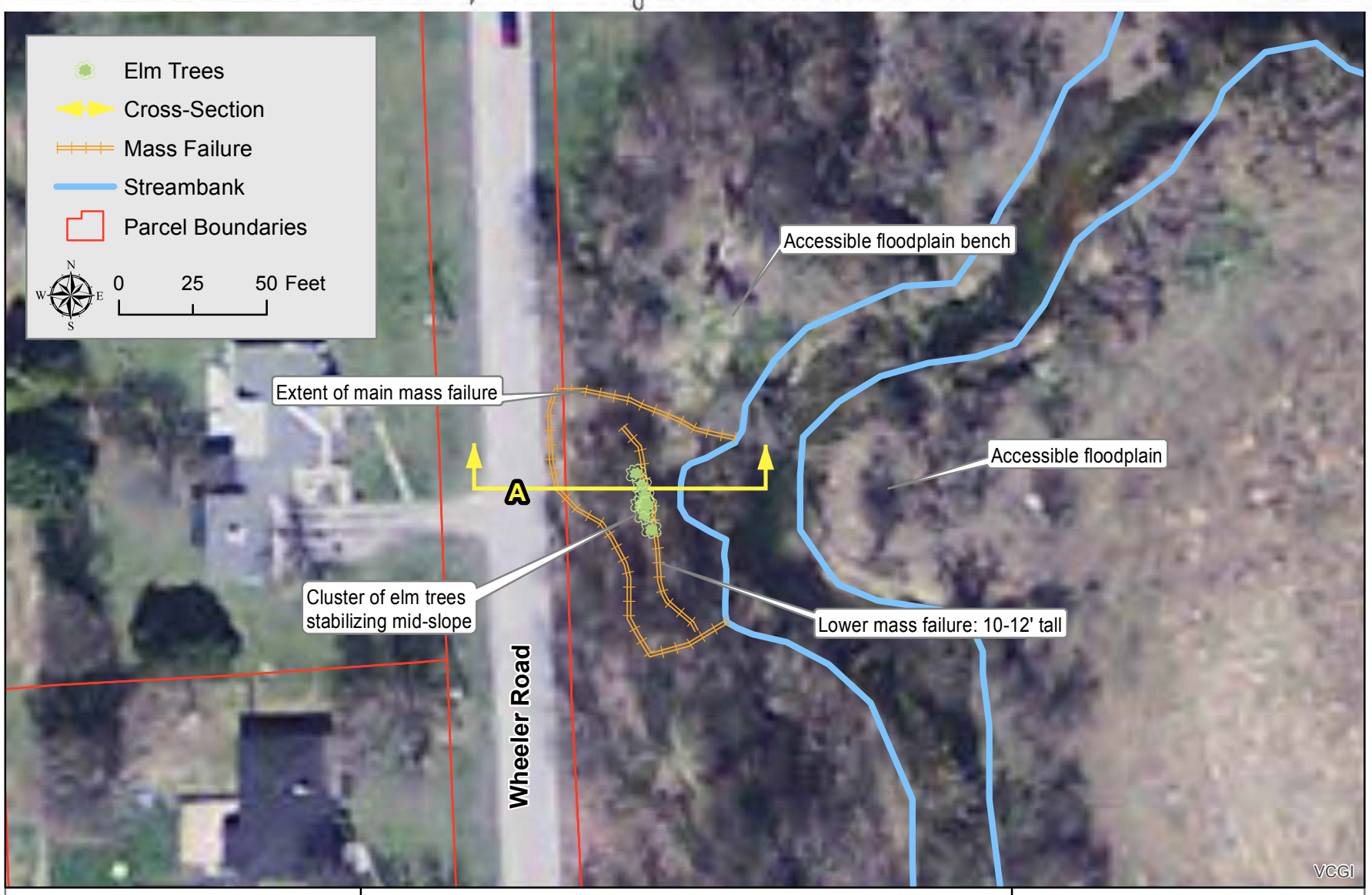
Job: VERI - Neshobe River, Wheeler Road Slope Stabilization
Sheet No. 1 of 1
Date: 2/16/2015
Drawn by: EPF
Vertical Scale: 1"=8'
Horizontal Scale: 1"=12'

Scale
2' | 3'

## Section A

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# Wheeler Road Bank Failure
# Brandon, Vermont

Vermont Economic Resiliency Initiative
Agency of Commerce & Community Development

Drawn: JHB & EPF
Date: Feb 27, 2015

Post-Irene background imagery from VCGI

A budget of approximately $23,000 was estimated to cover the materials, excavator time, and VYCC crew time to stabilize the eroding bank along Wheeler Road.

| Item | Cost/Unit | Quantity | Estimated Total Cost |
|---|---|---|---|
| Contractor | --- | 2 to 3 days | $6,000 |
| Topsoil/Compost | $35/yard | 130 yards | $4,550 |
| Erosion Control Fabric | $0.99/yd | 300 yd | $300 |
| BioStakes | $70/box | 2 | $140 |
| Conservation Seed Mix | $25/pound | 4 pounds | $100 |
| Shrub plantings | $2.00/plug | 500 | $1,000 |
| Coir logs | $7.50/ft | 500ft | $3,750 |
| Earth anchors | $50/per | 10 | $500 |
| VYCC crew | $7,000/week | 1 | $7,000 |
| | | **Approximate Total Cost:** | **$23,340** |

Pre stabilization

Post stabilization

Bioengineering approach to bank stabilization using toe armor with coir mat and dense native plantings. Photographs provided by Bear Creek Environmental for a Vermont Agency of Transportation project along VT Route 102 and the Connecticut River in Maidstone, VT.

Mass failure before restoration

Mass failure after restoration

Bioengineering approach to bank stabilization using coir logs and mat and dense native plantings. Photographs provided by Fitzgerald Environmental for a project along the Crosby Brook in Brattleboro, VT.

# Appendix H:

## Community Forum Meeting Notes

# Vermont Economic Resiliency Initiative (VERI)

# Community Forum - Village of Brandon

## MEETING NOTES

October 16, 2014 – 7:00 – 9:00 PM

### Project Overview

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.

VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy.

### For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI

### Summary

17 community members, business owners, and homeowners from the Neshobe River catchment area in Brandon attended the Vermont Economic Resiliency Community Forum. The community identified three major flood hazard risks in Brandon – inadequate water drainage along Newton Road, Furnace Road, Pearl Street, and Route 7, infrastructure needing improvements along Briggs Lane and east of the railroad near Maple Street, and placement of the town hall and the Forest Dale Mobile Home Park in the floodway. Successful mitigation projects in Brandon have included restoring riparian buffers, minimizing development in the flood plain, and adopting fluvial erosion hazard zone and NFIP standards. Further analysis and technical assistance needs of the community emphasized adapting the golf course to be an intentional flood catchment area, relocation of electrical utilities near the wastewater treatment plant, resizing the Wheeler Road box culvert and bridge, and risk management in the mobile home park.

## Present

- Residents and Business Owners: Line Barral (Café and Gourmet Provence), Bernie Carr (Brandon Area Chamber of Commerce), William Tracy Carris, Anissa DeLauri, Jim Emerson, Karen Emerson, George Matthew, Gary Meffe, Steven Zorn (Found Objects Store), Steve Paddock (VT Small Business Development Center), Jeff Stewart (Downtown Organization), Paul Gladding (Holden Insurance)
- Technical Assistance: Evan Fitzgerald (Fitzgerald Environmental Associates)
- Town of Brandon: Richard Baker, Bill Moore, Ethan Swift, Devon Fuller, Linda Stewart
- Regional Planning Commission: Barbara Pulling, Steve Schild, Laura Keir and Kitt Shaw (Rutland Regional Planning Commission)
- State of Vermont: Noelle MacKay (DHCD), Steve Carr (Vermont House of Representatives), Josh Carvajal (ANR), Peg Flory, Eldred French and Kevin Mullin (VT State Senate)

## Introduction

Bernie Carr, Brandon Area Chamber of Commerce, convened the Vermont Economic Resiliency Initiative (VERI) Community Forum in Brandon and he introduced Commissioner Mackay from the Vermont Department of Housing and Community Development. Commissioner MacKay welcomed everyone and thanked people for participating in a first round of community forums presently being held in five Vermont communities state-wide. The Commissioner explained that the community forums are examining ways to improve economic resiliency for natural disaster impacted communities in the aftermath of Tropical Storm Irene. Through the Vermont Economic Resiliency Initiative, the State will analyze risks to public infrastructure, alongside economic activity, river corridor and flood data, to better mitigate future flood hazards and to ensure businesses rebound quickly. The Commissioner provided the audience with a VERI project overview and the findings of the first two phases of the project. After her introductory remarks, the Commissioner explained that the purpose of the meeting was to collect information about risks to infrastructure and economic activity observed during Irene, subsequent risk reduction, and suggested improvements for long-term resiliency.

## Overview of the Riverine Study Area

The State has contracted with a team of river scientist and engineers to review the geomorphology, flood hazard risks, sediment deposition potential, and impacts to the built environment of select rivers and tributaries within each targeted VERI community. The scientists presented an overview of their

work and initial observations in the river corridors at each of the community forums and provided technical assistance to the respective community throughout the meeting.

Notes

- Evan Fitzgerald provided a brief overview of the Neshobe River corridor analysis to date. He noted that the river has good access to long stretches of well-connected flood plains closer to downtown, and it is a very different river in Forest Dale where the river roars out of the mountains.

### For more information on past river studies

This area has had a river study completed in the past and the consultants are incorporating this past work in to the VERI project. Those studies can be found here: https://anrnode.anr.state.vt.us/SGA/finalReports.aspx. (River Corridor Plan, 2011 and Phase 1 Stream Geomorphic Assessment (SGA) for the Neshobe River, 2004).

## Public Input

The DHCD Commissioner solicited input from forum participants with regard to flood risk and mitigation opportunities in Woodstock. The questions posed were:

1) What are the hazards and risk areas in the town?
2) What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?
3) What still needs to be addressed in the interests of long-term security and sustainability?
4) What information should the final report include and how should this information be presented?

Identified hazards and risks will be further analyzed in Phases 3 and 4 of VERI.

## Identified Natural Disaster Hazards and Business Risks

What are the hazards and risk areas in the town?

Notes

- **Stone Mill corner** flooded the golf course in 2006, 2008, 2011 resulting in $100,000 in damages collectively. During TS Irene, golf course flooding helped to protect the downtown, absorbing twelve feet of water here.
- 4 or 5 homes on **Newton Road** and homes along the North side of **Furnace Road** had their basements, not first floors, filled with water during Irene. Flooding on Newton Road is affected by old concrete mill in the river; water went right round it. There is a Hazard Mitigation Grant Program (HMGP) application under review to remove this structure.
- Downtown the river makes 90 degree turns, flowing under the **town office**. Irene damage looks the same as 1938 flood photos did. Town has applied to FEMA for an overflow structure, have yet to hear from FEMA.
- Town does have a couple of roads that can be used to get around problem areas. After TS Irene, **Route 7** was closed for only one week, affecting trucking (Omya) and local businesses.
- A trouble spot exists at the railroad intersection where houses on **Pearl Street** are slightly elevated and end up holding standing water. One concern with this is the mosquito control, it has never been sprayed in previous years. What could be done here? Dredging? Is silt a problem too causing higher river levels? Is there a way to tell how old silt is? Evan said yes, but it would be rather expensive to do. There are several severe bends in the river near here and that leads to flooding and several trees and other vegetation are dying due to the standing water.
- Comments read from Stephen Cijka (not in attendance, emailed comments), wastewater treatment plant operator: To properly guard the downtown against further flooding some type of gigantic culvert would have to be built under **Route 7** from Kennedy Park next to Watershed Tavern across to Green Park next to Vermont Sandwich Shop. The cost is very expensive but may be the only logical solution. Other concern is some type of **warning system** for flooding as the next flood may occur at night or during business hours. Last concern is having a backup generator to run the **town office** in case of an extended power outage.
- Sandbags, emergency planning, trained volunteers, planning exercises, home emergency plans, etc. are part of local emergency response

- Issues with **water or wastewater pipes** near the falls where a water main broke and had to be shut off. And a couple sanitary sewer lines broke by **Briggs Lane**, repaired it as it was before, it still needs repairs now.
- A sanitary sewer line 30 feet east of the railroad (near Maple Street?) that goes under the river is in danger of breaking. A manhole was overflowing there.
- Cornfield in rear part of Newton Road (away from Forest Dale) was damaged significantly when river flooded.
- **Mobile home parks** on Route 53 and Route 73 in Forest Dale are problem areas.
- Culvert under the road may become obstructed which may compromise the integrity of the **railroad embankment.**

### Effective Hazard Mitigation and Risk Reduction

What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?

Notes

- Need to **stabilize the river bank** to prevent more corn field damage (upstream from the golf course). **Tree plantings** have recently been done in that area for that purpose and that there is a **conservation easement** and some current use program work done as well.
- The town has adopted a fluvial erosion hazard (FEH) zone and is enrolled in the National Flood Insurance Program (NFIP). Ethan Swift from the Town will sit down with Rutland Regional Planning Commission (RRPC) and map damaged areas.
- Land **behind Park Street**/Brandon Inn acted as a floodplain during TS Irene. A question arose about development of the floodplain, it is usually discouraged to develop in the floodplain. Josh Carvajal of Agency of Natural Resources shared that the town allows development in the floodplain, but it could go beyond the state's minimum standards.

### Resiliency and Sustainability Planning

What still needs to be addressed in the interests of long-term security and sustainability?

Notes

- Something should be done so the golf course doesn't have to be rebuilt after each flood event. Maybe use the **driving range as a catch basin** by berming both ends?
- What are we really trying to protect? The town core?

- Information has to be available very quickly in an emergency situation.
- How did Dot's Restaurant in Wilmington came back so fast after TS Irene? Thought maybe there was some public monies used. The answer from Commissioner Mackay was that they had insurance and help with engineering from the Preservation Trust and a state historic tax credit program.
- **Could Green Mountain Power help move a power source/pole at the wastewater treatment plant that is very close to the river bank?** Moving it would be good, and the bank has been armored there. By the wastewater plant there is lots of erosion, need to continue to stabilize the bank.
- On North Street, TS Irene uncovered an unknown box culvert next to the bridge giving the idea that more capacity is needed here to handle water coming out of the mountains. The trailer park owners there filled it back in, the **mobile home park is in a bad spot**. They are now rebuilding a trailer there about one foot higher than before. Is there suitable land where the mobile home park could be relocated?
- Wheeler Road bridge, funds are needed to do a study for a **bigger bridge**.
    - Wheeler Road floods on a regular basis. Would have to raise the road, don't remember Wheeler Road flooding in the past the way it does now.
    - May be due to more development and impervious surfaces.
    - Historically the river was dredged along Wheeler Road, have found a couple of agricultural drainage ditches no longer in use.

**Information Sharing and Dissemination**

What information should the final report include and how should this information be presented?

Notes

- **Proactive projects that the town has already completed** need to be organized and shown in the report when the town is applying for competitive grants. This will also help showcase the work done by the community.
- The Planning Commission could look into **restricting development in the floodplain** using ANR model regulation language as a guide.
- Why is it that businesses can reopen but not the town office? The response from commissioner MacKay was that the town had a lot of responsibility after TS Irene that businesses didn't have to address.
- There are **mitigation techniques for historical buildings** including floodproofing.

    - New office should be designed with flood mitigation in mind, want to apply for Community Development Block Grant.
    - An emergency plan helps the town more than the businesses.
    - The town continues to update its Local Emergency Operations Plan as required.
- **Lessons learned/advice regarding emergency operations** (not just for flooding but other types of disasters too).

# Vermont Economic Resiliency Initiative (VERI)

# Community Forum - Village of Brandon

## MEETING NOTES

April 6, 2015 – 7:00 – 9:00 PM

### VERI Project Overview

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.
VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy.

### For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI/Brandon

### Summary

15 community members, business owners, and town officials from the Neshobe River watershed attended the second VERI community forum in Brandon. The forum showcased 13 high priority projects which could significantly decrease flood risk for Brandon, if implemented. Community members were given the opportunity to ask questions, provide input, and rank the proposed projects. The projects which the community most supported included: the installation of an overflow culvert on Route 7, the removal of a berm in Forest Dale, and floodproofing downtown businesses. Integrating these projects into the town bylaws, policies, and plans will help Brandon to be safer and more resilient to future floods.

### Welcome and Overview

[Noelle MacKay, Commissioner of the Department of Housing and Community Development]

Noelle MacKay provided background information on the VERI project and talked about a successful project in Bennington that led to this project. She also explained the process for selecting the five towns included – each town demonstrated an intersection between flood risk, economic activity and at-risk infrastructure. Brandon was selected as a VERI pilot community because it has an active

downtown, a major commercial core, it already has done a lot as a community flood resiliency planning, and it has existing river corridor maps. Noelle went over the agenda for the evening and emphasized the importance of community input on the proposed flood reduction projects. The Agency of Commerce and Community Development will work with partners to help identify funding sources once priority projects are chosen. It was noted that Brandon is also currently working on town plan and zoning code updates, so we hope the town will consider some of the municipal plan and policy recommendations in the update.

## Overview of Municipal Policies and Programs to Reduce Future Floods

[Ed Bove, Executive Director of the Rutland Regional Planning Commission]

Ed Bove spoke about the town's current efforts to help businesses recover more quickly from disaster. Brandon is one of three towns in the Rutland Region that qualifies for the highest reimbursement available by the State Emergency Relief and Assistance Fund (ERAF) at 17.5%.

Ed described the physical location of the study area. He spoke about the Brandon town plan and the ways it addresses flood hazard areas, including the newly required flood resilience element. Ed suggested that lands such as floodplains, upland forests, and steep slopes should be identified for conservation in the town plan.

Recommendations for the town's land use bylaws included: prohibiting fill in the floodplain, requiring improvements to structures to undergo conditional use review, and not including high slopes, wetlands, etc. in density calculations for new development. Ed also discussed improvements to the town's hazard mitigation plan, including the importance of noting past disaster damages to facilitate reimbursement in the event of another disaster.

## Overview of Project Recommendations and Conceptual Designs

[Evan Fitzgerald, Principal Watershed Scientist at Fitzgerald Environmental Associates, LLC]

Evan Fitzgerald gave a brief overview the Neshobe River assessment to date, and he spoke about how he relied on local knowledge, feedback from state agencies, and past river studies to enhance his findings.

Evan explained each of the 13 site specific-project recommendations for Brandon. The site-specific projects were divided into four categories: Building and Site Improvements, Channel and Floodplain Management, Infrastructure Improvements, and Public Safety Improvements. Two projects, the

Forest Dale berm removal and Wheeler Road embankment failure were looked in depth and conceptual plans were developed for each.

**Channel and Floodplain Improvements:** These are projects that lower the risk of flooding and erosion to properties along the river through the improvement of natural river and floodplain functions. High priority recommendations in this category include:

- The removal of an old berm along the river in Forest Dale. Removal would allow greater access to the floodplain, decreasing the speed of water and debris entering the downtown.

  Notes and Responses from the Public: The river is very different in Forest Dale than in downtown Brandon. In Forest Dale, the river is much more confined and has a steep gradient as it comes out of the mountains. Protecting undeveloped floodplain between Forest Dale and the downtown is crucial to help alleviate downstream flooding issues.

**Infrastructure Improvements:** These are projects that lower the risk of flooding and erosion to utilities, roadways and other municipal or state-owned infrastructure. High priority recommendations in this category include:

- Installation of an overflow box culvert in downtown Brandon was the highest priority recommendation.

  Notes and Responses from the Public: When the river reaches a certain level, it begins to divert into the overflow pipe lessening what would flow under the town and through the double bridge on Route 7. The town has been pursuing funding for design and engineering of the overflow culvert and would like to coordinate it with the work on Route 7, segment 6.

- Upsizing the North Street Bridge and the Wheeler Road Bridge. Both of these structures are outdated and undersized compared to the average width of the river channel. The small mobile home park near the North Street Bridge should also be considered for relocation.

  Notes and Responses from the Public: People were concerned that the debris could build-up near these bridges and destroy the downtown. They have more of a localized effect, however, and would not create a buildup of water that could potentially be released at once and head towards the downtown.

- Bank stabilization for failure encroaching upon Wheeler Road - erosion is right up to the road and the road embankment is 35 feet tall. The conceptual design for the bank includes terracing with coir logs and leaving in place existing vegetation and woody debris.

  Notes and Responses from the Public: Bank failure would shift the erosion downstream and perhaps cause more issues. If it does, the river downstream bends away from the road and potential impacts on infrastructure would be much less, if at all.

- Relocation of the Waste Water Treatment Facility (WWTF)

  Notes and Responses from the Public: The WWTF is located in the floodway. It has extensive rock armoring already in place to protect the roadway, but it is on a sharp bend in the river, has a crucial utility pole in the floodway, and the bridge in front of the facility is undersized. It has sustained repetitive damage throughout the years (built in 1960) and a plan for long term stabilization or relocation needs to be set in place. The State Revolving Loan Fund might be able to be used to fund this work.

**Building and Site Improvements:** These are projects which lower the risk of flooding and/or erosion to specific properties through improvements to the building and/or surroundings. High priority recommendations in this category include:

- Floodproof downtown buildings and businesses

  Notes and Responses from the Public: The approximate cost to floodproof is $10,000 per business. More resources for floodproofing will be made available on the VERI project web page and at the upcoming Downtown Conference in Burlington on June 6, 2015.

**Public Safety Improvements:** These projects lower the risk of flooding and erosion to properties through the avoidance of future flood risks (e.g., FEMA buyouts of properties highly vulnerable to flooding). High priority recommendations in this category include:

- There were no high priority projects in the public safety improvement category for Brandon

## Project Prioritization

Sticky dots were handed out for people to place on the charts to prioritize project recommendations in Brandon. The town's ranking of the high priority projects can act as a road map for the town to follow moving ahead. The results of the project prioritization are below, in order of popularity - with number of sticky dots received in parenthesis.

1. Overflow culvert in downtown Brandon to prevent/reduce flood flows out of river channel and along Route 7. (16)
2. Remove berms downstream of VT Route 53 to store floodwaters and sediments in floodplain. (11)
3. Flood proof businesses in downtown. (10)
4. Stabilize embankment along Wheeler Road 800 feet south of Stone Mill Dam Road. (6)
5. Replace VT Route 53 Bridge with a larger span. (6)
6. Long term stabilization and/or relocation of the Waste Water Treatment Facility (WWTF) on Union Street, south of the village. (6)
7. Neshobe Golf Club Floodplain/Corridor Improvements. (5)
8. Consider buy outs for at-risk properties in flood and erosion hazard area. (5)
9. Replant floodplain and river corridor between Wheeler Road and VT Route 73; Consider conservation easements for long-term, permanent protection. (4)
10. Replace Wheeler Road Bridge with a larger span. (4)
11. Flood proof homes along Newton Road. (2)
12. Retain overflow structure next to VT Route 53 Bridge. (2)
13. Replant floodplain and river corridor west of Town Farm Road, Consider conservation easements for long term, permanent protection. (1)

## Next Steps and Where to Get Help

The town of Brandon has already taken steps to make the town safer, and continuing with this effort is in everyone's best interest. The Brandon community can become more flood resilient by understanding the risks and developing by bylaws, policies, plans, and projects which address those risks. Community members can help the town to:

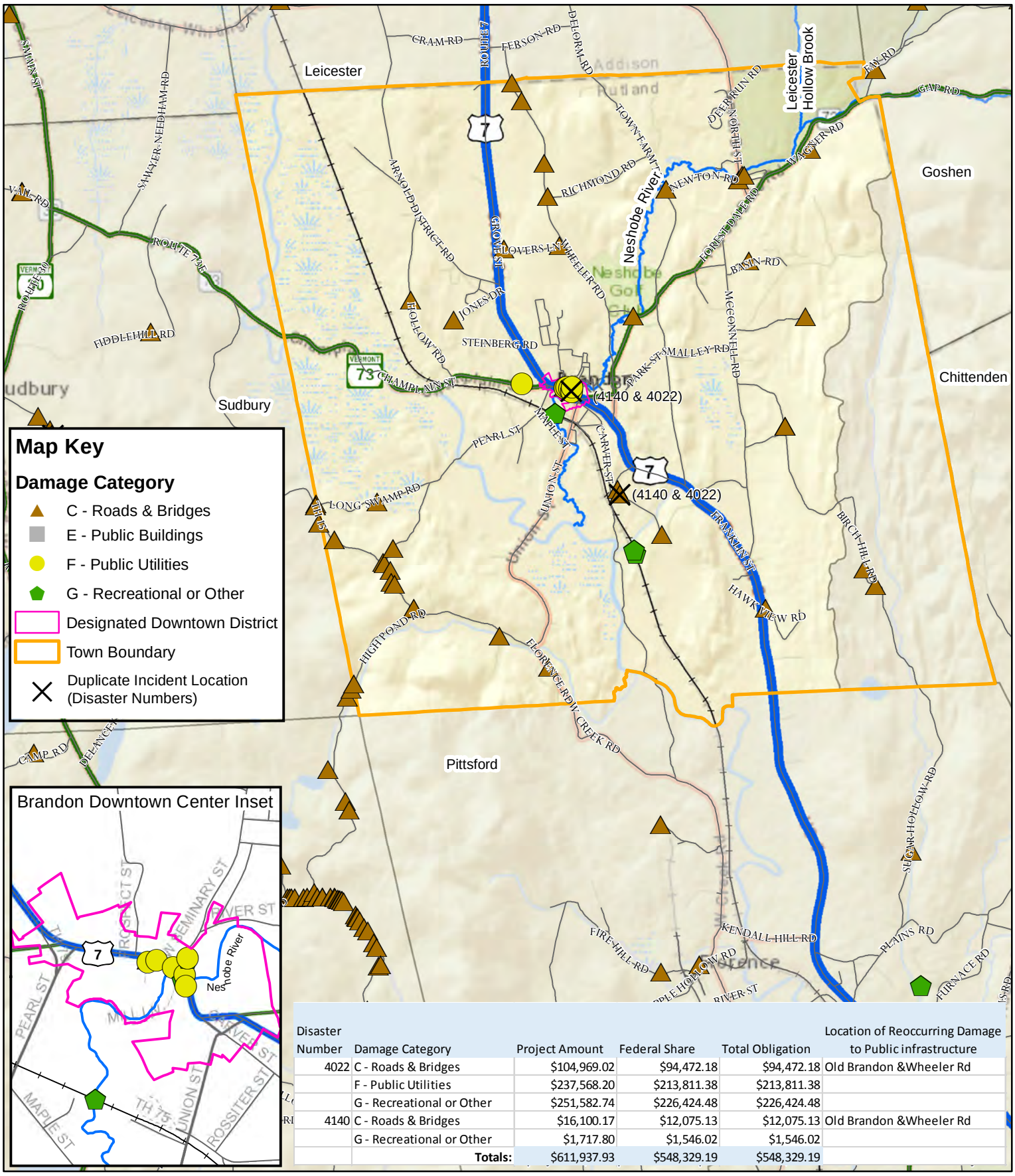
- Prioritize projects to better secure funding.
- Try to do a couple of projects per year, not all at once, to better identify resources and to build momentum.
- Know who owns your town's work plan- Select Board, Planning Commission, Fire Department or others.

Any comments or suggestions on the draft report can still be sent to Wendy Rice via the VERI website. The final report will be ready for distribution in late May.

# Appendix I:

## Maps of Repetitive Damage to Brandon

# Neshobe River, Brandon, VT




| Disaster Number | Damage Category | Project Amount | Federal Share | Total Obligation | Location of Reoccurring Damage to Public infrastructure |
|---|---|---|---|---|---|
| 4022 | C - Roads & Bridges | $104,969.02 | $94,472.18 | $94,472.18 | Old Brandon &Wheeler Rd |
| | F - Public Utilities | $237,568.20 | $213,811.38 | $213,811.38 | |
| | G - Recreational or Other | $251,582.74 | $226,424.48 | $226,424.48 | |
| 4140 | C - Roads & Bridges | $16,100.17 | $12,075.13 | $12,075.13 | Old Brandon &Wheeler Rd |
| | G - Recreational or Other | $1,717.80 | $1,546.02 | $1,546.02 | |
| | **Totals:** | $611,937.93 | $548,329.19 | $548,329.19 | |



Author: Map provided by the Department of Housing & Community Development (DHCD). FEMA Data.Gov Map & Project Work Sheets. Map created 1/22/2015.

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT

# Vermont Economic Resiliency Initiative [VERI]

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VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

# Vermont Economic Resiliency Initiative [VERI]

## Brattleboro, VT

Community Report
July 2015

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

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Noelle MacKay, Commissioner of Housing and Community Development

# Table of Contents


Vermont Economic Resiliency Initiative (VERI) Brattleboro Executive Summary ..... i
List of Acronyms ..... 1
Glossary of Terms ..... 2
Project Overview ..... 4
  Why was Brattleboro Selected? ..... 5
  Study Area ..... 5
  Research and Outreach ..... 6
Flood History and Town Accomplishments ..... 9
  Flood History and Risk ..... 9
  Town Accomplishments ..... 11
    Town Wide Flood Policy ..... 11
    Vermont - Downtown Action Team (V-DAT) ..... 12
    Site Specific Accomplishments ..... 13
Strategies and Projects to Protect Brattleboro ..... 14
  Municipal Policy and Program Recommendations ..... 14
  Specific Project Recommendations ..... 16
    Channel and Floodplain Improvements ..... 17
    Infrastructure Improvements ..... 18
    Public Safety Improvements ..... 20
Conceptual Project Designs to Protect Brattleboro ..... 21
  Remove At-risk Sewer and Water Lines within the Whetstone Brook Channel ..... 21
    Overview and Objectives ..... 21
    Data Analysis and Results ..... 21
    Conceptual Design ..... 22
    Steps for Project Implementation ..... 22
    Project Benefits ..... 23
  Conserve Eight Acres of Floodplain Upstream of Downtown ..... 23
    Overview and Objectives ..... 23
    Data Analysis and Results ..... 23
    Conceptual Design ..... 23
    Steps for Project Implementation ..... 24
    Project Benefits ..... 25
Next Steps ..... 26
  Education and Outreach ..... 27
  What Can Individuals Do to Reduce Their Risks? ..... 29
    Steps to Reduce Risks ..... 29
  What Can Businesses Do to Reduce Their Risks? ..... 31
    Steps to Reduce Risks ..... 31
References ..... 34

## Figures and Tables

Figure 1: Study area ..... 5
Figure 2: Attendees at the first community forum ..... 7
Figure 3: Field assessment of existing conditions ..... 8
Figure 4: Example of floodplain formation in West Brattleboro ..... 8
Figure 5: Damage to downtown, 1869 Freshet (Brattleboro Historical Society) ..... 9
Table 1: Estimated Number of Businesses, Employees & Multi-family Residences At-risk ..... 10
Figure 6: Homemade flood gauge at Glen Park assists residents in estimating flood risk and knowing when to evacuate ..... 10
Figure 7: Town Plan Cover, 2013 ..... 11
Table 2: How Brattleboro Met its ERAF Match ..... 12
Table 3: Categories of Municipal Policies and Programs ..... 15
Table 4: Mitigation Project Types ..... 17
Figure 8: View of Eastern Williams Street Bridge from upstream. Left abutment eroded during Irene, sediment buildup shown right. ..... 19
Figure 9: Misaligned VT Route 9 Bridge (2008) before Tropical Storm Irene ..... 19
Figure 10: Mobile Home in floodway lost during Irene ..... 20
Figure 11: Sewer line crossing Whetstone Brook, before it washed out in Tropical Storm Irene ..... 21
Figure 12: Eight acres of floodplain upstream of downtown ..... 24

## Appendices

Appendix A: Town of Brattleboro and Whetstone Brook Data Sources
Appendix B: Tropical Storm Irene Damages and Developed Floodplain Map
Appendix C: V-DAT One-Page Visual Summary of the Top Recommendations for Brattleboro
Appendix D: Tables of Projects to Protect Brattleboro
Appendix E: Maps of Projects to Protect Brattleboro
Appendix F: EPA Flood Resilience Checklist
Appendix G: Table of Municipal Policy and Program Recommendations
Appendix H: Economic Zones Map
Appendix I: Bridge Summary Table
Appendix J: Eastern Williams Street Bridge Conceptual Design
Appendix K: Housing Study
Appendix L: Map of Sewer and Water Lines in the Floodway
Appendix M: FIRM Cross Sections and Change in Flood Level for Floodplain Restoration
Appendix N: Community Forum Meeting Notes

# Vermont Economic Resiliency Initiative (VERI) Brattleboro Executive Summary

In communities around Vermont, rapidly melting snow and torrential downpours can bring nightmares of washed out bridges, closed roads, flooded basements and shuttered businesses. To calm these fears, Vermonters have been working to better understand the flood risks they face and identify and implement projects to reduce, avoid or minimize these risks and flood damages. The goal: to protect lives, help businesses remain open and reduce costs to taxpayers for repetitive repair to infrastructure.

After Tropical Storm Irene, Governor Peter Shumlin challenged us to "build back stronger than Irene found us." The Vermont Economic Resiliency Initiative (VERI) is designed to help meet that challenge. It is modeled after a successful project in Bennington, Vermont that minimized business interruption and saved taxpayers money by substantially reducing flood recovery costs (DHCD, 2015). With funding from the US Department of Commerce, Economic Development Administration (EDA), the Agency of Commerce and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched VERI to help ensure Vermont recovers quickly and remains open for business after disaster strikes.

In the first phase of the project, the VERI team evaluated and ranked areas where economic activity and associated infrastructure are at high risk of flooding. Based on this state-wide assessment, input from the team's economic steering committee and interest from local municipalities, five areas in seven communities (Barre City and Town, Brandon, Brattleboro, Enosburgh Town and Village, and Woodstock) were selected for a more detailed analysis of the local flood risks to the community and businesses.

Brattleboro was selected for the VERI project because of its role as a regional economic center – it has the fourth highest level of economic activity in the State (tied with Rutland). It is also located on Routes 5 and 9, critical north-south and east-west travel corridors that are particularly vulnerable to floods. Finally, Brattleboro has completed a number of flood protection projects identified in the 2008 Whetstone Brook River Corridor Plan and is working to floodproof downtown buildings.

The VERI team hosted community meetings and has worked directly with local leaders, municipal staff, local businesses and interested citizens to determine the locations of greatest flood risk and associated cost, identify potential projects and highlight the work communities have accomplished to date to reduce the impact of floods. Based on this community insight, along with data collection and analysis, the team evaluated local flood risk to business and infrastructure and identified strategies and projects Brattleboro can implement to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining the local economy.

This report summarizes the team's work and identifies town-wide policy and program recommendations as well as site specific projects -- including five that river scientists and engineers ranked as high priority:

## Top Municipal Policy and Program Recommendations

Top recommendations include the following:

- **Achieve a Higher Community Rating System (CRS) Rating:** The Town of Brattleboro should take steps to achieve a higher rating within FEMA's CRS based on land preservation efforts, outreach efforts, elevation certificates, higher standards in the floodplain ordinance, and stormwater regulations. A higher rating will result in reduced flood insurance rates for residents and businesses.
- **Identify Areas for Conservation:** The Whetstone Brook and the Crosby Brook River Corridor Plans both identify potential riparian easement sites. Various agencies and organizations working in the community, including the Windham County Natural Resources Conservation District, Brattleboro Conservation Commission, and Vermont Land Trust, can identify and work with willing landowners to establish those riparian easements to prevent future development in flood prone locations**.**
- **Regulate Development in Fluvial Erosion Hazard Areas:** Much of the flood damage in Vermont is caused by bank erosion from swollen rivers within river corridors. Stream banks can fail causing structures to be undermined or fall into the river. Regulating development in the areas mapped as Fluvial Erosion Hazard Areas by the Agency of Natural Resources (ANR) as part of a Stream Geomorphic Assessment would reduce flood risk and increase public safety. Additionally, the regulations should be written for the town to achieve a higher state Emergency Relief Assistance Fund (ERAF) rating.
- **Regulate Grading and the Clearing of Trees and Plants on Slopes Greater than 15%:** These areas are particularly susceptible to erosion and allowing these practices puts the entire community at risk.

## High Priority Specific Project Recommendations

**Channel and Floodplain Management:** These are projects that lower the risk of flooding and/or erosion to properties along the brook through the improvement of natural river and floodplain functions.

- **Conserve Remaining Undeveloped Floodplain to Protect the Downtown Area and Businesses (Site 16):** The community should conserve eight acres of remaining undeveloped floodplain upstream of the downtown near Williams Street. The community could also further increase flood water, sediment and debris storage in this area by creating a flood chute or by lowering (cutting) the elevation of this upstream area.

In downtown, Tropical Storm Irene destroyed or damaged roads and sidewalks, caused minor damages to eight buildings and major damages to three buildings, including four businesses that employ approximately 52 people. Increasing the capacity of this undeveloped floodplain to store water could reduce local flood elevations by four to five feet in the downtown. Further study of the benefits may reveal flood reduction downtown that may reduce the cost of flood insurance. It will also help protect Williams Street, an important access for these local businesses and an alternate route to downtown.

**Infrastructure Improvements:** These types of projects lower the risk of flooding and/or erosion to utilities, roadways and other municipal or state-owned infrastructure.

- **Manage Sediment at Eastern Williams Street Bridge (B35, at West Street):** To reduce threats or damage to the bridge, remove the plug of sediment from the right (facing downstream) bridge opening to increase channel capacity, reduce erosion and the likelihood of debris jams during high water flows. Williams Street provides important redundancy to the downtown transportation network in addition to access for the businesses and employees mentioned above.
- **Address Alignment Issues at VT Route 9 Bridge (B51, near Cumberland Farms) in West Brattleboro**: The Whetstone Brook flows through this bridge at an angle which causes erosion on the right abutment (facing downstream). This alignment issue required the repair of the streambank after Tropical Storm Irene. Armoring this bank with riprap and improving the road/river alignment would help keep VT Route 9 open for employers, employees, residents and emergency responders. In addition to keeping West Brattleboro and the State Police barracks connected to Brattleboro, VT Route 9 is the primary, and therefore critical, east/west economic connector for people and commerce in southern Vermont.
- **Remove At-risk Sewer and Water Lines within the Whetstone Brook Channel**: Public health and threats to business operations require responsible location of the sewer and water lines.

**Public Safety Improvements:** These projects lower the risk of flooding and/or erosion to properties by avoiding future flood risks.

- **Pursue Buyouts or Relocation Strategies for At-risk Properties (Sites 4, 10 & 6):** Three areas of Tri-Park Mobile Home Park – two in Mountain Home and one in Glen Park, were identified in the Whetstone Brook River Corridor Plan as vulnerable to severe flood damages due to their location. In Mountain Home alone, there are currently 93 homes in the 100-year floodplain, 20 of which are in the floodway. Many homes were washed away or damaged by Tropical Storm Irene and they remain in harm's way. While moving people out of harm's way is an expensive and time consuming process, is an important goal to pursue and implement as funding and other opportunities allow.

Three of these high priority projects -- managing sediment at the Eastern Williams Street Bridge, conserving eight acres of floodplain near downtown and removing the sewer and water lines from the floodway -- are further detailed as conceptual designs in this report to help the community take the next steps and to create model project designs to help other communities learn from this project.

## Next Steps

As part of the ongoing community discussion regarding the VERI effort, the team recommends the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization;
- Prioritize one to two projects to pursue each year with assistance from the Vermont Department of Environmental Conservation and Windham Regional Commission staff to identify appropriate funding sources and partners;
- Apply for one to two grants each year to advance project development and/or designs;
- Implement projects as funding allows; and
- Monitor project success.

Irene taught us many lessons – a key one was that no one individual, business, organization, town or state agency can address and tackle large and complicated projects alone. Reducing the risk of future floods in Brattleboro will require partnerships, funding and time to implement. The Agency of Commerce and Community Development, its sister agencies and the Windham Regional Commission are committed to helping Brattleboro take the steps outlined in this report to save lives and protect jobs and the economy from future storms and floods.

Flooding due to severe storms will happen again, the question is how can we best reduce the recovery costs to communities and ensure businesses remain open.

# List of Acronyms

**ACCD** – Vermont Agency of Commerce and Community Development

**ANR** – Vermont Agency of Natural Resources

**CDBG-DR** – Community Development Block Grant – Disaster Recovery

**CRS** – FEMA Community Rating System

**DHCD** – Vermont Department of Housing and Community Development

**DEC** – Vermont Department of Environmental Conservation

**EDA** – US Economic Development Administration

**EPA** – US Environmental Protection Agency

**ERAF** – Emergency Relief Assistance Fund

**FEH** – Fluvial Erosion Hazard

**FEMA** – Federal Emergency Management Agency

**GPS** – Global Positioning System

**HMGP** – Hazard Mitigation Grant Program

**HMP** – Hazard Mitigation Plan

**LNRP** – Landslide Natural Resource Planning, Inc.

**NFIP** – National Flood Insurance Program

**SFHA** – Special Flood Hazard Area

**USGS** – United States Geological Survey

**VERI** – Vermont Economic Resiliency Initiative

**V-DAT** – Vermont Downtown Action Team

**VTrans** – Vermont Agency of Transportation

**WCNRCD** – Windham County Natural Resources Conservation District

**WRC** – Windham Regional (Planning) Commission

# Glossary of Terms

Terms are bolded the first time they appear in the text.

**100-Year Floodplain** – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Flood Zone or 100-Year Flood Hazard Area.

**500-Year Floodplain** – The area that will be inundated by the flood event having a 0.2% chance of being equaled or exceeded in any given year. Also called 500-Year Flood Zone or 500-Year Flood Hazard Area.

**Base Flood Elevation** – The computed elevation to which floodwater is anticipated to rise during a 100-year flood.

**Berm** – An artificial ridge or embankment, e.g., a raised bank bordering a river that prevent flow out of the main channel.

**Community Rating System (CRS)** – Program that provides a flood insurance premium rate reduction based on a community's floodplain management activities. CRS recognizes community floodplain management activities that exceed the minimum NFIP standards. Besides the benefit of reduced insurance rates, CRS floodplain management activities enhance public safety, reduce damages to property and infrastructure, avoid economic disruption and losses, and protect the environment.

**Culvert** – A pipe or tunnel underground, usually under roads, that transports flowing water from one side to the other

**Emergency Relief Assistance Fund** – This program allows towns in Vermont to increase the amount of state aid money they could receive as a match to federal aid for post-disaster recovery projects that enhance public safety, reduce damages to property and infrastructure, avoid economic disruption and losses, and protect the environment. **Erosion** – The wearing away of rock or soil by flowing water.

**Floodplain** – Area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge.

**Floodway** – The area immediately adjacent to the river channel that must remain open to allow floodwaters to pass.

**Flood Chute** – A short cut taken by a river or similar waterway during high water, rather than following the normal meandering route

**Flood Resiliency** – The ability of individuals, communities, organizations and states to adapt to and recover from flooding hazards without compromising long-term prospects for development.

**Fluvial Erosion Hazard Area –** Area delineated with field data by the Vermont Rivers Program adjacent to rivers and streams to provide room to restore and maintain the natural stability of a river and avoid property damage. These areas are often at higher risk of erosion.

**Hazard Mitigation Plan** – A document and planning process that provides actions to reduce the long-term risk to human life, property, and the economy from natural disasters.

**Mitigation** – Any sustained action taken to reduce or eliminate the long-term risk to life and property from hazard events. It is an on-going process that occurs before, during, and after disasters and serves to break the cycle of repetitive damage and repair.

**National Flood Insurance Program** – A federally funded and locally implemented program to reduce the impacts of flooding through individual insurance policies and incentives for floodplain regulations.

**Riparian Buffer** – Mixed composition, vegetated land adjacent to a stream separating it from other land uses.

**Special Flood Hazard Area** – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Floodplain, 100-year Flood Zone or 100-Year Flood Hazard Area.

**State River Corridor** – Area delineated by the Vermont Rivers Program adjacent to rivers and streams to provide room to restore and maintain the natural stability of a river and avoid property damage. These areas are often at higher risk of erosion.

# Project Overview

In May 2013 the Vermont Agency of Commerce and Community Development (ACCD) received disaster recovery funding from the US Economic Development Administration (EDA) for the Vermont Economic Resiliency Initiative (VERI). The overarching goal of the project is to ensure that businesses and communities bounce back quickly when disaster strikes, saving time and money in recovery costs.

The objectives of VERI are to:

1. Analyze threats to areas of economic activity and their associated infrastructure;
2. Develop plans to reduce impacts and avoid future losses and costs; and
3. Identify projects that communities and businesses can implement that avoid, minimize or reduce their flood risk and thus ensure businesses stay open and communities minimize costs.

**The primary objective of the focus area assessments is to develop strategies and projects to make businesses and the communities more resilient to floods and other disasters.**

VERI is led by ACCD's Department of Housing and Community Development (DHCD) in partnership with the Agency of Natural Resources (ANR), Agency of Transportation (VTrans), and Vermont's Regional Planning Commissions, which in Brattleboro is the Windham Regional Commission (WRC). Early in the process, these agencies mapped places where flood hazard risks intersect with areas of economic activity and infrastructure. Five priority communities were selected for a detailed assessment of those risks: Barre City and Town, Brandon, Brattleboro, Enosburgh Village and Town, and Woodstock. A river scientist and engineering team consisting of five consulting companies - Bear Creek Environmental, LLC, DuBois & King, Inc., Fitzgerald Environmental Associates, LLC, Landslide Natural Resource Planning, Inc., and Milone & MacBroom, Inc. - were hired to analyze the rivers and assist in developing recommendations to reduce the vulnerability of infrastructure and businesses to flood damage.

A number of factors played a role in the selection of the five communities for more detailed assessments. First, the project team ranked towns across the state by flood risk, economic activity and infrastructure at risk. Then the team looked at the 20 highest ranking communities and removed any that had undergone or had funding for similar analysis (i.e., Bennington and Waterbury). Next the team strived to select five pilot communities that represented different economic profiles (i.e., agriculture, tourism, downtowns) as well as different sizes. Other considerations included risk of future damage, economic factors, and level of community engagement and interest. Together, these factors helped determine the five pilot communities selected.

## Why was Brattleboro Selected?

Brattleboro was selected as one of the pilot communities for the following reasons:

- It is a regional economic center with total employment in 2013 of 10,698 at 731 businesses;
- The community has the fourth highest level of economic activity in the State (tied with Rutland) and it is a state designated downtown;
- Brattleboro has critical transportation infrastructure at risk from floods. Failure of the transportation network would impact employees and customers trying to get to businesses and slow the flow of goods and services;
- Whetstone Brook flooding threatens numerous commercial buildings and infrastructure; and
- Brattleboro has successfully identified and reduced flood and erosion risks in the past.

## Study Area

Located along the Connecticut River in the southeastern part of the state, Brattleboro is Vermont's seventh largest town with a population of 12,046 (US Census Bureau, 2010) in 32 square miles (20,490 acres). It is bisected east-west by the Whetstone Brook and bounded by Dummerston to the north, the Connecticut River and New Hampshire to the east, Guilford and Vernon to the south and Marlboro to the west. The western quarter of town is bounded by the steep forested slopes of the Green Mountains where the Whetstone Brook originates in Marlboro. The valley is naturally narrow and the brook is further constrained by the location of VT Route 9 adjacent to the Brook. As the river flows east, the slope eases and the valley widens in West Brattleboro. This study is focused on the lower 5.7 miles of the Whetstone Brook that includes downtown Brattleboro, West Brattleboro Village and West Brattleboro, all located along the Whetstone Brook (Figure 1).

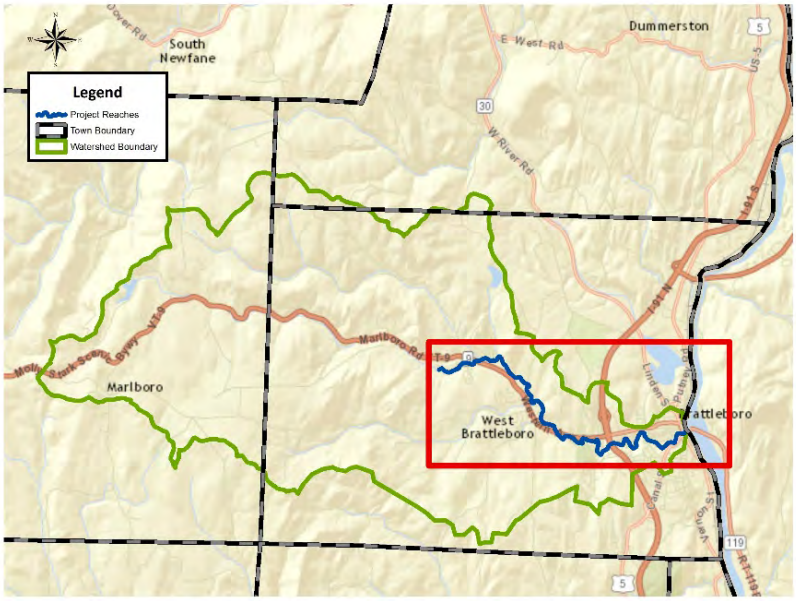


**Figure 1:** Study area

Brattleboro is a regional transportation hub with the railroad, US Route 5 and Interstate 91 that run north/south along the Connecticut River in the eastern quarter of town. VT Route 9 travels west to Wilmington (and its ski areas), Bennington and Albany, New York and east into New Hampshire, providing the key east-west regional travel corridor for commerce in the southern part of the state. VT Route 30 follows the West River through Windham County in a northwest direction out of Brattleboro, connecting towns along the West River Valley, Manchester in western Vermont, and

US Route 7 on Vermont's western side. Routes 9 and 30 are important year-round access routes to Haystack Mountain, Mount Snow and Stratton Ski Resorts, along with Bromley and Magic Mountains, drawing large numbers of visitors and second home owners (WRC, 2014b).

Urban development throughout the study area is significant – in the downtown it is greater than 60% of the land area; in West Brattleboro it is greater than 20%; and in West Brattleboro Village it is greater than 40%. Watersheds with more than 10% developed land are known to experience increased run-off that can result in permanent changes to the width, depth and slope of the river channel. Despite intense commercial and residential development, agriculture and forestry remain important parts of the economy and over 2,776 acres of land in the upper reaches of the watershed in Brattleboro and Marlboro are conserved (LNRP, 2008).

VT Route 9 is critical to commerce and is the most significant highway located in the study area. While it is adjacent to the Whetstone Brook in the mountainous terrain in Marlboro and the western third of Brattleboro, once the slope eases and the valley widens, the highway is mostly outside of the **floodplain**, though it does cross the Brook twice. The same cannot be said for the town water and sewer line with 8,445 feet of sewer pipe and 4,881 feet of water line at risk in the **floodway**. However, the sewer and water treatment facilities are located outside of the flood prone areas of the Whetstone Brook.

The Vermont State Police Barracks in West Brattleboro is on the southern edge of the floodplain. It is separated from the town's main population centers by two VT Route 9 Whetstone Brook bridges. The West Brattleboro Fire Station is outside of the floodplain, but is located between the two VT Route 9 bridges. It is separated from the main fire station (Central Station), by one of those bridges. Central Station is located downtown, north of and outside of the floodplain. Within the study area, three-phase power follows VT Route 9 and Williams Street, crossing Whetstone Brook four times in the study area. All these are key services and essential to first responders in the event of a disaster.

## Research and Outreach

The team kicked-off the project in August 2014 at a meeting with town staff to share information about flood risk and ongoing efforts to reduce that risk. DHCD Commissioner Noelle MacKay emphasized the overall objective of helping businesses bounce back rather than break after disasters. Following this meeting, the team reviewed existing information about the town, Whetstone Brook, and associated community hazard planning (see table of data sources in Appendix A).

Following the kick-off meeting, DHCD and the Windham Regional Commission (WRC) hosted a community forum on October 15, 2014 (Figure 2). Community members, town officials, business owners and homeowners from the region attended and learned more about the background of the VERI project from Commissioner MacKay. Amy Sheldon, from Landslide Natural Resources Planning, Inc., provided an overview of the Whetstone Brook. Then the floor was open for ideas and questions from the community members.

At that forum, Brattleboro community members highlighted successfully completed and ongoing flood resilience projects including:

- The conservation of the Locke Field (below Sunset Lake Road and behind Chelsea Royal Diner) to protect critical floodplain from development.
- The Vermont Downtown Action Team's (V-DAT) post-Irene work developing a downtown master plan, as well as branding and marketing campaigns.
- The construction of a new downtown food cooperative designed with flooding in mind -- including infrastructure to minimize stormwater run-off from the site.

**Figure 2:** Attendees at the first community forum

Participants also highlighted areas vulnerable to flooding and erosion including:

- Flat Street is a low point along the brook and continues to see flooding on a more frequent basis.
- Debris catches at the Main Street Bridge because the bridge is narrow and the water has to flow around an 'S' curve and the overflow around the bridge causes flooding to local businesses.
- All the bridges upstream of and including VT Route 9 Bridge by Melrose Street are undersized. Failure of a VT Route 9 bridge would impact a critical transportation corridor that, according to VTrans, carries over 16,000 vehicles per day.

In the fall of 2014, the river scientist and engineer on the team spent a day walking the entire project area with the Phase 2 **Stream Geomorphic Assessment** data and the post Tropical Storm Irene damage inventory in hand (Figure 3). Global Positioning System (GPS) points and photos were taken along the route. The team noted the following:

- Location of vulnerable structures and utility poles;
- Formation of new floodplain adjacent to areas that were dredged during Irene;
- Areas where the sewer line broke and failed during Tropical Storm Irene; and
- Areas of new sediment build up.

Earlier studies of the Whetstone Brook informed the work of the team. A 2008 **River Corridor Plan** (LNRP, 2008) helped to establish a baseline understanding of the pre-development characteristics of the Brook and its watershed, as well as the impacts of existing development. The plan made recommendations to help the community reduce future floods and enjoy the many benefits of the Brook (Figure 4). This River Corridor Plan, along with the Town of Brattleboro All **Hazards Mitigation Plan** (Brattleboro Planning Services Department, 2014), an inventory of the post-Tropical Storm Irene damages and the Brattleboro Town Plan and land use regulations were all utilized in developing the recommendations made in this report. In addition to those documents, 36 US Geological Service (USGS) flood elevation points helped evaluate the extent of flooding during Tropical Storm Irene.

**Figure 3:** Field assessment of existing conditions

The VERI analysis differs from the 2008 Whetstone Brook River Corridor Plan as it focuses on flooding impacts to individual businesses, the overall economy of the region and the cost of repetitive repairs to infrastructure. Stepping back and looking at Brattleboro as a regional economic center brought to the forefront the necessity of improving and protecting the transportation corridors and maintaining redundant transportation networks. Also, significant portions of the sewer and water lines - that thousands of people and hundreds of businesses depend upon - are located in the river corridor making them particularly vulnerable to damage and failure during flood events.

**Figure 4:** Example of floodplain formation in West Brattleboro

Businesses in Brattleboro and the region depend on the VT Route 9 corridor. Many of the most vulnerable transportation structures on VT Route 9 are located outside of the VERI study area and VTrans is working to protect and ensure that this critical transportation corridor remains open for business when the next flood occurs.

# Flood History and Town Accomplishments

## Flood History and Risk

It is difficult to find specific historic information about flooding in Brattleboro, though the National Weather Service mentions Brattleboro in all of Vermont's storms of record, including the 1869 "Freshet," and the 1927, 1938, 1973 and 2011 floods (Figure 5)(NWS, 2014). Flood elevation measurements taken following Tropical Storm Irene indicate that it was between a 50 and 100-year flood event (Schiff, 2012). There is evidence throughout the watershed of historic channel straightening, dredging and berming – practices that, in large part, were repeated following Tropical Storm Irene.

There were 35 years between the major floods of 1938 and 1973 and 38 years between the major floods of 1973 and 2011. Between these major flood events, many smaller flood events occurred, but were mostly contained within the existing, often incised or over-widened channel. This can lead to a sense of complacency regarding development in the adjacent floodplain area. In fact, the rate of development increased in the most flood prone areas in the watershed between these major flood events. However, with precipitation patterns changing and large storm events becoming more frequent, future development in the floodplain should be minimized. In the past five years, at least one county in Vermont was declared a federal disaster each year. It's therefore important to take steps today to protect the community and its economy from the inevitable.

Ice jams are common on the Whetstone Brook, causing inundation and leading to road closures and damage to homes in Mountain Home Park. The most recent jam was at the Westgate Bridge in 2013/2014 (WRC, 2014a).

The team inventoried developed and undeveloped floodway and floodplain as part of this project.

**Figure 5:** Damage to downtown, 1869 Freshet (Brattleboro Historical Society**)**

**What is the Floodway?**

The floodway is the area immediately adjacent to the channel that must remain open to allow floodwaters to pass.

**What is the 100-year Floodplain?**

The 100-year floodplain is also called the Special Flood Hazard Area, and is the base floodplain shown on FEMA maps.

**What is the State River Corridor?**

The River Corridor is the area delineated by the Vermont Rivers Program adjacent to rivers and streams that provide functions that restore and maintain natural channel stability. These areas are often at higher risk of erosion and/or flooding.

Within the study area, there are 120 acres of floodway, with 22 acres (18%) developed. There are another 304 acres of floodplain, with 144 (47%) acres developed. There are approximately 300 buildings located in the floodplain in the study area and 50 in the floodway.

Table 1 provides an estimated number of businesses and employees that work in buildings in the various flood zones along with the number of single-family residents. There are approximately 58 licensed businesses located in the **100-year floodplain** and 10 in the **500-year floodplain.**

Development in the floodway and floodplain reduces the area available for storing water, sediment and ice during flood events and increases flooding downstream. The cost of building in the floodplain must be evaluated, not only in the context of removing active areas of floodplain that can store flood waters and sediment during floods, but also by understanding that new development will increase run-off and exacerbate downstream flood effects.

**Table 1: Estimated Number of Businesses, Employees & Multi-family Residences At-risk**

| | Floodway | 100-year Floodplain | State River Corridor |
|---|---|---|---|
| Number of Licensed Businesses* | 2 | 68 | 31 |
| Number of Commercial Buildings** | 3 | 49 | 24 |
| Number of Employees* | 6 | 711 | 204 |
| Single-Family Residences** | 6 | 73 | 55 |
| Multi-Family Residences** | 5 | 43 | 27 |
| Mobile Homes** | 35 | 111 | 30 |

*The Town of Brattleboro has a business licensing program. Not all businesses participate. The number of employees is based on voluntary information provided by licensed businesses who choose to share.
**This data is from the statewide E911 database.

There are approximately 50 buildings in the floodway throughout the study area and many of those are residences in West Brattleboro. Concern for flooding is so great that they have created their own flood gauge (Figure 6) to assist with evacuation notification.


**Figure 6:** Homemade flood gauge at Glen Park assists residents in estimating flood risk and knowing when to evacuate

According to DHCD, damages from Tropical Storm Irene to Brattleboro roads, bridges, public buildings, utilities, and recreation facilities were $1.5 million dollars. Appendix B provides a map of the locations of damaged property from Tropical Storm Irene in the study area.

Irene damaged 174 buildings along the Whetstone Brook (WRC, 2011). Of those buildings, 29 were businesses. The remainder were residences. There were 20 incidences of road damage, 13 incidences of debris on the road and 16 erosion sites

documented. Additionally, 16 bridges were damaged including two town highway bridges that were completely washed away.

## Town Accomplishments

### *Town Wide Flood Policy*

Brattleboro's Town Plan identifies what the community cares about – its shared values and priorities – and builds a vision for Brattleboro's future based on this information. It also identifies current conditions and gathers public input to inform future public investments.

The Land Use section of the Town Plan, adopted in 2013, identifies a number of important flood and erosion hazard goals and policies, including:

> "Promote development of a future land use pattern that promotes public health and safety against floods, ensures the viability of agricultural and forestry economies, protects natural resources, promotes transportation accessibility, and reinforces a compact development pattern and reduce the impact of flooding and erosion" (Brattleboro Planning Services Department, 2013).

The Plan goes on to articulate the following specific policies:

- Provide the highest degree of flood protection at the least cost, through the identification and accommodation of natural flooding and channel migration processes posing hazards to life or property.
- Implement strategies within the watershed that reduce the environmental, health, and welfare hazards associated with flooding.

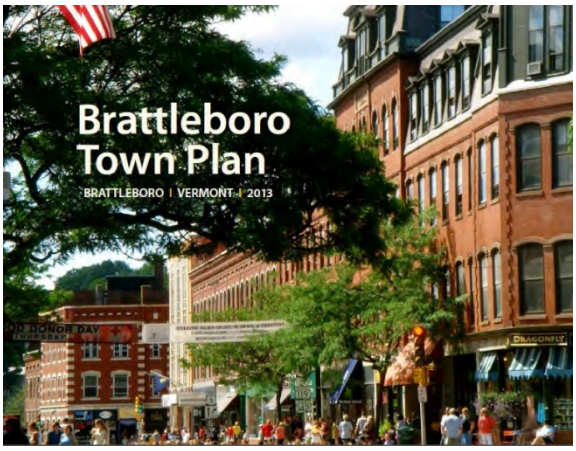


**Figure 7:** Town Plan Cover, 2013

The Town of Brattleboro should be commended for the work they have done to address flooding and related impacts thus far. The Town is one of only three communities in Vermont that participates in the Federal Emergency Management Agency (FEMA) **Community Rating System** (CRS). This federal program recognizes community floodplain management activities that exceed minimum **National Flood Insurance Program (NFIP)** standards. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions.

The town also has a full-time zoning administrator who also serves as the floodplain administrator. The Town of Brattleboro website http://www.brattleboro.org/ has a "Flood Hazard Information" page. The link to this page is clearly placed on the home page, with the text "Emergency Services & Flood Preparedness." As indicated, the Town of Brattleboro has higher standards than FEMA

minimums in their floodplain ordinance. They also have shore land regulations along the Connecticut River and West River.

In 2014, the State of Vermont established an **Emergency Relief Assistance Fund** (ERAF) to provide matching funding for federal assistance after federally declared disasters. This program allows towns in Vermont to increase the amount of state aid money they can receive as a match to federal recovery aid. Towns that take certain steps to become more prepared are eligible for increased state money. Certain damage costs from federally declared disasters are reimbursed 75% by federal money. The State of Vermont contributes a minimum of 7.5% of the total cost, but if a town takes additional steps, the state aid can increase to 12.5% or 17.5% of the cost, leaving less for the town itself to pay (State of Vermont, 2015a).

In early 2015, the Town of Brattleboro qualified for increased state aid for federally declared disasters. As seen in Table 2 below, the town has policies, plans and programs in place to receive the 12.5% state funding. While it participates in FEMA's Community Rating System, a key next step to increase the state match to 17.5% is to protect State River Corridors or protect flood hazard areas from new encroachment.

**Table 2: How Brattleboro Met its ERAF Match**

| **Steps to increase State aid to 12.5%** | |
|---|---|
| Participate in the National Flood Insurance Program | Yes |
| Adopt 2013 State Road & Bridge Standards | Yes |
| Adopt Local Emergency Operations Plan | Yes |
| Adopt Local **Hazard Mitigation Plan** | Yes |
| **Step to increase State aid to 17.5% (one needed to qualify)** | |
| Adopt no new development in a River Corridor | No |
| Adopt no new development in Flood Hazard areas and participate in the Federal Community Rating System | No |

## *Vermont - Downtown Action Team (V-DAT)*

With funding from a Community Development Block Grant for Disaster Recovery (CDBG-DR), DHCD hired a team of experts in community design and economic development and partnered with eight communities, including Brattleboro, to help speed recovery from Tropical Storm Irene. The Vermont-Downtown Action Team (V-DAT) visited Brattleboro on a number of occasions to gather input, develop projects and build consensus on the recommendations. The final reports included short, mid and long-term recommendations to support local economic development efforts. Brattleboro's complete report and supporting documents are available at http://accd.vermont.gov/strong_communities/opportunities/revitalization/vdat. A one-page visual summary of the top recommendations is included in Appendix C. Recommendations in the V-DAT report should be incorporated into any project prioritization moving forward.

## *Site Specific Accomplishments*

In the past five years, the Town of Brattleboro has implemented 20 projects to decrease flood risk including: lengthening three bridges; replacing six undersized **culverts**, adding three new culverts and improving ditching along two roads to prevent future washouts, removing 22 residences from the **Special Flood Hazard Area** (SFHA) and floodproofing critical infrastructure in the Special Flood Hazard Area, including the Wastewater Treatment Plant and the Spring Tree Pumping Station.

Brattleboro has been a key partner in facilitating a multi-agency planning effort to update the School Crisis Plan with tabletop exercises, staff training, and planned drills. The training effort includes identifying, purchasing and staging materials needed for an emergency response. The plan has become a model in the state.

The town continues to work on buyouts of frequently flooded properties to improve public safety and reduce the recovery costs to individuals, businesses and taxpayers. In a buyout, the town purchases the property from the landowner at fair market value, removes any structures on the property and protects the site from future development.

The Windham County Natural Resource Conservation District (WCNRCD) and the Town of Brattleboro Housing Authority have also made progress on the top six projects identified in the 2008 Whetstone Brook River Corridor Plan (LNRP, 2008) including the following:

- Acquiring and protecting the floodplain behind the Chelsea Royal Diner – completed.
- Working with the Farmer's Market to make their site flood accessible and either make flood ready improvements or find a safer location for the market – ongoing.
- Relocating at-risk housing units in the floodway – ongoing.
- Planting **riparian buffer** along the Whetstone Brook on Vermont Land Trust parcel – completed.

# Strategies and Projects to Protect Brattleboro

The team has developed a list of policy and program recommendations and site specific projects to protect Brattleboro's businesses and infrastructure during future floods. Based on data collection and analysis, review of the town plan and bylaws, hazard mitigation plan, previous reports and community input, the team developed a list of flood **mitigation** objectives for the Whetstone Brook in Brattleboro to address town-specific flood damages. These objectives include:

- Keeping VT Route 9 corridor open for commerce, emergency responders and the traveling public;
- Reducing flood effects in the three main economic centers of downtown Brattleboro, the Village of West Brattleboro and West Brattleboro;
- Maintaining water, sewer and power during and after a flood; and
- Protecting businesses and residences from floods.

Using the objectives outlined above, the team developed a list of recommended projects to reduce the impacts of floods (Appendix D). To complement input from the community, the team also created maps to guide the development of project ideas and highlight specific areas with elevated flood risk (Appendices B and E). These maps summarize:

1. Land development located in flood hazard areas; and
2. Damages sustained during Tropical Storm Irene in 2011.

The municipal policy and program recommendations and site specific projects for the community are summarized below.

## Municipal Policy and Program Recommendations

Reducing the impacts of floods involves an ongoing process of evaluating and adjusting policies to minimize risks through protection, prevention and education. Accordingly, the VERI team first reviewed Brattleboro's municipal plan, hazard mitigation plans and land use regulations to identify the policies they contain and those that are absent. These documents were reviewed with the goal of identifying gaps and opportunities to improve the flood preparedness, safety and resilience of residents, visitors, businesses and local government.

The team then used the US Environmental Protection Agency's (EPA) **flood resiliency** checklist that was developed from a study in the Mad River Valley in Vermont (US EPA, 2014). This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

The checklist review found that Brattleboro currently employs 33 of 56 items on the checklist, including participating in the National Flood Insurance Program Community Rating System,

adopting floodplain development limits that go beyond FEMA's minimum standards for SFHAs, and promoting better management of stormwater runoff (including through regulation). (WR RPC, Appendix F).

The results of these reviews identified 26 policy and program recommendations that were then organized into four groups: Land Use Regulations, Community Planning, Emergency Planning, and Education and Outreach. The distribution of the opportunities to improve policies and programs is shown in Table 3, below

**Table 3: Categories of Municipal Policies and Programs**

| Category | Description | Policies and Programs |
|---|---|---|
| Land Use Regulations | Avoid and minimize land use conflicts around watershed resources that help lower the risk of flooding and/or erosion to properties | 7 |
| Community Planning | Develop long term goals, recommendations and budgets to improve flood resilience | 6 |
| Emergency Planning | Specific projects for supporting mitigation and recovery actions for flooding and other hazards | 10 |
| Education and Outreach | Programs targeted at critical businesses and vulnerable populations to educate them about flood risk, mitigation and recovery | 3 |

The results of the plan and policy reviews were then combined and each was scored with either a one (ineffective), three (limited) or five (effective) using the three objectives:

- Reduces flood risk (proposed project lowers the flood level);
- Reduces erosion risk (proposed project lessens the vulnerability to erosion); and
- Protects businesses, infrastructure and property.

The three scores were added to provide a total score. Cost and ease of implementation and input from the community were also considered. To assist the town with implementation, potential partners and funding sources were identified. Each recommendation was further explained and next steps were identified. This information was compiled into easy to read charts found in Appendix G.

The top priority policy and program recommendations were presented at the community forum and local feedback was incorporated into the final prioritization, below.

Top recommendations include the following:

- **Achieve a Higher Community Rating System (CRS) Rating:** The Town of Brattleboro should take steps to achieve a higher rating within FEMA's CRS based on land preservation efforts, outreach efforts, elevation certificates, higher standards in the floodplain ordinance, and stormwater regulations. A higher rating will result in reduced flood insurance rates for residents and businesses.
- **Identify Areas for Conservation:** The Whetstone Brook and the Crosby Brook River Corridor Plans both identify potential riparian easement sites. Various agencies and organizations working in the community, including the Windham County Natural Resources Conservation District, Brattleboro Conservation Commission, and Vermont Land Trust, can identify and work with willing landowners to establish those riparian easements to prevent future development in flood prone locations**.**
- **Regulate Development in Fluvial Erosion Hazard Areas:** Much of the flood damage in Vermont is caused by bank erosion from swollen rivers within river corridors. Stream banks can fail causing structures to be undermined or fall into the river. Regulating development in the areas mapped as Fluvial Erosion Hazard Areas by the Agency of Natural Resources (ANR) as part of a Stream Geomorphic Assessment would reduce flood risk and increase public safety. Additionally, the regulations should be written for the town to achieve a higher state Emergency Relief Assistance Fund (ERAF) rate.
- **Regulate Grading and the Clearing of Trees and Plants on Slopes Greater than 15%:** These areas are particularly susceptible to erosion and allowing these practices puts the entire community at risk.

Local stakeholders (residents, businesses, planning commission, Selectboard, etc.) are encouraged to review these recommendations and seek assistance from the identified partners and programs and take these steps to reduce flood risk over time.

## Specific Project Recommendations

The Whetstone Brook Watershed Stream Geomorphic Assessment and River Corridor Plan (LNRP, 2008) helped inform site-specific flood mitigation project ideas; in many cases projects conceived in the River Corridor Plan prior to the 2011 flooding are still valid today. These River Corridor Plan project locations were evaluated in the field during 2014 to determine if river conditions have changed significantly since the development of the plan in 2008, and whether or how the project concept should be adapted to account for these changes. Additional project ideas were developed through the course of discussions with stakeholders, and additional data analysis and field visits. Projects identified to meet town-specific objectives were organized by the project types outlined in Table 4. A table summarizing projects to protect businesses and infrastructure from flooding is included in Appendix D. Maps depicting the location of each project site in Brattleboro, along with other relevant economic asset and flood hazard information, are also included in Appendix E and H.

To begin, the team screened and scored each project. Each project received a score of one (ineffective), three (limited) or five (effective) for the three objectives:

| Table 4: Mitigation Project Types | | |
|---|---|---|
| **Project Category** | **Description** | **Projects** |
| Building and Site Improvements | Lowers the risk of flooding and/or erosion to specific properties through improvements to the building and/or surroundings, e.g., sealing off buildings to prevent water infiltration. | 4 |
| Channel and Floodplain Management | Lowers the risk of flooding and/or erosion to properties along the river through the improvement of natural river and floodplain functions, e.g., tree plantings along unstable river banks. | 7 |
| Infrastructure Improvements | Lowers the risk of flooding and/or erosion to roadways and other municipal or state-owned infrastructure, e.g., increasing the size of bridges and culverts to pass more flood waters. | 4 |
| Public Safety Improvements | Lowers the risk of flooding and/or erosion to properties through the avoidance of future flood risks, e.g., FEMA buyouts of improved properties highly vulnerable to flooding. | 3 |

1. Reduces flood risk (proposed project lowers the flood level)
2. Reduces erosion risk (proposed project lessens the vulnerability to erosion)
3. Protects businesses, infrastructure and property

The three scores were added to provide a total score, which was then weighted based on the importance of the project in the region. Projects that would result in a regional economic boost and help keep businesses open were given the greatest weight, while projects that would offer minimal economic benefit to the business economy were assigned a lesser weight. Many of the high priority projects are from the Infrastructure Improvements category, as those at-risk areas potentially affect the greatest number of community members and businesses.

Project partners and stakeholders, including representatives from DHCD, VTrans, ANR, WRC, and the Town of Brattleboro, provided feedback on a draft list of mitigation strategies and their priorities in October 2014. The feedback was incorporated into the prioritization of projects. Below are brief descriptions of the high priority projects from each of the project categories described in Table 4. A summary of efforts to develop conceptual designs for two of the high priority projects follows.

## *Channel and Floodplain Improvements*

**Conserve Eight Acres of Undeveloped Floodplain to Protect the Downtown Area and Businesses (Site 16):** There are 43.6 acres of floodplain in the downtown and all but 10 acres are developed. The community should consider conserving eight acres of remaining undeveloped

floodplain upstream of the downtown near Williams Street (the remaining two acres are upstream of Elm Street and are frequently flooded).

The community could also further increase flood water, sediment and debris storage in this area by creating a **flood chute** or by lowering (cutting) the elevation of this upstream area.

In the area around Williams Street, Tropical Storm Irene destroyed or damaged roads and sidewalks, caused minor damages to eight buildings and major damages to three buildings, including four businesses that employ approximately 52 people. Increasing the capacity of this undeveloped floodplain to store water could reduce local flood elevations in the downtown by four to five feet. Further study of the benefits may reveal flood reduction downtown that may reduce the cost of flood insurance. It will also help protect Williams Street, an important access for these local businesses and it is an alternate route to access downtown.

The protection of existing floodplain not only allows for the storage of flood water and sediment but it will also prevent new development, which if allowed to happen will increase the likelihood of downstream flooding. Conserving the parcel and potentially reducing the elevation by excavating the floodplain to increase flood storage on the parcel will reduce flood elevations in the area, provide for flood water and sediment storage and dissipate erosive energy from within the channel. This is a moderately difficult project that will take two to five years to complete and cost more than $200,000. See conceptual designs below for further analysis and next steps.

### *Infrastructure Improvements*

There are 15 bridges located in the VERI Study Area. Seven bridges were described as having had 'minor erosion' following Tropical Storm Irene and only the eastern Williams Street Bridge was described as having been damaged (WRC, 2011). It is identified and described as a project below and a conceptual design is presented in Appendix J. Community members and the Town of Brattleboro has indicated that the VT Route 9 Bridge near Melrose Street is a concern. This bridge, with a 55 foot span is sized at approximately the bankfull width, which is the state standard for bridge sizing. A VTrans inspection done on June 17, 2013 states that the "structure is in fair to good condition. Stone should be added to the south end of the arch to help stop the scour" (VTrans, 2014). While this structure is in good shape, it is located in a section of the river that is 100% straightened and the floodplain and floodway contain significant development that was damaged during Irene. The river also jumped its banks upstream of this bridge and flowed across VT Route 9.

See Appendix I for a summary of the span, bankfull channel width and notes on each of the 15 bridges in the study area.

**Manage Sediment at Eastern Williams Street Bridge (B35, at West Street)(Site 15):** Tropical Storm Irene undermined this bridge that is situated askew to the flow of Whetstone Brook. As a result, the east abutment takes the main force of the current (Figure 8). Additionally, sediment has built up in the right opening (facing downstream) and upstream of the opening. Removing the

sediment to allow the flow to utilize the full bridge span will increase channel capacity and decrease erosive energy. It is likely that regular maintenance will be required at this site until the misalignment is addressed. Williams Street provides redundancy in the transportation connection to the downtown. This project is relatively easy to implement and will cost less than $10,000. See Appendix J for more details.

**Figure 8:** View of Eastern Williams Street Bridge from upstream. Left abutment eroded during Irene, sediment buildup shown right.

**Address West Brattleboro Alignment Issues at VT Route 9 Bridge (B51, near Cumberland Farms):** This bridge is misaligned with the Brook causing upstream erosion along the left bank and erosion along the right (facing downstream) bridge abutment (Figure 9). The alignment issue could be addressed by utilizing an existing flood chute upstream of the structure to move the stream flow closer to perpendicular to the bridge. This will reduce scour and help prevent a possible failure. The loss or reduction in traffic on this bridge would affect more than 30 businesses and 140 employees in the immediate vicinity. The State Police Barracks, located west of this bridge, and service to Brattleboro, Wilmington and Bennington is also at risk. Design and implementation of the project is moderately difficult and it is likely to require two to five years to complete. Costs are estimated between $100,000 and $200,000. VTrans has identified the eroding upstream left bank as a priority for repairs in their most recent bridge inspection report. This project seeks to balance the competing costs and benefits of utilizing a relatively new bridge structure with the potential for increasing erosive energy downstream. The engineering analysis needs to include an evaluation of the potential impact of straightening the channel on the downtown stream properties. Reaching out to state engineers to discuss the project and potential funding sources and design and permitting process is the logical next step.

**Figure 9:** Misaligned VT Route 9 Bridge (2008) before Tropical Storm Irene

**Remove At-risk Sewer and Water Lines within the Whetstone Brook Channel:** There are 8,500 feet of sewer line and 4,900 feet of water line located within the floodway of the Whetstone Brook. In 2011, the sewer line broke in two places in the river channel during Tropical Storm Irene releasing 300,000 gallons of untreated waste into the Brook (WRC, 2014a). In addition to being a public health and environmental hazard, businesses cannot function without sewer or water service.

This is an expensive project that will take longer than five years to plan and execute. However, it is necessary given increasing flow and storm events and the amount of water and sewer lines at-risk in the channel. See Appendix L for more details.

## *Public Safety Improvements*

**Consider Buyouts or Relocation Strategies for At-risk Properties (Sites 4, 10 & 6):** Three areas of Tri-Park Mobile Home Park – two in Mountain Home and one in Glen Park, were identified in the Whetstone Brook River Corridor Plan (LNRP, 2008) as vulnerable to severe flood damages due to their location. In Mountain Home alone, there are currently 93 homes in the 100-year floodplain, 23 of which are in the floodway (Figure 10). Many homes were washed away or damaged by Tropical Storm Irene and others remain in harm's way. Although removing mobile homes, relocating residents and creating replacement housing is expensive, Tri-Park provides much needed affordable housing including for working households that must be maintained somewhere in the community. Avoiding both personal and public damages associated with flooding is critical to economic resiliency. These same areas were included in an Alternatives Analysis done for the Brattleboro Housing Authority following Tropical Storm Irene by Milone & MacBroom, Inc., (see Appendix K). The report studied Melrose Terrace, Glen Park, Mountain Home and Hayes Court with the following management goals in mind:

- Reduce flood risks;
- Reduce erosion risks;
- Remove flood-prone structures that are repeatedly damaged;
- Maximize the number of housing units;
- Protect existing structures from flooding;
- Re-connect historic floodplain where possible;
- Maximize the ease of construction;
- Develop a project with straight forward permitting needs; and
- Control project costs.

**Figure 10:** Mobile Home in floodway lost during Irene

The Brattleboro Housing Authority and Housing Vermont are developing 55 units of replacement housing and relocating the majority of the residents of Melrose Terrace to a building in an area safe from flood risks, known as Red Clover Commons. With the help of a DHCD funded consultant, the Tri-Park Cooperative is currently examining the infrastructure needs of the park and identifying the possibilities and operational challenges associated with relocating or elevating the at-risk mobile homes. While moving people out of harm's way is an expensive and time consuming process, and one that is disruptive to peoples' lives, it is an important goal to pursue and implement as funding and other opportunities allow.

# Conceptual Project Designs to Protect Brattleboro

Using input from the community and the team's professional judgment of projects that would provide multiple benefits, three projects were selected to advance to the conceptual design stage. These projects include managing sediment at the Eastern Williams Street Bridge (see Appendix J for the conceptual design), removing sewer and water lines in the Whetstone Brook channel, and conserving eight acres of floodplain upstream from the downtown. The conceptual designs will require further design and engineering work to advance toward implementation. If the community wishes to advance the projects, the designs provide enough detail to apply for grants.

## Remove At-risk Sewer and Water Lines within the Whetstone Brook Channel

### *Overview and Objectives*

There are 8,500 feet of sewer line and 4,900 feet of water line located at-risk within the floodway of the Whetstone Brook. In 2011 the sewer line broke in two places in the river channel during Tropical Storm Irene causing 300,000 gallons of untreated waste to flow into the Brook (WRC, 2014a). One of the washed out sewer lines was at a river crossing. This line was replaced, crossing the brook at the same location and height above the channel (Figure 11), but remains vulnerable to debris jams and erosion during floods. The other wash out was due to erosion of the river bank where the sewer line was buried in a road embankment. This area also remains vulnerable to erosion in future flood events.

In addition to being a public health and environmental hazard, businesses cannot function without sewer or water service. This is an expensive project that will take longer than five years to plan and execute, although, it is necessary given increasing flow and storm events and the extent of water and sewer lines in the channel.

### *Data Analysis and Results*

There are four main areas where the sewer and water lines are in the floodway: downtown, near the Farmer's Market, West Brattleboro Village and West Brattleboro. (See map in Appendix L.) As aging infrastructure is replaced, it presents an opportunity to relocate sewer and water to areas outside of the floodway.

The cost to move the water and sewer is dependent on a number of variables, including:

**Figure 11:** Sewer line crossing Whetstone Brook, 2008 before it washed out in Tropical Storm Irene.

- Size and type of pipe;
- Number and size of manholes and bury depth of the sewer line;
- Number of valves, air release valve stations, pressure releasing valve stations, fire hydrants, etc. on the water line;
- Whether there is a public right-of-way available to move the lines or will property acquisition or easements be required? Establishing new right of ways can be expensive and requires legal counsel;
- Number of existing connections;
- How difficult is it to transfer existing customers to the new water and sewer lines?
- Will gravity sewer connections now require grinder pumps at each customer? These types of infrastructure improvements on private property can be complicated;
- Water tight manholes covers (bolted and gasketed lids) could be added, but this requires locating the air vents outside the floodplain;
- Number of stream crossings or bridge crossings;
- Can the new sewer be constructed with the existing pipe in operation or will bypass pumping be required in some areas; and
- Traffic control.

## *Conceptual Design*

A typical gravity sewer main with eight inch plastic pipe would cost around $200 to $300 per linear foot (includes pipe, excavation, manholes and reasonable surface restoration). Estimated costs for 8,500 feet of sewer in the floodway range between $1.7 million and $2.5 million. Installation of a typical eight inch ductile iron water line will cost around $100 to $150 per linear foot (includes pipe, excavation, and reasonable surface restoration). Estimated costs for 4,900 feet of water line in the floodway range between $500,000 and $750,000. The costs for all the other ancillary items listed can increase costs. The Vermont Department of Environmental Conservation (DEC) offers grants and loans to design and finish water and wastewater improvement projects. Hazard Mitigation Grant Program (HMGP) funding should be considered as well.

## *Steps for Project Implementation*

Municipal officials should closely examine each of the four sections of sewer line and identify alternative locations for the pipe outside of the floodway. A full engineering evaluation should be completed to estimate the cost of floodproofing the system in place versus relocating it out of the channel. A priority ranking system could be used to phase-in upgrades over time based on risk assessment, age of infrastructure and cost.

### *Project Benefits*

The implementation of this project would improve the flood reliability of the water and sewer service to more than 125 businesses and 700 employees and avoid the negative health and environmental impact of a ruptured sewer line.

## Conserve Eight Acres of Floodplain Upstream of Downtown

### *Overview and Objectives*

There are 43.6 acres of floodplain in the downtown and all but 10 acres are developed. The eight acres located south of the river along Williams Street were accessed by floodwaters during Tropical Storm Irene when the upstream **berm** was breached and a new channel was formed (Figure 12). The remaining two acres are upstream of Elm Street and are accessed more often during flood events. The protection of existing floodplain not only allows for the storage of flood water and sediment, but it will also prevent development of more impervious surface that will increase the likelihood of downstream flooding.

Tropical Storm Irene caused minor damages to eight buildings and major damages to three buildings, including four businesses, in the immediate area. These businesses employ approximately 52 people. Additionally, the road was damaged and the sidewalk was destroyed in this area. Allowing these eight acres to be developed will worsen local flood risks. Conserving it and potentially reducing the elevation by excavating the floodplain to increase floodwater access will reduce local flood elevations, provide for flood water and sediment storage and dissipate erosive energy from within the channel. Additional benefits include providing an area for natural storage of woody debris and ice during flood events, keeping such material out of the downtown area.

### *Data Analysis and Results*

Using the FEMA Flood Insurance Study from 2007, the team plotted the cross sections at T and U respectively shown in Figure 14 above and found in Appendix M. The river has cut down in this area and therefore does not access the floodplain during the channel forming flow. If the floodplain was excavated down to the 10 year flood elevation (approximately 6 feet of cut) it would reduce local flood elevations during major storm events by four to five feet. Additionally the eight acres of floodplain will store 40 acre feet of water during 100 year floods, reducing the volume of water in the channel and reducing its erosive force downstream. There will also be some upstream flood reduction with the creation of floodplain in this area. A hydrologic and hydraulic analysis is required to understand the full up and downstream benefits of the project.

### *Conceptual Design*

To provide floodplain access at the 10 year flood interval would require excavating six feet of material over eight acres. This would be expensive ($620,000 plus $100,000 for design, permitting, project and bid oversight) and logistically challenging. A less expensive alternative would be to remove the recently replaced berm at the upstream end of the property and allow the river to

reclaim the floodplain on its own over time. The cost of conserving the property would likely be greater than $200,000. Ecosystem Restoration funds have been available in the past for similar types of projects.

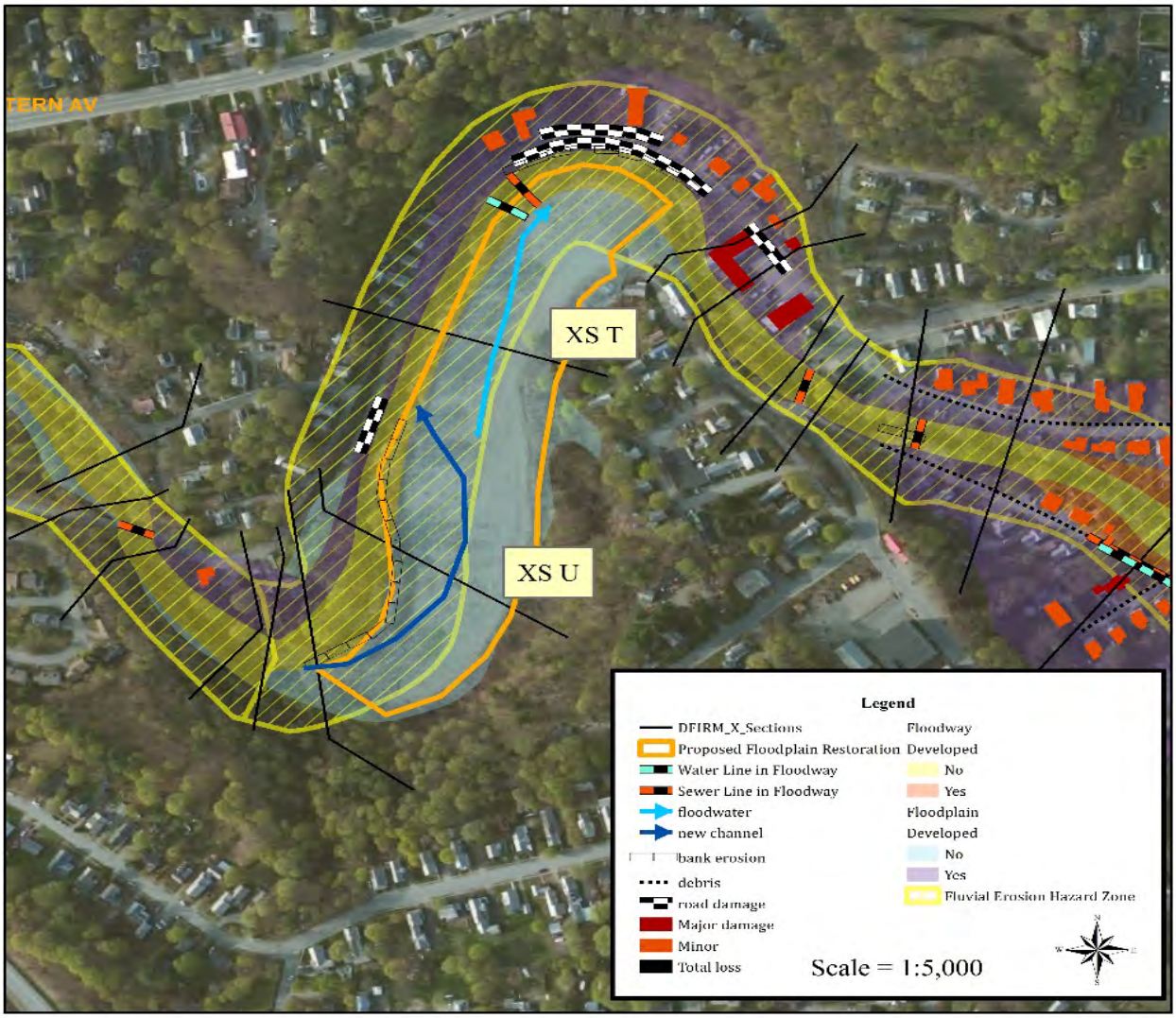


**Figure 12:** Eight acres of floodplain upstream of downtown

## *Steps for Project Implementation*

Landowner outreach, to see if the property is still on the market, would be the first step to move this project forward. Coordinated outreach efforts are critical to ensuring that multiple entities are not approaching the land owner or working at cross purposes. If this is a priority project for the community, a 'point' entity (e.g. Conservation Commission, Town Manager, Conservation District director, etc.) should be identified. If a purchase price were agreed to, the next step would be to identify sources and apply for funding. The flood storage capacity of the site should be determined to ensure that conserving this property would provide the needed capacity. If acquired, an engineer

would be hired to model both floodplain excavation and allowing the river to reclaim the floodplain on its own. If the excavation option is chosen, all necessary state and federal permits would be required, including additional assessment of disturbance to rare, threatened, or endangered species and an archeological evaluation. An area for, or a use of, removed material would need to be located and the project put out to bid and implementation overseen.

### *Project Benefits*

The implementation of this project is anticipated to provide benefits for reducing flood risks in Brattleboro.

Undertaking no action at this site will likely result over the long term in consequences very similar to what happened during Irene — erosion and closure of the adjacent road and damages to nearby businesses and residences. The upstream berm being enlarged and reinforced following Tropical Storm Irene may increase downstream erosion along the road and lead to the road and sewer line washing out.

# Next Steps

On April 23, 2015 the team hosted the second community forum to share the list of policy and project recommendations to decrease flood risk for Brattleboro. At the forum, community members asked questions, provided input and helped rank the proposed list of priority recommendations.

The site specific projects which the community most supported included conserving the eight acre parcel just upstream from downtown, and removing the sediment plug under the Williams Street Bridge. Buyouts of at-risk properties also ranked high. Participants noted that the recommendation to straighten channels in an effort to solve alignment issues at the Route 9 Bridge (B51, near Cumberland Farms) could increase the energy of the river. While true, the lens of this study was to develop recommendations protect existing infrastructure and the local economy.

The policy and program recommendations which the community most supported included regulating new development in both the flood hazard area and in fluvial erosion hazard areas. Participants also supported continued and increased participation in FEMA's Community Rating System to reduce flood insurance rates.

The town-wide policy and program recommendations and site specific projects recommendations (Appendices D and G) provide a comprehensive list of recommended projects for the community to further discuss, explore, and advance as resources permit. The conceptual designs presented above and in Appendix J are intended to provide examples for how to advance high priority projects to the next level and acquire funding for final design and implementation. As part of the ongoing community discussion regarding the VERI effort, the team recommends the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization;
- Prioritize one to two projects to pursue each year with assistance from DEC and WRC staff to identify appropriate funding sources and partners;
- Apply for one to two grants each year to advance project development and/or designs;
- Implement projects as funding allows; and
- Monitor project success.

The Town of Brattleboro is now involved in a number of efforts that directly address some of the policy and program recommendations and site specific projects outlined in this report. The Town is participating in the EPA's Smart Growth Implementation Assistance program, which focuses on the Whetstone Brook corridor from Main Street upstream to near West Street. This is a mixed-use, walkable community adjacent to downtown.

The program will look at how the neighborhood can be made more resilient through techniques such as open space that also functions as flood storage or flood control, rehabbing existing

structures to make them more flood resilient, and encouraging re-development that takes into consideration both smart growth principles and flood resiliency. As part of these efforts, the Town is taking a closer look at what can be done with the eight acre parcel off Williams Street, which is another of VERI's high priority projects.

Other efforts the Town is undertaking include working on a higher rating for FEMA's Community Rating System. This is one of the top VERI policy and program recommendations. The Town will also be doing a downtown master plan, a component of which will look at ways to strengthen community interaction with both the Whetstone Brook and the Connecticut River. Having a better understanding and appreciation of these waterways can improve awareness of flooding issues, and help support the education and outreach initiatives outlined in this report. Addressing the issue of sewer lines in the floodpain is one of VERI's high priority projects. The Town is looking to receive technical advice on the sewer line, including floodproofing.

The state is advancing a project to improve public safety in and around Brattleboro by closing the barracks in Brattleboro and Rockingham and consolidating all the troopers in the single building in Westminster.

Brattleboro, its businesses and homeowners are not alone in implementing the recommendations outlined in this report. For example, the WRC can help gather and review sample bylaws, capital plans and hazard mitigation plans and help draft town specific language for review and local adoption. DHCD's Municipal Planning Grants http://accd.vermont.gov/strong_communities/opportunities/funding/overview/municipal_planning_grants , the Vermont Rivers Program http://www.anr.state.vt.us/dec/waterq/rivers.htm and www.floodready.vermont.gov can help support these efforts. The Vermont Land Trust http://www.vlt.org/ can assist landowner's protection of critical floodplain with easements. The State's Hazard Mitigation Grant Program http://vem.vermont.gov/mitigation can help implement projects within Brattleboro's HMP. The Vermont Small Business Development Center http://www.vtsbdc.org/ has offered extensive disaster assistance to businesses as well as compiling a great guide for owners to navigate these programs. And several federal and state programs can assist in funding the recommendations outlined in the report. Working together we can reduce the risk and financial burden of future flooding events.

## Education and Outreach

Vermont has a long tradition of managing its rivers to limit or prevent flood damage including armoring riverbanks with rocks, moving or straightening river channels and building dams and berms. Despite these efforts, flooding is the most common natural disaster in Vermont (ANR). Tropical Storm Irene showed Vermonters that rivers and streams are powerful and tend to make their own way during a flood. Because we cannot reliably control flooding, educating citizens, business and property owners about rivers and potential flood risks within their communities is critical.

Ongoing community education and outreach is an important part of any effort to promote flood safety and to protect local business and economies. Ultimately, the better informed everyone in the community is about the behavior of local rivers and streams, the more likely it is that they will make sound decisions.

> *"We all have short memories when it comes to flooding. It's just human nature to think it couldn't happen here again anytime soon."*
>
> Chris Campany, Executive Director
> Windham Regional Commission

**Make Information Readily Available:** Easy access to river and floodplain information is an essential way to help citizens and businesses incorporate flood risks into the decisions they make. Most communities offer printed information at the town office or library as well as on town webpages.

**Common Handouts or Webpage Information Includes:**

- Maps of the local flood hazard areas and the permitting requirements in the floodplain;
- Information about flood insurance and floodproofing buildings;
- Information about how rivers, streams and watersheds work; and
- Benefits of green infrastructure and conservation of existing floodplain.

**Actively Engage:** Many communities work to increase the understanding of rivers and risks via email or by posting information on their local Front Porch Forum. Communities often include flood maps and permitting information in their town meeting reports and other municipal mailings like sewer and water bills. Others promote awareness of flood history and risk by placing high water lines on prominent buildings in the community.

However, education and outreach efforts should not be the sole responsibility of local governments. Community groups like chambers of commerce, downtown business associations, neighborhood groups, and watershed organizations are encouraged to partner with state, regional and local groups to offer local workshops and education sessions.

**Potential Workshop Topics, Partners or Presenters:**

- Flood Insurance and What You Need to Know (Department of Finance Regulation, Division of Emergency Management and Homeland Security, Vermont League of Cities and Towns )
- Developing a Continuity of Operations Plan (Small Business Development Centers, Regional Planning Commissions, Regional Development Corporations )
- Resilient Road Designs to Reduce Recurring Damage and Improve Water Quality (Agency of Natural Resources, Agency of Transportation)
- Planning for Resilience (Regional Planning Commissions)
- Flood Risk, Preparedness and Safety (Division of Emergency Management and Homeland Security, Regional Planning Commissions)

- Extreme Weather and Climate Change (Agency of Natural Resources, Vermont Natural Recourses Council )
- How Rivers, Streams and Watersheds Work (Agency of Natural Resources, Vermont Natural Resources Council, Vermont Land Trust )
- Low Cost Techniques to Reduce Flooding and Improve Water Quality (Agency of Natural Resources, Vermont Natural Resources, Regional Planning Commissions, Vermont League of Cities and Towns)

**Invest in Staff Training and Certification:** In many of Vermont's cities and towns, floodplain management is just one of many responsibilities of the local planning office or zoning administrator. Yet, administration of a floodplain ordinance is quite complex and the consequences of limited staff time and understanding of the regulations can easily allow inappropriate development in dangerous areas. The consequences of granting improper variances and not enforcing against violations may preclude the community from participating in the federal flood insurance program. Therefore, local government officials are strongly encouraged to support staff training and certification in floodplain management.

## What Can Individuals Do to Reduce Their Risks?

Most of us remember to annually change the batteries in our smoke alarms to reduce the risk of fire, but few of us prepare for floods or disasters. Vermont has had two or more federally-declared disasters every year since 2000, and floods have occurred nearly everywhere in the state (ANR, 2015). Buildings located in a 100-year floodplain have a 1% chance of being flooded every year. Over a 30 year period (length of most home mortgages), there is a 26% chance of a 100-year flood (USGS, 2010).

The good news is that there are many steps that individuals can take to reduce the risks, loss, disruption and costs associated with flooding. Understanding what the risks of flooding are for your home and family will help you. It is recommended that you:

- Make sure that you have the right amount of insurance coverage;
- Protect your home and take steps to limit potential damage;
- Prepare plans detailing how your family will respond if flooding looks likely; and
- Practice so family members know what actions to take in the event of a flood or upon receiving a flood warning.

### *Steps to Reduce Risks*

- **Identify Flood Risk.** The first step is to identify your risk so you can plan appropriately. Floodplain maps are available at most town offices or click this link http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your home or apartment is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** While homeowners' or renters' insurance helps pay to repair or rebuild your home and replace personal property due to a covered loss, it does not cover any damages caused by floods or your rent and living expenses while your home is rebuilt. All insurance policies have overall policy limits and specific limits for different types of coverage. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Fill Gaps in Your Insurance Coverage.** If your home is underinsured at the time of a loss, there is frequently a penalty or reduction in the amount the insurance company will pay for the loss. Property insurance does not cover flood damages or your expenses if you cannot live in your home due to flood damages. All homeowners who live in flood-prone areas should carry flood insurance. Flood insurance is available for your home and personal property and can be obtained from your local agent.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

- **Plan Ahead.** Draft an emergency response and communications plan (including family phone numbers) for your home and family. Use the process as an opportunity to bring family members together to discuss the roles needed during an emergency and how best to assign responsibilities. Make sure you have a designated place to meet other family members in the event of an emergency. Also, don't forget to plan for individuals with special needs like prescription medication and for your pets as many public shelters or hotels do not allow animals.
    - Pack an emergency kit and make sure family members know where it is located.
    - Keep copies of your insurance policy, computer data and other important documents like tax returns and financial information safe from flooding on upper floors or stored offsite.
    - Document your home and possessions with photos or video to help simplify the insurance claims process. Generally, the more detailed documentation (receipts, serial numbers, etc.) you can supply during the claims process, the fewer problems you will experience.

- **Train and Practice.** Many of us participate in fire drills at work or school, but few of us practice at home for disasters. Training and practicing your emergency response and communications plan will help assure the plan is workable and family members understand their roles and responsibilities.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. If you know a storm is headed your way, fill up your gas tank in case you must evacuate. (If the power is out, it is not always easy to find an operating gas station.) If you must evacuate, try to contact your employer and let them know your plans. Having a plan and a few extra minutes to evacuate can make a difference.

FEMA http://www.ready.gov/make-a-plan and the Vermont Division of Emergency Management and Homeland Security http://vem.vermont.gov/preparedness/hazards/floods both provide more detailed information on how to prepare and protect your home and family from disasters and floods.

## What Can Businesses Do to Reduce Their Risks?

According to FEMA, nearly 40% of businesses do not reopen after a disaster and data from the US Small Business Administration indicates that over 90% of businesses fail within two years after being struck by a disaster.

It can take years to repair the damage to the building, furnishings, equipment and inventory. Disasters can also require businesses to relocate or cease operation temporarily, which may lead to canceled contracts and customers going elsewhere for goods or services. Even if the event does not impact the business directly, severe weather from snow or rain or even extended power outages can strand employees at home and complicate deliveries.

Identifying your risk can significantly reduce potential damages and business recovery costs. Understanding what the risks of flooding are for your business will help you:

- Make sure that you have the right insurance coverage for business interruption;
- Plan ahead and take steps like developing a continuity of operations plan to limit potential damage; and
- Train employees so they know what actions to take in the event of a disaster or after receiving a flood warning.

### *Steps to Reduce Risks*

- **Identify Flood Risk.** Vermont has had two or more federally-declared disasters every year since 2000 and floods have occurred nearly everywhere in the state (ANR). Identifying your risk is a good place to start. Floodplain maps are available at most town offices or click here http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your business is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** Many types of disasters are not covered under normal insurance policies and funding or loans from government agencies is often too little and too

late. All insurance policies have overall policy limits and specific limits for different types of coverage. Any business located in a flood-prone area should carry flood insurance. Also check to make sure your insurance includes business interruption coverage and that it reimburses other unexpected costs (like service interruptions from lost power or Internet access, law suits and unemployment compensation claims filed by employees). Business interruption insurance compensates a business for lost income, expenses and profits if a disaster, such as a flood, closes your doors. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

- **Plan Ahead.** There are also a number of low-cost steps you can take to reduce the impacts of a flood. At a minimum, regularly back up computer data and store important tax and financial records and information such as your insurance policy details in a flood safe place. Documenting your building, furnishings, equipment and inventory with photos or video can speed the insurance claims process.

  All businesses should have a continuity of operations plan. A continuity of operations plan is a written document that outlines how your business will respond and recover from a flood or other disaster. At a minimum, your plan should include:

  - A list of important contacts including your insurance company, key customers and vendors and evacuation contacts for staff.
  - A map showing locations of important equipment to relocate (computers and servers) and where to shut off electricity, gas and other services.
  - Procedures to protect your property and minimize business disruption – e.g. remote back up of computer files, a plan to relocate inventory or livestock.
  - A back up location to conduct business while the building is being repaired.

  Having a continuity of operations plan will help you identify and assign essential tasks that will help minimize the damage caused by flooding. Training and practice will help assure the plan is workable and employees are properly trained.

  The Vermont Small Business Development Center http://www.vtsbdc.org and many of Vermont's Regional Development Corporations http://accd.vermont.gov/business/partners/rdc and Regional Planning Commissions

http://www.vapda.org can also provide training and one-on-one assistance to help your business develop a continuity of operations plan.

CERF+ (Craft Emergency Relief Fund + Artists' Emergency Resources) offers tailored disaster guidance and recourses for artists (http://studioprotector.org/OnlineGuide/DisasterPlanning/DisasterSpecificPlanningResources.aspx ).

- **Train and Practice.** Employees need to understand flood warnings and what to do when they get one. This includes understanding the dangers of flooding and how to evacuate the building safely. Train all staff on procedures to shut down the business and how to deploy loss reduction measures like relocating equipment and inventory to upper floors and deploying door and window dams to reduce flooding. Finally, remember that flooding can also affect employees' ability to work, as their priority may be to protect their home and family first.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. Having a continuity of operations plan and a few extra minutes to evacuate can save lives and your business.

The US Small Business Administration https://www.sba.gov/content/disaster-preparedness offers more detailed information on how to prepare and protect your employees and business and from disasters and floods.

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# Appendix A:

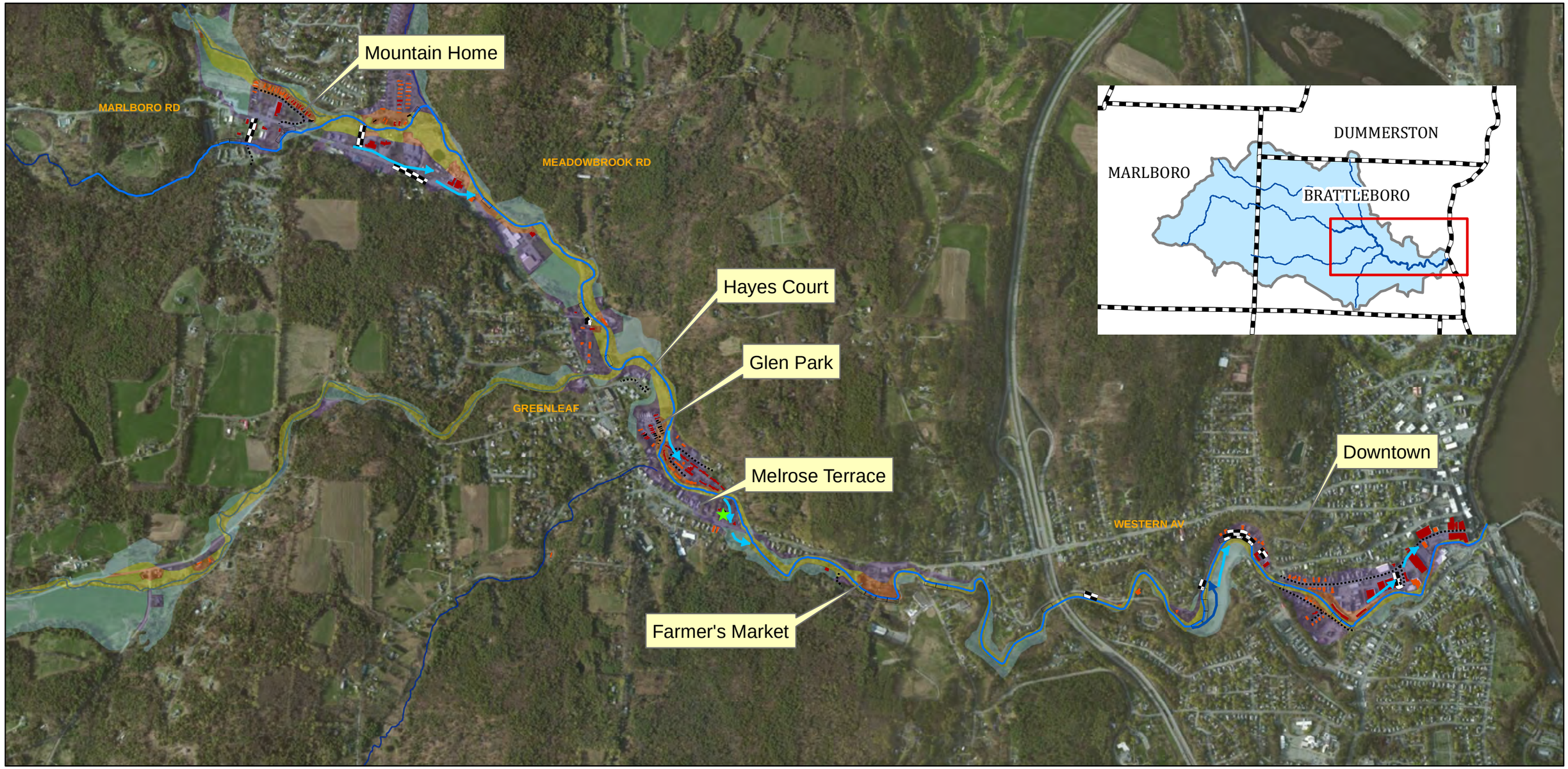
# Town of Brattleboro and Whetstone Brook Data Sources

| Name | Description | Source |
|---|---|---|
| Licensed Businesses | Mapping of licensed businesses throughout Brattleboro. | Town Of Brattleboro |
| Fluvial Erosion Hazard Zone (FEH) & Interim Ordinance | River corridor most likely to erode to accommodate a stable channel planform. | VANR; Town of Brattleboro |
| USGS topographic maps | Current and historic topographic mapping of Brattleboro. 1893, 1935, 1954 and circa 1980's. | USGS |
| Whetstone Brook Geomorphic Assessment and River Corridor Plan | Data and maps of channel stability and aquatic habitat, and recommended actions to improve river stability and reduce flood hazards. | LNRP 2008; Vermont Agency of Natural Resources (VANR) |
| Flood Insurance Study | Basis for Flood Insurance Rate flood insurance and floodplain management applications. | FEMA, 2007 |
| FEMA Floodplain and Floodway | Digital mapping of Floodway, 100-year and 500 year floodplain. | VANR/VCGI |
| Vermont River Corridor | State-mapped erosion hazard area where river is most likely to be located. | VANR, 2008 |
| EPA Flood Resiliency Checklist | This checklist can help communities identify opportunities to improve their resilience to future floods through policy and regulatory tools. | EPA, July, 2014 |
| Completed Resiliency Projects | Information about completed projects and flood resiliency efforts initiated by the Town | Windham County Natural Resource Conservation District |
| Repeat Damage Maps | Mapping of repeat damage sites associated with FEMA-declared disasters | Vermont Agency of Commerce and Community Development (ACCD), FEMA |
| Aerial photographs | Current aerial photographs | Various sources accessed through ESRI ArcMap 10.0 |
| Brattleboro Town Plan | Vision for Brattleboro | 2013 Town of Brattleboro |
| Photographs | Miscellaneous photographs of project area | LNRP 2008, 2014 |

# Appendix B:

# Tropical Storm Irene Damages and Developed Floodplain Map

# Tropical Storm Irene Damages & Developed Floodplain
# Brattleboro, VT
# Vermont Economic Resiliency Initiative (VERI)




**Legend**

| | | | |
|---|---|---|---|
| Buyout | bank erosion | Floodway Developed | Floodplain Developed |
| floodwater | debris | | |
| new channel | road damage | No | No |
| | Major damage | Yes | Yes |
| | Minor | | |
| | Total loss | | |



N
W E
S

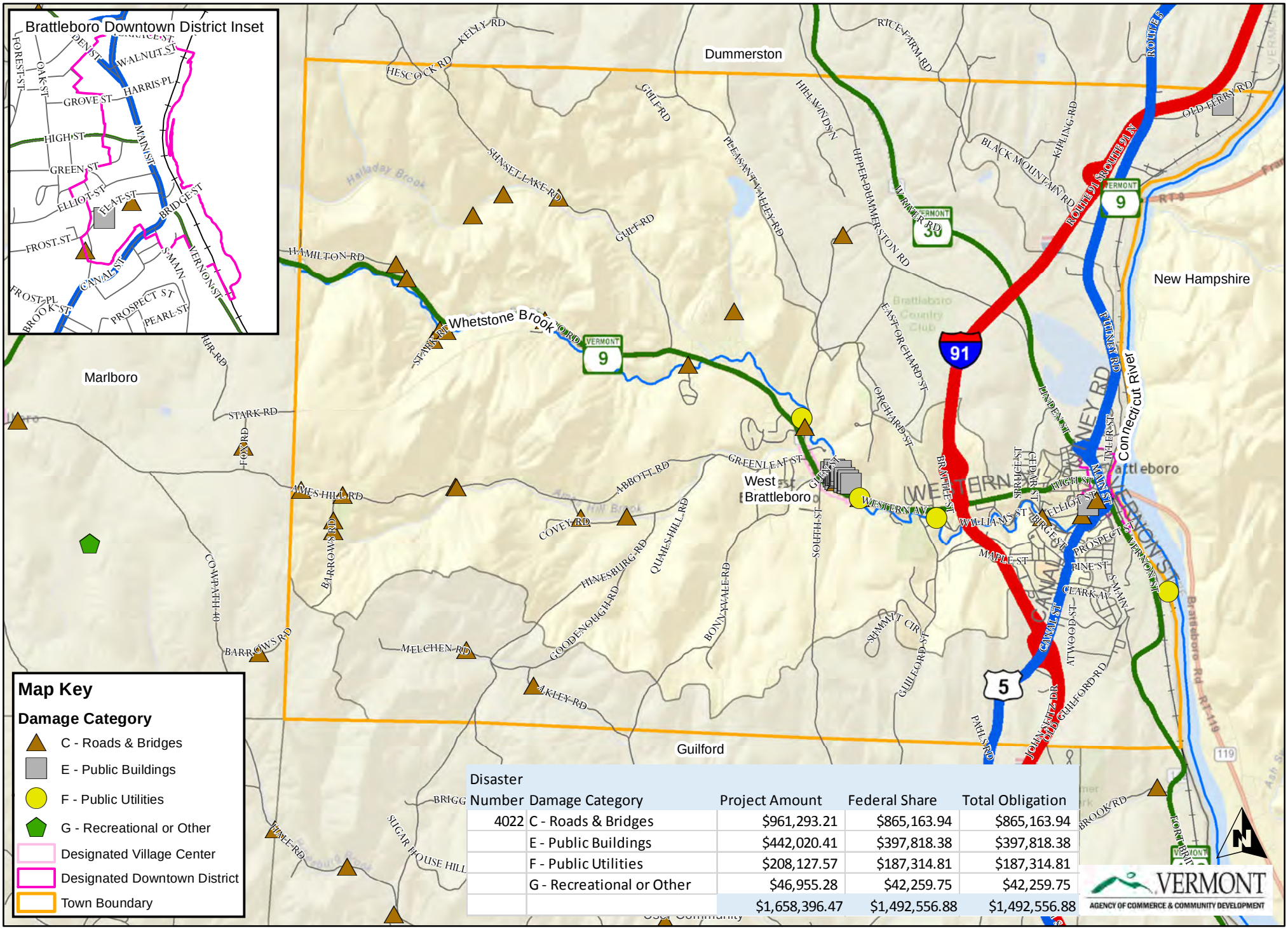
Scale = 1:16,000

0 0.125 0.25 0.5 0.75 1 Miles

Landslide Natural Resource Planning
Linking people to their landscape

January, 2015

# Whetstone Brook, Brattleboro, VT




| Disaster Number | Damage Category | Project Amount | Federal Share | Total Obligation |
|---|---|---|---|---|
| 4022 | C - Roads & Bridges | $961,293.21 | $865,163.94 | $865,163.94 |
| | E - Public Buildings | $442,020.41 | $397,818.38 | $397,818.38 |
| | F - Public Utilities | $208,127.57 | $187,314.81 | $187,314.81 |
| | G - Recreational or Other | $46,955.28 | $42,259.75 | $42,259.75 |
| | | $1,658,396.47 | $1,492,556.88 | $1,492,556.88 |

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT

Author: Map provided by the Department of Housing & Community Development (DHCD). FEMA Data.Gov Map created 1/22/2015.

# Appendix C:

# V-DAT One-page Visual Summary of the Top Recommendations for Brattleboro

# **Brattleboro, VT** Conceptual Vision for **Our Community**

Brattleboro is one of the larger communities in Vermont with a population of 12,500. The community is a "gateway" to Vermont from Massachusetts and a crossroads connecting New Hampshire, Massachusetts, and Vermont. Downtown Brattleboro is a vibrant community. Although not a city, Brattleboro feels more "urban" than most other Vermont communities with three and four story buildings, bustling street traffic, and an abundance of shops and restaurants, cultural amenities, and civic institutions.

Often cited as a livable community and resembling a college town, Brattleboro is home to several significant downtown attractions including one of the largest Co-op markets in the state, the Latchis Theatre and Hotel, The Robert H Gibson River Garden and the Brattleboro Museum and Art Center.

While the community is located along the Connecticut River, downtown has only a few direct connections to the water. Whetstone Brook passes through downtown Brattleboro and is a scenic yet underutilized asset.

## Catastrophic Events

Brattleboro has suffered from a number of events over the past several years that have negatively impacted the community. Spring floods in 2011 flooded West Brattleboro and a large fire gutted the Brooks House in 2012, a prominent mixed-use building on the 100% corner of downtown. The fire took out numerous residential units and retail locations in a prime location. Tropical Storm Irene flooded many businesses along Flat Street and caused major damage to the Latchis in 2011.

## Recovery

To date, much has happened in Brattleboro to recover. The Brooks House will become home to the Community College of Vermont, which will bring students into the heart of downtown. The Latchis Hotel and Theater has reopened and has unveiled renovations to its art deco main theatre. A new restaurant has opened along the Connecticut River, and the Co-op has significantly expanded. Plans are underway for a significant creative economy space in downtown. The Town has also deployed wayfinding signs directing visitors from the Interstate into downtown.

## V-DAT

The Vermont Downtown Action Team (V-DAT) was selected by the State of Vermont, Department of Housing and Community Development, Vermont Downtown Program in May 2013 to conduct a community planning and economic development charrette in Brattleboro. The V-DAT was comprised of experts in architecture, planning, landscape architecture, historic preservation, economic development, organizational structure, landscape architecture, engineering and community branding.

The V-DAT planning charrette operates on three key tenants: utilizing an asset based approach, addressing the community in a holistic manner, and conducting the exercise in a public forum.




## Illustrative Master Plan

The plan for Downtown Brattleboro outlines public realm improvements, parking improvements, private sector investments, infill opportunities, and enhanced connections throughout downtown.

## River Overlook

Brattleboro benefits from dramatic views to the Connecticut River. However, in many instances like this one, significant undergrowth prevents clear views to the river and the spaces that could accommodate viewing areas have not been designed to enhance that viewing experience.

## Waterfront Area

Downtown Brattleboro is located at a wide point in the Connecticut River, affording dramatic views of the river valley to the north and south. Currently, however, the waterfront area does not capitalize on river, with the exception of the Whetstone Station Restaurant and Brewery. Once the bridge at Bridge Street is converted to a pedestrian and bicycle bridge, this area could be enhanced as a significant open space amenity and gateway to downtown. Additionally, the waterfront could offer a memorable gateway for visitors arriving by train.


## Building Rehabilitation

Downtown Brattleboro has excellent building stock and wonderful architecture. Many of the buildings in downtown have been renovated and the Brooks House renovation will bring one of the most important structures in downtown back to its former glory. While in Brattleboro, the V-DAT Team was able to meet with property owners interested in rehabilitating or renovating their own buildings. The illustrations above show before and after renderings of the Market Block and the Brattleboro Bicycle Shop. These renderings are designed to provide guidance to property owners as they make improvements or seek financing for more comprehensive rehabilitation.

## Whetstone Brook

The Whetstone Brook is a tremendous but underutilized asset through the heart of downtown. Rock outcrops, rapids and building foundations combine to create memorable views throughout the brook corridor, particularly between the pedestrian bridge and the outfall at the Connecticut River. There are several opportunities to celebrate the Whetstone and provide more opportunities for residents and visitors to experience it as a destination or while conducting daily business around it. These areas include the edges west of the Main Street Bridge, the area along Bridge Street south of the Main Street Bridge and along the railroad right-of-way and future trail connection. With simple improvements such as clearing vegetation, removing utilitarian fences, lighting, and art this space can emerge as a focal point in downtown.

V-DAT VERMONT DOWNTOWN ACTION TEAM

VERMONT DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

**Project Funding and Support**

This project was supported by funding from the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant – Disaster Recovery. The plan was prepared as a cooperative effort of the State of Vermont Department of Housing and Community Development, the Division of Community Planning and Revitalization and the Town of Brattleboro. The contents of this document do not necessarily reflect the official views or policy of HUD or the State of Vermont. For more information on the Vermont Downtown Action Team [V-DAT] program and links to the detailed presentation and report for Brattleboro please visit http://accd.vermont.gov/strong_communities/opportunities/revitalization/vdat or call (802) 828-5229.

# Appendix D:

# Tables of Projects to Protect Brattleboro

## Recommended Projects to Protect Businesses and Infrastructure from Flooding

**Brattleboro, VT**
**Vermont Economic Resiliency Initiative (VERI)**
**January, 2015**

**Legend**
● Effective ◒ Limited ○ Ineffective

* Priority rating based on objectives and potential business impact

| | | | | OBJECTIVES | | | FEASIBILITY | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| **Building and Site Improvements** | | | | | | | | | | |
| Continue to flood proof downtown buildings **(see site 17)** | Businesses and residences | >60 businesses and 500 employees | Medium | ○ | ○ | ● | Moderate | <$10K per building | 1-2 years | The downtown has 114 buildings in the floodplain; 10 in the floodway, three of those severely damaged during Tropical Storm Irene; 18 buildings with major damage in the downtown and 29 with minor damage during Tropical Storm Irene. There is a pending project to upgrade the storm water collection in this area. |
| Flood proof existing buildings in the floodplain **(see site 11)** | Businesses and residences | Seven town licensed businesses and Melrose Terrace | Low | ○ | ○ | ● | Moderate | <$10K per building | 1-2 years | This reach has 91 buildings in the floodplain 12 of which are in the Floodway; 12 are recorded as a total loss after T.S. Irene; 21 had 'major damage' from Tropical Storm Irene; and nine had 'minor' damage from TS Irene for a total of 42 damaged properties in this reach. |
| Flood proof buildings **(see site 7)** | Businesses | > 23 town licensed businesses and 100 employees | Low | ○ | ○ | ● | Moderate | <$10K per building | 1-2 years | This area has 61 buildings in the floodplain; 10 in the floodway; two mobile homes were total losses; 11 buildings had major damage; 15 had minor damage. |
| Flood proof buildings **(see site 3)** | Businesses | 7 town licensed businesses and 30 employees | Low | ○ | ○ | ● | Moderate | <$10K per building | 1-2 years | This area has 34 units in the floodplain; 23 in the Floodway; three total losses; nine with major damage; 11 with minor damage. |
| **Channel and Floodplain Management** | | | | | | | | | | |
| Adopt Town Zoning to prohibit new development in fluvial erosion hazard zone and 100 year flood inundation zone | Future business and residential buildings | >125 businesses and 700 employees | High | ◒ | ◒ | ● | Difficult | $10K-$50K | 2-5 years | Protect existing businesses by maintaining flood storage capacity and eliminate damage to future business and residential development by not building in the areas most prone to flood and erosion risk. |
| Conserve 8 acres of floodplain, upstream of the downtown, accessed during Tropical Storm Irene and remove berm **(see site 16)** | Downtown businesses and residents | >60 businesses and 500 employees | High | ● | ● | ◒ | Moderate | >$200K | 2-5 years | There are 43.6 acres of mapped floodplain downtown, 33.6 of which are developed. The remaining ten, on two sites, are locally significant for flood storage that will reduce risks to downstream businesses. This was project #8 in the River Corridor Plan. |

[1]**Reduces Flood Risk** - The proposed project/strategy lowers the flood level.
[2]**Reduces Erosion Risk** - The proposed project/strategy lessens the vulnerability of a location to erosion.

## Recommended Projects to Protect Businesses and Infrastructure from Flooding

**Brattleboro, VT**
**Vermont Economic Resiliency Initiative (VERI)**
**January, 2015**

**Legend**
● Effective ◒ Limited ○ Ineffective

* Priority rating based on objectives and potential business impact

| | | | | OBJECTIVES | | | FEASIBILITY | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| Preserve existing undeveloped wetland corridor **(see site 1)** | West Brattleboro businesses and public safety (police) | VT State Police Barracks; three businesses and Westgate Apartments | Medium | ● | ● | ◒ | Easy | $10K-$50K | 1-2 years | Upstream flood storage capacity is critical in the Whetstone Watershed. Not only does this area provide storage for flood waters as they come off the mountain, it also captures large amounts of woody debris, preventing it from causing debris jams downstream. This project was identified in the River Corridor Plan. |
| Assist Farmer's Market with relocating, conserve parcel and remove berm; stabilize erosion on south bank **(see site 12)** | Businesses and residences | Farmer's Market; Evergreen Condos; Guilford Road Bridge | Medium | ● | ● | ◒ | Moderate | $100K-$200K | 2-5 years | The Farmer's Market is located entirely in the floodway, and the structures are prone to washing out and causing debris jams downstream. The south bank, across from the Farmer's Market, is eroding. Moving to higher ground is the safest and least cost alternative over time and will increase flood storage capacity and reduce erosion on the south bank. |
| Protect remaining undeveloped floodplain (7 acres south + 5 acres north of Whetstone Brook) **(see site 9)** | Businesses and residences | > 10 businesses in immediate vicinity and 15 employees; Meadowbrook Road bridge | Medium | ● | ● | ◒ | Difficult | >$200K | 2-5 years | Maintaining flood storage capacity will reduce potential damages within the reach and downstream. The remaining floodplain is locally significant for flood storage and it will reduce risks to downstream businesses. |
| Conserve narrow piece on south bank; improve floodplain access on Locke Field **(see site 2)** | Businesses | 16 West Brattleboro businesses, including State Police Barracks | Medium | ● | ◒ | ◒ | Easy | $10K-$50K | 1-2 years | This small, narrow strip of land was not part of the original Locke Field conservation project although it is on the same side of the river. The berms on it inhibit floodplain access to the already conserved land. |
| Work with businesses to decrease impervious surfaces and install rain gardens/green infrastructure **(see site 8)** | Businesses | N/A | Low | ◒ | ○ | ◒ | Easy | $10K-$50K/site | 1-2 years | Localized flooding during smaller storm events due to a lot of impervious surfaces. Parking lots and storage areas in this confluence area could be re-designed to provide floodplain function during rain events while still being used for parking and storage. This was priority project #6 in the River Corridor Plan. |



[1]**Reduces Flood Risk** - The proposed project/strategy lowers the flood level.
[2]**Reduces Erosion Risk** - The proposed project/strategy lessens the vulnerability of a location to erosion.

## Recommended Projects to Protect Businesses and Infrastructure from Flooding

**Brattleboro, VT**
**Vermont Economic Resiliency Initiative (VERI)**
**January, 2015**

**Legend**
● Effective ◒ Limited ○ Ineffective

* Priority rating based on objectives and potential business impact

| | | | | OBJECTIVES | | | FEASIBILITY | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| **Infrastructure Improvements** | | | | | | | | | | |
| Remove channel blocking sediment upstream of the downstream Williams Street Bridge **(see site 15)** | Town bridge and road; secondary transportation network | >60 businesses and 500 employees | High | ● | ● | ● | Easy | $10K-$50K | 1-2 years | 103' span can adequately pass bankfull+ events (67') if right channel is cleared out. The bridge was closed for a couple of weeks after scour from Tropical Storm Irene undermined the east abutment. Vermont Agency of Transportation bridge inspection on 6/19/14 also recommends removing the gravel and doing other maintenance. Bridge pier and alignment need adjustment to improve sediment transport. |
| Realign Route 9 bridge or realign the river **(see site 5)** | State highway and bridge | >30 businesses and 140 employees | High | ○ | ● | ● | Moderate | $100K-$200K | 2-5 years | This bridge is is misaligned and the left bank is eroding and required repair after Tropical Storm Irene. Riprapping the left bank and improving the road/river alignment will avoid future washouts. |
| Remove sewer and water lines within the river channel at locations throughout the project area **(see site 13)** | Businesses and residents of Brattleboro | >125 businesses and 700 employees | High | ○ | ◒ | ● | Difficult | >$2.5 million | >5 years | Public health and risks to businesses require responsible location of the sanitary sewer and water lines. |
| Stabilize utility poles along river corridor **(see site 14)** | Power and communications | >125 businesses and 700 employees | Medium | ○ | ◒ | ● | Easy | $50K-$100K | 2-5 years | Utility pole in stream channel east of I91 crossing where the road was damaged and the sewer line broke during Tropical Storm Irene. |
| **Public Safety Improvements** | | | | | | | | | | |
| Consider buyout for at risk properties; remove berm **(see site 4)** | Mountain Home Mobile Home Park | Affordable housing | High | ◒ | ● | ● | Difficult | >$400K | >5 years | Maintaining affordable housing units in the floodway and floodplain puts the most vulnerable in harm's way. |
| Consider buyouts for at risk properties; remove berms **(see site 10)** | Glen Park Mobile Home Park | Affordable housing | High | ◒ | ● | ● | Difficult | >$200K | >5 years | Maintaining affordable housing units in the floodway and floodplain puts the most vulnerable in harm's way. This was priority project #5 in the corridor plan. |
| Consider buyouts for at risk properties **(see site 6)** | Mountain Home Mobile Home Park | Affordable housing | High | ◒ | ● | ● | Difficult | $100K-$200K | >5 years | Maintaining affordable housing units in the floodway and floodplain puts the most vulnerable in harm's way. This was priority project #4 in the corridor plan. |

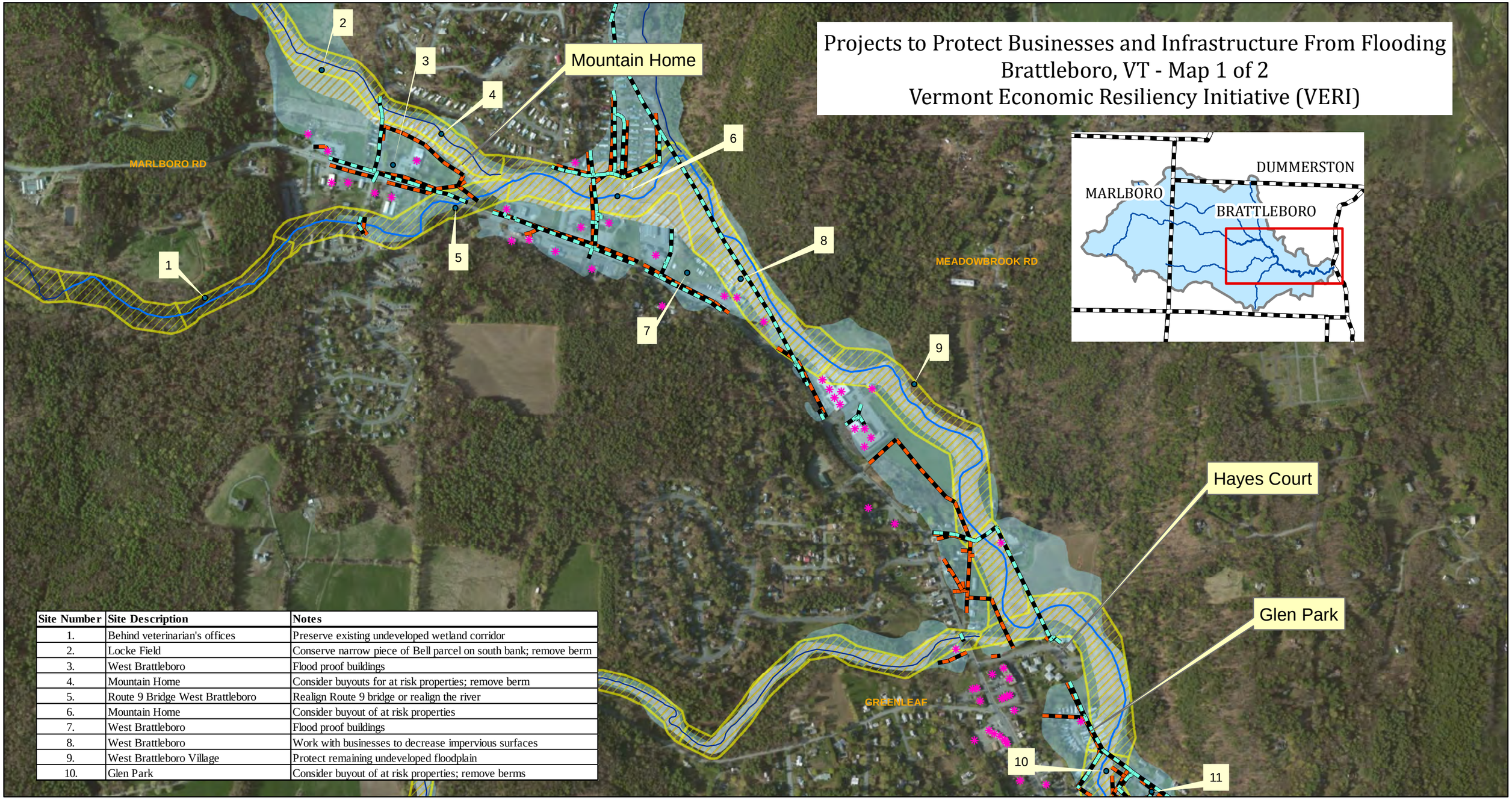
[1]**Reduces Flood Risk** - The proposed project/strategy lowers the flood level.
[2]**Reduces Erosion Risk** - The proposed project/strategy lessens the vulnerability of a location to erosion.

# Appendix E:

# Maps of Projects to Protect Brattleboro

# Projects to Protect Businesses and Infrastructure From Flooding
## Brattleboro, VT - Map 1 of 2
## Vermont Economic Resiliency Initiative (VERI)




| Site Number | Site Description | Notes |
|---|---|---|
| 1. | Behind veterinarian's offices | Preserve existing undeveloped wetland corridor |
| 2. | Locke Field | Conserve narrow piece of Bell parcel on south bank; remove berm |
| 3. | West Brattleboro | Flood proof buildings |
| 4. | Mountain Home | Consider buyouts for at risk properties; remove berm |
| 5. | Route 9 Bridge West Brattleboro | Realign Route 9 bridge or realign the river |
| 6. | Mountain Home | Consider buyout of at risk properties |
| 7. | West Brattleboro | Flood proof buildings |
| 8. | West Brattleboro | Work with businesses to decrease impervious surfaces |
| 9. | West Brattleboro Village | Protect remaining undeveloped floodplain |
| 10. | Glen Park | Consider buyout of at risk properties; remove berms |

**Legend**

- Project Site
- Licensed Business
- Water Line in Floodplain
- Sewer Line in Floodplain
- Fluvial Erosion Hazard Zone
- Floodway
- Floodplain


Landslide Natural Resource Planning
Linking people to their landscape
P O Box 311
East Middlebury, VT 05740
Telephone: 802-388-9278




Please see Projects Table for more information.

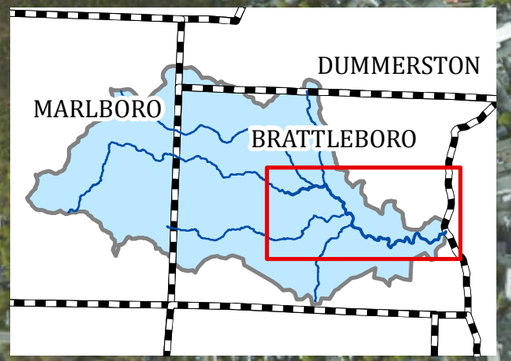
N W E S

Scale = 1"= 700'

0 350 700 1,400 2,100 Feet

January, 2015

# Projects to Protect Businesses and Infrastructure From Flooding
## Brattleboro, VT - Map 2 of 2
## Vermont Economic Resiliency Initiative (VERI)




Glen Park

11

Melrose Terrace

Farmer's Market

12

13

WESTERN AV

14

15

16

17

| Site Number | Site Description | Notes |
|---|---|---|
| 11. | West Brattleboro Village | Flood proof existing buildings in the floodplain |
| 12. | Farmer's Market | Assist Farmer's Market with relocating; remove berm; stabilize erosion on south bank |
| 13. | Throughout the project area | Remove sewer and water lines within the river channel |
| 14. | Throughout the project area | Stabilize utility poles along river corridor |
| 15. | Eastern Williams Street Bridge | Remove channel blocking sediment upstream of the downstream Williams Street Bridge |
| 16. | Cersasimo former lumber storage area | Conserve 8 acres of floodplain and remove berm |
| 17. | Downtown | Continue to flood proof downtown buildings |



**Legend**

- Project Site
- Licensed Business
- Water Line in Floodplain
- Sewer Line in Floodplain
- Fluvial Erosion Hazard Zone
- Floodway
- Floodplain

Please see Projects Table for more information.

N W E S

Scale = 1"= 700'

0 350 700 1,400 2,100 Feet

January, 2015

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# Appendix F:

# EPA Flood Resilience Checklist

# Flood Resilience Checklist

Is your community prepared for a possible flood? Completing this flood resilience checklist can help you begin to answer that question. This checklist was developed as part of the U.S. Environmental Protection Agency's Smart Growth Implementation Assistance project in the state of Vermont. More information about the project can be found by reading the full report, *Planning for Flood Recovery and Long-Term Resilience in Vermont*, found online at www.epa.gov/smartgrowth/sgia_communities.htm#rec1.

## What is the Flood Resilience Checklist?

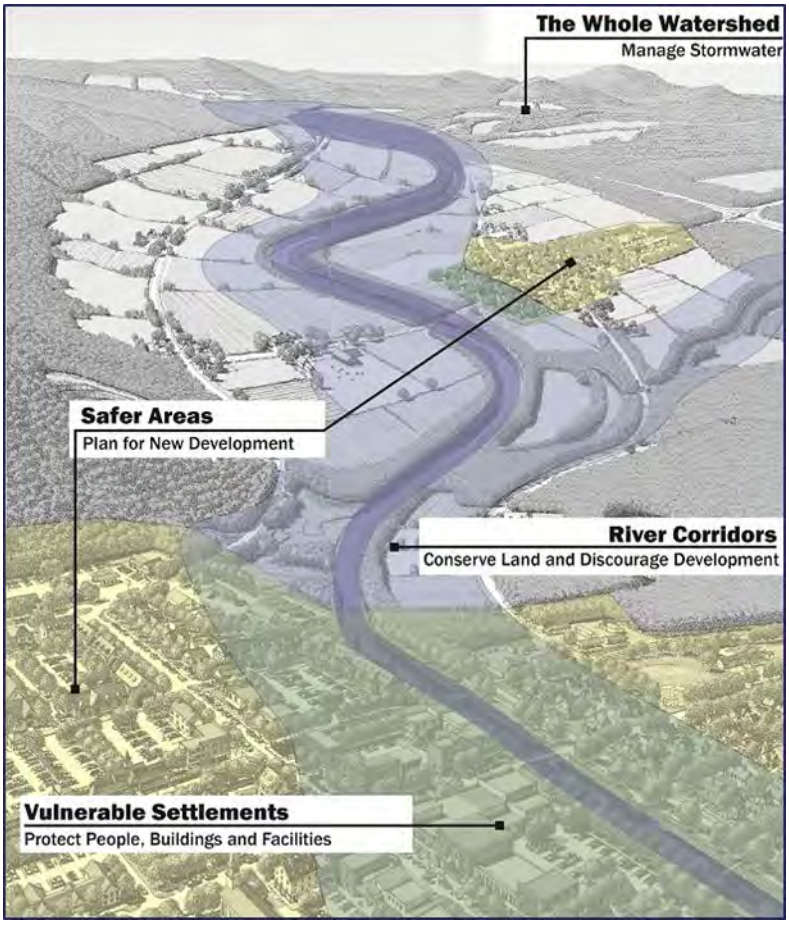
This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

## Who should use it?

This checklist can help communities identify opportunities to improve their resilience to future floods through policy and regulatory tools, including comprehensive plans, Hazard Mitigation Plans, local land use codes and regulations, and non-regulatory programs implemented at the local level. Local government departments such as community planning, public works, and emergency services; elected and appointed local officials; and other community organizations and nonprofits can use the checklist to assess their community's readiness to prepare for, deal with, and recover from floods.

## Why is it important?

Completing this checklist is the first step in assessing how well a community is positioned to avoid and/or reduce flood damage and to recover from floods. If a community is not yet using some of the strategies listed in the checklist and would like to, the policy options and resources listed in the *Planning for Flood Recovery and Long-Term Resilience in Vermont* report can provide ideas for how to begin implementing these approaches.




*This graphic illustrates the four categories of approaches to enhance resilience to future floods. Credit: Vermont Agency of Commerce and Community Development.*

# FLOOD RESILIENCE CHECKLIST

**Overall Strategies to Enhance Flood Resilience**
(Learn more in Section 2, pp. 9-11 of
*Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Does the community's comprehensive plan have a hazard element or flood planning section? | ☐ Yes | ☐ No |
| a. Does the comprehensive plan cross-reference the local Hazard Mitigation Plan and any disaster recovery plans? | ☐ Yes | ☐ No |
| b. Does the comprehensive plan identify flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas, if applicable? | ☐ Yes | ☐ No |
| c. Did the local government emergency response personnel, flood plain manager, and department of public works participate in developing/updating the comprehensive plan? | ☐ Yes | ☐ No |
| 2. Does the community have a local Hazard Mitigation Plan approved by the Federal Emergency Management Agency (FEMA) and the state emergency management agency? | ☐ Yes | ☐ No |
| a. Does the Hazard Mitigation Plan cross-reference the local comprehensive plan? | ☐ Yes | ☐ No |
| b. Was the local government planner or zoning administrator involved in developing/updating the Hazard Mitigation Plan? | ☐ Yes | ☐ No |
| c. Were groups such as local businesses, schools, hospitals/medical facilities, agricultural landowners, and others who could be affected by floods involved in the Hazard Mitigation Plan drafting process? | ☐ Yes | ☐ No |
| d. Were other local governments in the watershed involved to coordinate responses and strategies? | ☐ Yes | ☐ No |
| e. Does the Hazard Mitigation Plan emphasize non-structural pre-disaster mitigation measures such as acquiring flood-prone lands and adopting No Adverse Impact flood plain regulations? | ☐ Yes | ☐ No |
| f. Does the Hazard Mitigation Plan encourage using green infrastructure techniques to help prevent flooding? | ☐ Yes | ☐ No |
| g. Does the Hazard Mitigation Plan identify projects that could be included in pre-disaster grant applications and does it expedite the application process for post-disaster Hazard Mitigation Grant Program acquisitions? | ☐ Yes | ☐ No |
| 3. Do other community plans (e.g., open space or parks plans) require or encourage green infrastructure techniques? | ☐ Yes | ☐ No |

| FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Do all community plans consider possible impacts of climate change on areas that are likely to be flooded? | ☐ Yes | ☐ No |
| 5. Are structural flood mitigation approaches (such as repairing bridges, culverts, and levees) and non-structural approaches (such as green infrastructure) that require significant investment of resources coordinated with local capital improvement plans and prioritized in the budget? | ☐ Yes | ☐ No |
| 6. Does the community participate in the National Flood Insurance Program Community Rating System? | ☐ Yes | ☐ No |
| **Conserve Land and Discourage Development in River Corridors**<br>(Learn more in Section 3.A, pp. 14-19 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Has the community implemented non-regulatory strategies to conserve land in river corridors, such as: | | |
| a. Acquisition of land (or conservation easements on land) to allow for stormwater absorption, river channel adjustment, or other flood resilience benefits? | ☐ Yes | ☐ No |
| b. Buyouts of properties that are frequently flooded? | ☐ Yes | ☐ No |
| c. Transfer of development rights program that targets flood-prone areas as sending areas and safer areas as receiving areas? | ☐ Yes | ☐ No |
| d. Tax incentives for conserving vulnerable land? | ☐ Yes | ☐ No |
| e. Incentives for restoring riparian and wetland vegetation in areas subject to erosion and flooding? | ☐ Yes | ☐ No |
| 2. Has the community encouraged agricultural and other landowners to implement pre-disaster mitigation measures, such as: | | |
| a. Storing hay bales and equipment in areas less likely to be flooded? | ☐ Yes | ☐ No |
| b. Installing ponds or swales to capture stormwater? | ☐ Yes | ☐ No |
| c. Planting vegetation that can tolerate inundation? | ☐ Yes | ☐ No |
| d. Using land management practices to improve the capability of the soil on their lands to retain water? | ☐ Yes | ☐ No |
| 3. Has the community adopted flood plain development limits that go beyond FEMA's minimum standards for Special Flood Hazard Areas and also prohibit or reduce any new encroachment and fill in river corridors and Fluvial Erosion Hazard areas? | ☐ Yes | ☐ No |

| FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Has the community implemented development regulations that incorporate approaches and standards to protect land in vulnerable areas, including: | | |
| a. Fluvial erosion hazard zoning? | ☐ Yes | ☐ No |
| b. Agricultural or open space zoning? | ☐ Yes | ☐ No |
| c. Conservation or cluster subdivision ordinances, where appropriate? | ☐ Yes | ☐ No |
| d. Other zoning or regulatory tools that limit development in areas subject to flooding, including river corridors and Special Flood Hazard Areas? | ☐ Yes | ☐ No |
| **Protect People, Buildings, and Facilities in Vulnerable Settlements**<br>(Learn more in Section 3.B, pp. 19-26 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Do the local comprehensive plan and Hazard Mitigation Plan identify developed areas that have been or are likely to be flooded? | ☐ Yes | ☐ No |
| a. If so, does the comprehensive plan discourage development in those areas or require strategies to reduce damage to buildings during floods (such as elevating heating, ventilation, and air conditioning (HVAC) systems and flood-proofing basements)? | ☐ Yes | ☐ No |
| b. Does the Hazard Mitigation Plan identify critical facilities and infrastructure that are located in vulnerable areas and should be protected, repaired, or relocated (e.g., town facilities, bridges, roads, and wastewater facilities)? | ☐ Yes | ☐ No |
| 2. Do land development regulations and building codes promote safer building and rebuilding in flood-prone areas? Specifically: | | |
| a. Do zoning or flood plain regulations require elevation of two or more feet above base flood elevation? | ☐ Yes | ☐ No |
| b. Does the community have the ability to establish a temporary post-disaster building moratorium on all new development? | ☐ Yes | ☐ No |
| c. Have non-conforming use and structure standards been revised to encourage safer rebuilding in flood-prone areas? | ☐ Yes | ☐ No |
| d. Has the community adopted the International Building Code or American Society of Civil Engineers (ASCE) standards that promote flood-resistant building? | ☐ Yes | ☐ No |
| e. Does the community plan for costs associated with follow-up inspection and enforcement of land development regulations and building codes? | ☐ Yes | ☐ No |

| FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 3. Does the community require developers who are rebuilding in flood-prone locations to add additional flood storage capacity in any new redevelopment projects such as adding new parks and open space and allowing space along the river's edge for the river to move during high-water events? | ☐ Yes | ☐ No |
| 4. Is the community planning for development (e.g., parks, river-based recreation) along the river's edge that will help connect people to the river AND accommodate water during floods? | ☐ Yes | ☐ No |
| 5. Does the comprehensive plan or Hazard Mitigation Plan discuss strategies to determine whether to relocate structures that have been repeatedly flooded, including identifying an equitable approach for community involvement in relocation decisions and potential funding sources (e.g., funds from FEMA, stormwater utility, or special assessment district)? | ☐ Yes | ☐ No |
| **Plan for and Encourage New Development in Safer Areas**<br>(Learn more in Section 3.C, pp. 26-27 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Does the local comprehensive plan or Hazard Mitigation Plan clearly identify safer growth areas in the community? | ☐ Yes | ☐ No |
| 2. Has the community adopted policies to encourage development in these areas? | ☐ Yes | ☐ No |
| 3. Has the community planned for new development in safer areas to ensure that it is compact, walkable, and has a variety of uses? | ☐ Yes | ☐ No |
| 4. Has the community changed their land use codes and regulations to allow for this type of development? | ☐ Yes | ☐ No |
| 5. Have land development regulations been audited to ensure that development in safer areas meets the community's needs for off-street parking requirements, building height and density, front-yard setbacks and that these regulations do not unintentionally inhibit development in these areas? | ☐ Yes | ☐ No |
| 6. Do capital improvement plans and budgets support development in preferred safer growth areas (e.g., through investment in wastewater treatment facilities and roads)? | ☐ Yes | ☐ No |
| 7. Have building codes been upgraded to promote more flood-resistant building in safer locations? | ☐ Yes | ☐ No |

# FLOOD RESILIENCE CHECKLIST

**Implement Stormwater Management Techniques throughout the Whole Watershed**
(Learn more in Section 3.D, pp. 27-31 of *Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Has the community coordinated with neighboring jurisdictions to explore a watershed-wide approach to stormwater management? | ☐ Yes | ☐ No |
| 2. Has the community developed a stormwater utility to serve as a funding source for stormwater management activities? | ☐ Yes | ☐ No |
| 3. Has the community implemented strategies to reduce stormwater runoff from roads, driveways, and parking lots? | ☐ Yes | ☐ No |
| 4. Do stormwater management regulations apply to areas beyond those that are regulated by federal or state stormwater regulations? | ☐ Yes | ☐ No |
| 5. Do stormwater management regulations encourage the use of green infrastructure techniques? | ☐ Yes | ☐ No |
| 6. Has the community adopted tree protection measures? | ☐ Yes | ☐ No |
| 7. Has the community adopted steep slope development regulations? | ☐ Yes | ☐ No |
| 8. Has the community adopted riparian and wetland buffer requirements? | ☐ Yes | ☐ No |

# Appendix G:

# Table of Municipal Policy and Program Recommendations

# Brattleboro

**Town-wide Policy and Program Options**

**Vermont Economic Resiliency Initiative (VERI)**

**Legend**

● Effective ◒ Limited ○ Ineffective

* Priority rating based on degree of community benefit

| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Land Use Regulations** | | | | | | | | | | |
| Consider prohibiting new development in mapped flood hazard area. | **High** | ● | ◒ | ● | Medium | < $10K | WRC, ANR | MPG | New development in the floodplain puts owners at risk, and reduces available floodplain - this raises the flood heights and puts emergency responders, residents and downstream property owners at risk. While the flood hazard portion of the zoning bylaw already requires elevation to one foot above BFE and prohibits development, fill and construction, or net increase of impervious surface in the floodway, it should be considered to prohibit all new development from the mapped flood areas. | Contact Town Planner and Planning Commission |
| Consider regulating development in fluvial erosion hazard areas. | **High** | ● | ● | ● | Medium | < $10K | WRC, ANR | MPG | · Much of the flood damage in Vermont is caused by bank erosion from swollen rivers within river corridors. Stream banks can fail causing structures to be undermined or fall into the river. Changes that steer development away from fluvial erosion hazard (FEH) areas help communities qualify for a higher state disaster recovery (ERAF) assistance rate. Consider adding FEH regulations for development in the mapped river corridor into the flood overlay section of the zoning bylaw. | Contact Town Planner and Planning Commission |
| Limit improvements after the flood. | **Medium** | ● | ◒ | ● | Medium | < $10K | ANR, DEMHS | MPG | When rebuilding after a flood, property owners should limit their improvements to their flood prone properties so any expansions do not create additional hazards to the community. These limits can be added to the development standards portion of the flood hazard section of the zoning bylaw. | Contact Town Planner and Planning Commission |
| Monitor rebuilding after a disaster. | **High** | ● | ◒ | ● | Medium | < $10K | WRC, FEMA | MPG | People want to return to normal as quickly as possible after a disaster and neighbors and the community can help them do just that but local officials, such as the zoning/floodplain administrator and code enforcement officer, need to monitor their work to ensure that it is not in violation of town and federal regulations. Without close monitoring, improper rebuilding may result in future federal disaster funding being unavailable for the town and its residences and businesses. | Contact Town Planner and Planning Commission |
| Ensure secondary access for large developments. | **High** | ◒ | ◒ | ● | Medium | Paid for by businesses | Local businesses | MPG | Consider regulations requiring two access roads for any new large development will help ensure access during hazard events. Some developments have become inaccessible during emergency events when a lone access was damaged, destroyed or blocked. | Contact Town Planner and Planning Commission |
| Provide incentives to regenerate. | **Medium** | ● | ● | ● | Medium | Depends on scale of incentives | Local businesses, ANR, County Forester | MPG | Consider adopting incentives for restoring vegetation in areas susceptible to flooding. Vegetation is an important part of the floodplain, helping to stabilize it and prevent erosion. Encouraging restoration through providing incentives, financial or otherwise, will increase the amount of vegetation in areas that particularly need it. Additionally, established vegetation will discourage landowners from putting structures in areas that are most susceptible to flooding. | Contact Town Planner and Planning Commission |
| Consider regulating areas of earth disturbance by means such as grading and vegetation clearing on slopes greater than 15%. | **High** | ○ | ● | ● | Easy | < $10K | WRC, Consultants, ANR | MPG | These areas are particularly susceptible areas that should be kept out of development to prevent erosion and lessen vulnerability. | Contact Town Planner and Planning Commission |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

## Brattleboro

**Town-wide Policy and Program Options**

**Vermont Economic Resiliency Initiative (VERI)**

**Legend**

● Effective ◒ Limited ○ Ineffective

* Priority rating based on degree of community benefit

| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Town Plan** | | | | | | | | | | |
| The next update to the Town Plan should include a cross reference and discussion of the hazard mitigation plan. | **Medium** | ◒ | ◒ | ● | Easy | < $10K | WRC, Consultants | HMGP grants | The hazard mitigation plan is currently in draft form, but will be approved and should be considered when doing the next town plan update. | Contact Town Planner and Planning Commission |
| The next update to the Town Plan should include a more comprehensive flood resiliency/planning section that identifies flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas. | **Medium** | ● | ◒ | ● | Easy | < $10K | WRC, Consultants | HMGP grants | The current plan does a good job of discussing flood hazards and reducing the impact of flooding and erosion. The state now recommends that a new flood resiliency chapter or element be added to all town plans. | Contact Town Planner and Planning Commission |
| Hazard Mitigation Plan goals should consider development of green infrastructure. | **Medium** | ● | ● | ◒ | Easy | < $10K | DEMHS, FEMA | HMGP grants | Green infrastructure provides a natural and low-tech way to control and lessen stormwater and floodwater. | Contact Town EMD |
| Document damages from flood events. | **High** | ◒ | ◒ | ● | Easy | < $10K | Vtrans, WRC | MPG | · Disasters are easily forgotten over time and damages from the 2011 floods as well as other smaller recent rain and flood events should be documented. This will help the community consider the implications of new investments in areas damaged by floods. The state now recommends that a new flood resiliency chapter or element be added to all town plans. | Contact Town EMD |
| Document road, sewer, and water infrastructure vulnerabilities in municipal and capital plans. | **High** | ◒ | ◒ | ● | Medium | < $10K | Vtrans, WRC | MPG | · Specific areas that were damaged or have known vulnerabilities should be documented so the community can plan for their replacement in their long-term budgets, easing the impact on taxpayers. Capital programs and budgets are not common in smaller towns but the local Selectboard may start this process with a list and a capital reserve fund. More detailed budgets and plans can be developed with the help of your RPC and financial advisors. | Contact Conservation Commission |
| Identify areas for conservation. | **Medium** | ● | ● | ● | Easy | < $10K | Corridor Plans identify these areas, Land Trusts, ANR | MPG | · The Whetstone Brook Corridor Plan and the Crosby Brook both identify potential riparian easement sites. The Conservation Commission can identify and work with willing landowners to establish those riparian easements to prevent future development in flood-prone locations. | Contact Conservation Commission |

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| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Emergency Planning** | | | | | | | | | | |
| Ensure that town staff is kept up to date on all training requirements. | **High** | ◒ | ◒ | ● | Easy | < $10K | DEMHS, LEPC 6 | MPG | NIMS/ICS training for senior staff and continuing training for emergency responders: training will facilitate coordination of town and multi-agency response to local or regional hazards. Town is coordinating training with other local agencies, including Brattleboro and regional schools. | Work with local committee |
| Maintain the energy around school crisis planning. | **High** | ◒ | ◒ | ● | Easy | < $10K | Police Department, Fire Department, School Administration, etc. | MPG | · Brattleboro has been a key partner in facilitating a multi-agency planning effort to update the School Crisis Plan with table top exercises, staff training, and planned drills. The training effort includes identifying, purchasing and staging materials needed for an emergency response. The plan has become a model in the state. Continue to work collaboratively with the school district to maintain the plan. | Contact Town Emergency Management Director and Principal |
| Set up appropriate list serves for use during emergencies. | **Medium** | ◒ | ◒ | ● | Easy | < $10K | None needed | HMGP grants | · The ability to reach a number of people at once is the primary benefit of VT Alert. Examples of who could be included are town staff, school personnel, business owners, regional commission staff, public infrastructure staff, and residents. Various lists can be set up for specific purposes or types of emergencies. | Work with town Emergency Management Director. |
| Identify structures in the dam inundation area for emergency alerts. | **Medium** | ● | ◒ | ● | Easy | < $10K | WRC | HMGP grants | · There is a mapped dam inundation area for dam breaks on the West River. The map also captures inundation risks for most areas of Brattleboro for a dam break on the Connecticut River. An inundation wave will take an hour or more to propagate downstream to Brattleboro. The use of the Code Red public mass notification system to alert residents of structures at risk will reduce loss of life. | Work with town Emergency Management Director. |
| Create a Drought Response Plan. | **Low** | ◒ | ◒ | ● | Medium | < $10K | WRC | HMGP grants | · In the past, drought response has been ad hoc. Creating a policy will help identify appropriate conservation actions for given drought conditions. The policy can outline public outreach actions. Adequacy of backup water supplies will be examined. | Work with town Emergency Management Director. |
| Develop protocol for collecting and maintaining records of damage information. | **High** | ● | ◒ | ● | Easy | < $10K | WRC, DEMHS | EMPG | · Information about past damage, including repair costs, is pivotal in doing Benefit Cost Analysis (BCA) for grant funded projects down the road. Having the data available at hand will make life easier and will put Brattleboro in a better position to receive funding for hazard mitigation projects. | Work with town Emergency Management Director. |

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| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Emergency Planning** | | | | | | | | | | |
| Keep Local Emergency Operation Plan (LEOP) updated each year. | **High** | ◒ | ◒ | ● | Easy | < $10K | WRC, DEMHS | EMPG | During a disaster, having quick access to the local public and private contacts in town for all of the critical systems and vulnerable populations is indispensable. The LEOP should include the local private water utility and municipal sewer superintendents in the contacts section. | Work with town Emergency Management Director. |
| Develop a local recovery plan and fund. | **High** | ◒ | ◒ | ● | Easy | < $10K | None needed | VT Community Foundation | · Towns will recover much more quickly after a disaster if they can marshal their own resources. Federal and state money will come, but these funds are slow to arrive. A local household and business small grant and loan fund is proven to speed recovery efforts. | Work with town Emergency Management Director. |
| Develop a local retrofit fund. | **Low** | ◒ | ◒ | ● | Easy | < $10K | None needed | VT Community Foundation | · Again state and federal grants take time and may not be available for small projects. As part of the recovery or pre-disaster mitigation plan and fund, towns could offer mini grants for retrofits such as backflow preventers (that keep stormwater and sewage from flooding buildings via the draining system), elevation of exterior utilities, and flood barriers for doors. | Reach out to schools and community groups. |
| Continue to participate in the Community Rating System and work to achieve a higher rating. | **High** | ● | ◒ | ● | Easy | < $10K | WRC, DEMHS, FEMA | HMGP grants | · Brattleboro should apply for a higher rating within CRS based on land preservation efforts, outreach efforts, elevation certificates, higher standards in the floodplain ordinance, and stormwater regulations. A higher rating will mean better flood insurance rates for residents and businesses. | Contact Town Planner and /or Zoning Administrator |
| **Education and Outreach** | | | | | | | | | | |
| Help businesses plan for disasters. | **High** | ● | ◒ | ● | Easy | < $10K | WRC, DEMHS | HMGP grants | If a home is damaged or washed away, occupants can go stay in a hotel, with friend or family, or find a rental. When a business is flooded, it is much harder or impossible to relocate. Continuity of operations plans outlines the steps business can take during and after a disaster to reduce disruption and losses. | Offer continuity of operations planning training for businesses. |
| Educate landlords and contractors about flood resilience. | **Medium** | ● | ◒ | ● | Easy | < $10K | WRC, DEMHS | HMGP grants | · Many landlords and contractors may not understand the requirements for rebuilding after a flood. Specific standards must be met to maintain eligibility for flood insurance and other federal grants. Education programs are critical component to raising awareness. | Reach out to landlords and contractors. |
| Promote and educate property owners on the value of flood insurance. | **Medium** | ● | ◒ | ● | Easy | < $10K | WRC, DEMHS | HMGP grants | · Homeowners insurance does not pay for any flood related damage. Only flood insurance does. In Brattleboro, only 44% of buildings in the flood hazard area have flood insurance. | Gather NFIP materials and set up training for realtors and other groups |

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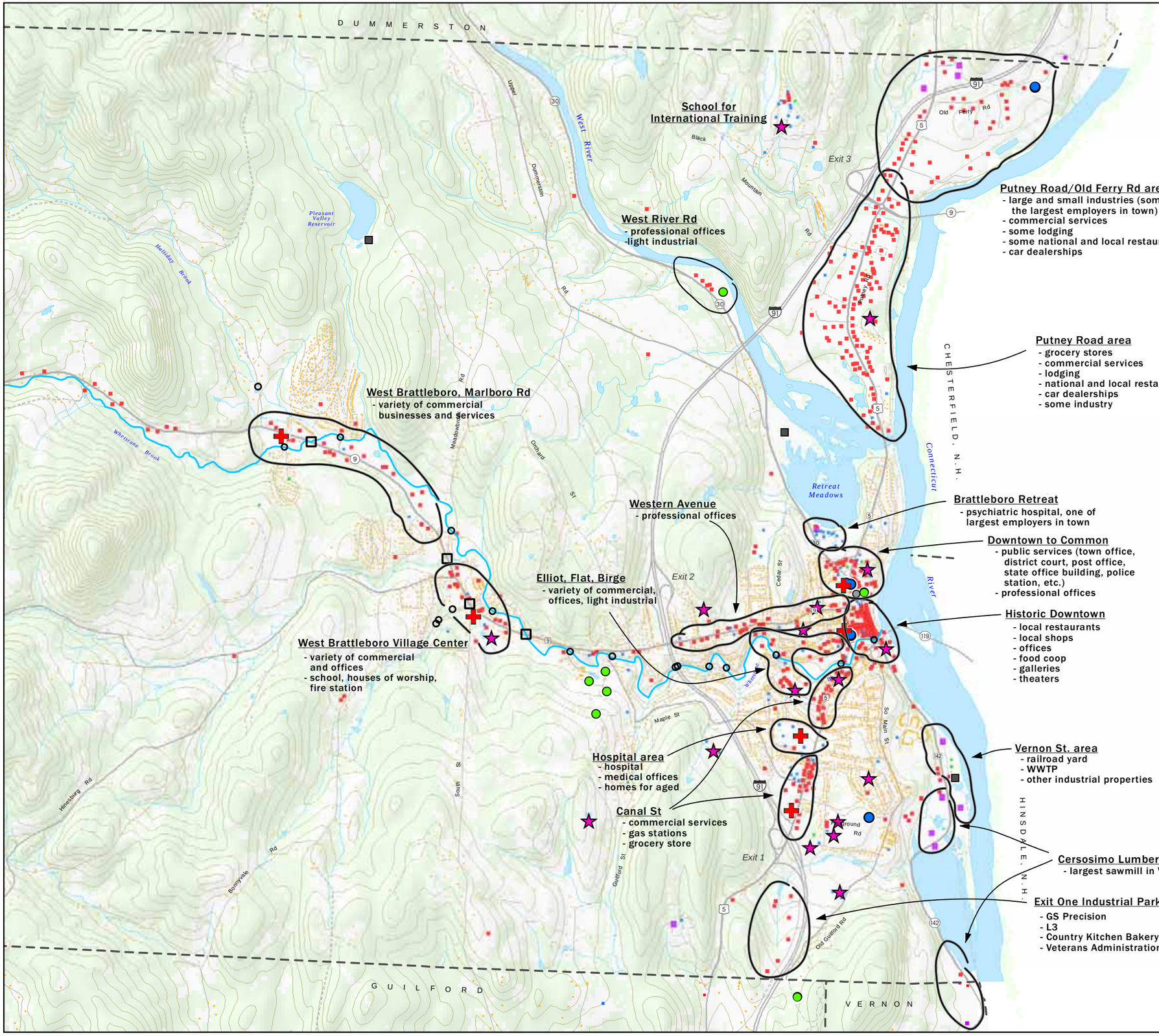
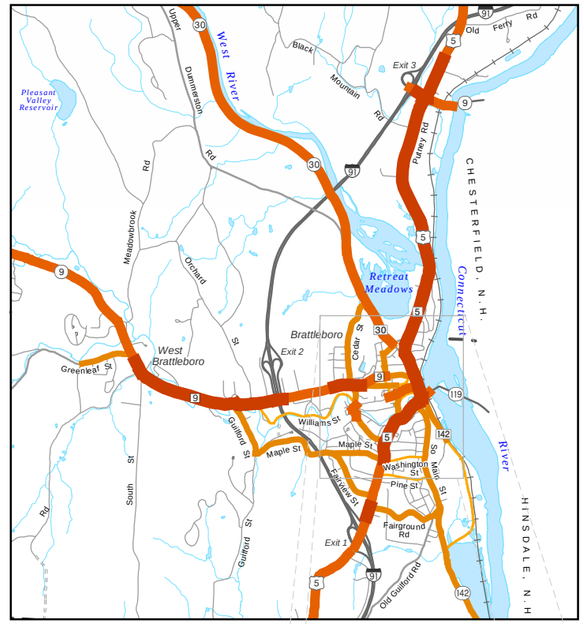
# Appendix H:

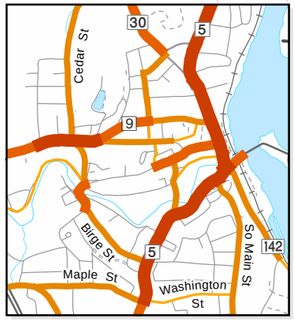
# Economic Zones Map




Average Daily Traffic, vehicles per day:

- 490 - 2000
- 2001 - 5000
- 5001 - 12000
- 12001 - 24600




Downtown inset

- Government/municipal services
- Cultural, educational, health
- Commercial
- Industrial
- Residential
- Unknown/other

## Municipal Facility:

- municipal services
- public safety/health services
- education
- parks/recreation
- utility
- other

## Bridges in Whetsteon Corridor:

- Route 9
- other roads

# Appendix I:

# Bridge Summary Table

| Reach | Bridge # | Road Name | Span | Channel Width | Bankful Width | Post Irene Note | VTRANS Inspection |
|---|---|---|---|---|---|---|---|
| M07 | 60 | Westgate Drive | 26' | 36' | 52' | minor erosion; armored corners of bridge | 9/6/2012 'structure is in good condition. Channel repairs should be made up and downstream.' |
| M07 | 51 | Route 9 | 76.3' | 36' | 52' | minor erosion; state armored bridge' | 6/6/2013 Both skeleton abutments filled in with concrete between the legs to help stop the undermining. Pavement should be removed and deck repaved in the near future. More riprap should be install on the banks up and downstream. |
| M06C | | Detman Drive | 52' | 47' | 38.5' | None | None |
| M06B | 11 | Meadow Brook | 47' | 47' | 50.6' | minor erosion at bridge' | 9/6/2012 'structure is in good condition' |
| M05A | 58 | George F. Miller Drive | 57' | 54' | 60' | 'minor erosion; added stone' | 9/6/2012 'structure is in good condition sidewalks should be clean of all loose material and patched' |
| M05A | 54 | Route 9 | 55' | 54' | 60' | 'minor erosion; added stone' | 6/17/2013 'structure is in fair to good condition. Stone should be added to the south end of the arch to help stop the scour.' |
| M04 | 51 | Brookside Drive | 42' | 55' | 52' | None | 9/6/2012 'structure is in good condition' |
| M04 | 30 | Guilford Road | 90' | 55' | 61'/52' | None | 6/19/2014 'structure is in good condition'; 6/28/2012 ;structure is in good condition. New in 2010'; 11/2/2011 'minor washout on abutment2 upstream bank and abutment 1 downstream bank from hurricane Irene.' |
| M02 | | I91 | | 56' | 67' | | New in 2013 |

| Reach | Bridge # | Road Name | Span | Channel Width | Bankful Width | Post Irene Note | VTRANS Inspection |
|---|---|---|---|---|---|---|---|
| M02 | 34 | Williams Street (west) | 96' | 56' | 67' | SW abutment washed out, did some stone armoring | 6/19/2014 'structure is in good condition. Beams should be spot cleaned and repainted. |
| M02 | 35 | Williams Street (east) | 103' (functionally 52' due to sediment in right opening) | 56' | 67' | washout behind E abutment, hole in bridge, bridge closed for several weeks | 6/19/2014 'gravel bar should be removed from the upstream channel. Beams could be spot cleaned and painted. Should consider repaving soon. Curbs should be cleaned and patched. 6/28/2012 Abutments should be monitored after high water. |
| M01D | 31 | Elliot | 87' | 56' | 60' | None | 6/19/2014 Deck will need rehab in the near future. Both laidup stone abutments could use some morter work. Beams should be cleaned and painted. Tubing rail should be repaired and repainted. 6/28/2012 Structures deck will need to be rehabbed. |
| M01B | 32 | Elm | 85' | 56' | 54' | None | 6/23/2014 Structure is in good condition. Spindles on the bridge rail should be repaired. |
| M01A | 7 | Main Street | 61' | 65' | n/a | None | 5/22/2013 Structure is in good condition. The small delams on the downstream fascia should be cleaned and patched. |

# Appendix J:

# Eastern Williams Street Bridge Conceptual Design

# Eastern William Street Bridge (B35, at West Street) sediment management (Site 15)

## Overview and Objectives

The total bridge span of 103' is adequate to pass the channel forming flow (bankfull width is 67') however, sediment has built up in the right (facing downstream) opening allowing water to pass only in the 52' wide left side opening.
Removing sediment from upstream of, and in the right (facing downstream) opening of the bridge will decrease the likelihood of this bridge being damaged or washed out during a flood event. Williams Street provides redundancy in the transportation connection to the downtown.


**Figure 10:** Easterly Williams Street Bridge 2008

By increasing channel and bridge capacity, the project will reduce the potential impact of debris jams during a flood event and reduce the erosive energy moving through the bridge (Figure 11). This project was identified during the site visit in September of 2014 and also called for in a VTRANS bridge inspection done June, 2014 (VTRANS, 2014) which also suggests monitoring of the abutments following high water. Approximately 450 cubic yards of material would need to be removed at $10/yard ($5,000). Permitting and planning would be an additional $5,000.

## Steps for Project Implementation

Landowner outreach would be the first step to move this project forward as permission for site access is needed. (NOTE: There is an old access area upstream of the jam site that could be utilized). The next step would be to identify sources of and apply for funding. There is a need to field measure the volume of material to be removed. All necessary state and federal permits would be required, including additional assessment of disturbance to rare, threatened, or endangered species and an archeological evaluation. An area for, or a use of, removed material would need to be located and the project put out to bid and implementation overseen.

**Figure 11:** Easterly Williams Street Bridge excavation area

Undertaking no action at this site is likely to lead to increased scour and possibly to undermining of the currently sound bridge structure.

## Project Benefits

The implementation of this project is anticipated to provide benefits for reducing flood risks in Brattleboro. These benefits include:

- Maintain redundancy in the transportation network to greater than 60 businesses and more than 500 employees downtown;
- It is a relatively easy project that can build on past successes; and
- It will improve channel capacity, reducing the possibility of a debris jam causing water and sediment to back up and flood upstream areas.

# Appendix K:

# Housing Study

# MEMORANDUM

TO: Adam Hubbard, Stevens & Associates

FROM: Roy Schiff and Jessica Louisos, Milone & MacBroom

DATE: June 15, 2012

RE: Whetstone Brook

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## Introduction

An alternatives analysis has been performed to reduce flood risks along Whetstone Brook in West Brattleboro, Vermont as part of a redevelopment project being undertaken by the Brattleboro Housing Authority. Existing data were reviewed and field reconnaissance was performed to inform the analysis.

The primary project site is approximately 2 miles of Whetstone Brook and its floodplain between the Dettman Drive and Route 9 Bridges in West Brattleboro. The area has mixed land use that includes commercial and residential development, agricultural fields, and woods. Repeated flooding occurs at the project site. Much of the improved public and private infrastructure is located in the river corridor where a FEMA mapped floodway and floodplain exist. (The floodway is the primary flow area during a large flood and the floodplain is the extent of the inundation during the flood.) Alternatives are being explored at two housing complexes – Melrose Terrace and Hayes Court – to reduce flood risks and repeated damages at flood-prone structures. Alternatives are also being considered at Glen Park and Mountain Home Mobile Home Parks, as well as other locations in the river corridor.

## Whetstone Brook

Whetstone Brook (watershed area ~ 28 square miles) is a mountain stream that originates in Marlboro and flows east through Brattleboro to the Connecticut River. The channel setting follows a trend that is common in Vermont where a steep channel flows out of the mountains in a narrow valley and then enters a broader valley where the slope of the channel decreases. The slope of Whetstone Brook is around 4% in upstream reaches and then it drops to 2.0% approaching the West Brattleboro project site, and is near 0.5% at the project site (Sheldon, 2008). Full natural valley width is 150 feet in the upper watershed and grows to around 1,000 feet near the project site (Figure 1). As the channel slope declines and the valley broadens, floodplains form and sediment deposition takes place leading to a channel that is likely to move around the landscape during floods. Channel movement is closely linked to sediment bar formation in deposition areas (FHWA, 2001). Many Vermont villages are located in these areas with some of the highest risks of flood and channel erosion hazards due to historic land use patterns.

The flatter locations with wide valleys are often confluence locations where two river channels join. Confluence areas such as where Ames Hill Brook and Halladay Brook join Whetstone Brook are known to be some of the most flood-prone areas on the landscape. Confluence locations are known to be dynamic due to abrupt changes in flow, sediment transport, channel shape, and flood hydraulics that can result in increased erosion and deposition (Benda et al., 2004).

Many Vermont valleys that were formed by river erosion now contain permanent infrastructure leading to a high degree of unnatural valley narrowing (i.e., confinement or floodplain encroachment). Channel confinement in the Whetstone Brook river corridor at the project site is 60% of the full valley width on average, with a local maximum of 80% in several locations. Confinement also exists in the upstream narrow corridor due to the presence of Route 9 (35%) and downstream in Brattleboro (75%). Confined channels tend to be more erosive and unstable than those connected to floodplains. Narrowing of the valley due floodplain development has set the stage for repeat damages during floods on Whetstone Brook.

Efforts to protect Vermont villages and roads have been taking place for centuries that include channel straightening, berming, bank armoring, sediment dredging, and moving out of the floodplain. The limited success of many of the historic active channel approaches that are costly to implement after each flood has led to a recent increase in the consideration and implementation of alternatives to remove flood-prone structures from floodplains and conserve these areas to permanently minimize future risks. In many Vermont villages that have abundant infrastructure exposed to flood and erosion risks, a mix of alternatives is needed to reconnect available floodplains while safeguarding improved property that will remain in the river corridor.

History shows that on average damaging floods tend to occur on Whetstone Brook every 30 years (Sheldon, 2008). The response to these events has left many reaches straightened and isolated from natural floodplain areas due to berming to protect improved property. For example, 5 miles of the 13-mile long channel (40%) has been straightened in the past. Much of the existing floodplain along Whetstone Brook contains roadways and buildings, and thus there is no safe place for the channel to drop sediment, store flood waters, and dissipate energy during flooding. On average, 20% of the floodplain cross sectional area is filled with infrastructure at the project site (Figure 2). The current project provides an opportunity to consolidate housing and re-connect historic floodplain to reduce future flood risks. The more floodplain available for flood water and sediment storage, the less flood damages will take place.

**Tropical Storm Irene**

A large flood took place on Whetstone Brook on August 28, 2011 during Tropical Storm Irene. Stream gauges do not exist on the brook, so flood estimations and regional flood data were reviewed to estimate the size of the flood. The predicted 100-year flood (i.e., the flood that has a 1% chance of occurring in each year) is 7,400 cubic feet per second (cfs) based on the effective FEMA flood insurance study (FEMA, 2007). Another estimate using the USGS StreamStats equations (Olson, 2002) indicates the 100-year peak flood on Whetstone Brook is 3,000 cfs (prediction range of 1,500 to 6,000 cfs).

Some of the highest rainfall amounts in Vermont during Tropical Storm Irene took place in the headwaters of the Whetstone Brook watershed. National Weather Service data indicate that more than 8 inches of rain fell in some mountain areas of Windham and Bennington Counties. The nearest USGS gauges on the Walloomsac River and Saxtons River both recorded floods of record since data collection began. The flow on the Saxtons River was 14,700 cfs (larger than the 100-year flood) and the peak flow on the Walloomsac River was 9,420 (estimated to be an 85-year flood). These data indicate that the 2011 flow on Whetstone Brook was possibly 5,000 cfs and likely between a 50- and 100-year flood.

Several previous flood studies have been performed along Whetstone Brook (See Sheldon, 2008). One study (USACE, 1972) illustrates the level of the 100-year (i.e., intermediate regional) flood. Flood waters are predicted to rise to nearly 3.5 feet above the ground surface at the upstream end of Melrose Terrace and Glen Trailer Park during the 100-year flood (Figure 3). The water marks on buildings after Irene observed in May were 1 to 2 feet from the ground providing verification that the flood was likely between a 50- and 100-year event.

Some of the observed flood water surface elevations around Vermont during Irene were higher than flow data would suggest due to many channels being filled with sediment from erosion in the mountains. As sediment reached flatter areas in Village centers deposition took place reducing flood conveyance and flood waters spilled out of the banks often cutting a new channel path (i.e., channel avulsion took place). A channel avulsion occurred at the upstream limit of the Melrose Terrace property where deposited sediment redirected the channel to flow over the flood wall and down the non-river side of Melrose Street. Avulsions due to sediment erosion and deposition do not follow normal inundation-based flood mapping and create unique flood patterns. For example, several properties in the 500-year floodplain at Melrose Terrace were damaged as water flowed along their foundation to find a path back to the main channel while some properties in the floodway had less damage.

A map showing the extent of flooding along Whetstone Brook during Tropical Storm Irene does not exist. Flooding, avulsion, and erosion led to river corridor damages. Portions of Route 9 were washed out in the confined valley upstream of West Brattleboro. Sediment deposition caused channel avulsion and flooding in the wider floodplain areas in the vicinity of the West Brattleboro project leading to damage of many structures. Downtown Brattleboro was flooded approaching the Connecticut River, severely impacting the downtown area. Many mobile homes, residential buildings, and commercial structures were damaged.

**Alternatives Analysis**

As the Brattleboro Housing Authority considers plans for updating and expanding units at Melrose Terrace and Hayes Court, and possibly in conjunctions with changes at Glen Park and Mountain Home, the recent flood has illustrated the need to carefully consider residential development alternatives in the context of Whetstone Brook and its floodplain. The current project provides an opportunity to reduce flood and erosion risks to provide safer housing in the area. Several flood protection and flood avoidance alternatives have been explored to see how each achieves the following project objectives:

- Reduce flood risks;

- Reduce erosion risks;
- Eliminate flood-prone structures that are repeatedly damaged;
- Maximize the number of housing units;
- Protect existing structures from flooding;
- Re-connect historic floodplain where possible;
- Maximize the ease of construction;
- Develop a project with straight forward permitting needs; and
- Control project costs.

A mix of floodplain re-connection and structural flood protection are being explored and it is likely that a combination of approaches will be needed to address the abundance of improved infrastructure that is prone to flooding at the project site as well as the limited available space for the housing stock that the Housing Authority is seeking to improve. Although not directly addressed in this analysis, new structures should contain the most aggressive floodproofing methods possible to limit future damages in the flood-prone Whetstone Brook corridor. For example, utilities should be raised above design flood level. Parking lots could be located on the first floor of larger buildings to limit damages when flooding and sediment deposition do take place.

The actions taken in West Brattleboro are important to break the cycle of channel confinement, flood damage and costly channel management that have dominated this area and many other locations across Vermont. The preferred alternative must reduce channel confinement and must not lead to increased flooding and erosion downstream in the developed river corridor that includes downtown Brattleboro.

Melrose Terrace (See Figure 4 and Table 1)

Alternative 1: No Action

The no action alternative maintains the current housing stock of eighty residential units, yet is not recommended due to the persistence of flood-prone conditions along Whetstone Brook described above.

Alternative 2: Improve Flood Wall

Improving the existing flood wall along Whetstone Brook would provide structural flood protection to the complex. The wall would need to be tied into the higher ground at the valley wall location on the abutting property upstream of the property. The flood wall at the upstream end of the property would need to be taller to prevent a channel avulsion at Melrose Street. The gaps in the existing wall would need to be connected.

A taller and more complete wall would reduce aesthetics at the site making a more formidable barrier between the channel and homes. Flood risks would remain at the local project site due to the persistence of 80% narrowing of the valley and structures being located in the floodway and floodplain. The wall would be under threat of frequent erosion and thus would need to have a robust design. Downstream flood risks would increase if a larger flood wall was built at the

project site as the flood waters, sediment, and erosive power released during avulsion would be transferred downstream. Flood risks would increase at George F. Miller Bridge.

The alternative of solely building an improved flood wall between Melrose Terrace and Whetstone Brook is not recommended as the negatives outweigh the positives.

Alternative 3: Remove Buildings in Floodway and Construct New Flood Wall at Upstream End of the Property

This alternative attempts to balance flood risk reduction and maintaining housing units by removing the structures that are likely most vulnerable during floods and installing a new flood wall to limit the chances of channel avulsion through the project site. Seven buildings and the existing flood wall would be removed from the floodway. A new flood wall would be constructed approximately 100 feet back from the river channel along the edge of the floodway from the upstream valley wall to the George F. Miller Bridge. The adjacent upstream landowner would have to partner on this alternative as the flood wall would cross that property.

Removal of the buildings would eliminate the flood-prone structures, open up 1.9 acres of floodway and low floodplain for the brook, and increase the width of the valley that can be occupied by the brook without property damage by 95 feet. Downstream flood risks would be reduced due to the re-connection of new floodplain.

The down side of this alternative is that seven existing residential buildings would be removed from the local housing stock and would need replacement. Remaining buildings at Melrose Terrace would still be exposed to some flood risk given their location in the fluvial erosion hazard zone and floodplain. The taller flood wall on the upstream end of the property would reduce aesthetics. Permitting the construction of new residential buildings in the flood-protected area would be complicated due to the history of flooding in the area and the fact that many of the new buildings would remain in the fluvial erosion hazard zone and regulated floodplain.

The alternative to remove structures from the floodway and construct a new flood wall is not recommended. Although this approach would result in both re-connected floodplain and a location to build safer housing, the extreme level of confinement that exists in this area suggests that pulling farther away from the river is desired to allow for a safer and more beneficial redevelopment project.

Alternative 4: Remove Buildings in the Fluvial Erosion Hazard Zone and Construct New Flood Wall at Upstream End of the Property (Preferred)

This alternative attempts to reduce flood and erosion risks while maintaining existing housing units that could be improved in the future. Buildings in the floodway and the Vermont fluvial erosion hazard zone that are most vulnerable to damage would be removed. A flood wall would be constructed along the upstream portion of the fluvial erosion hazard zone boundary to limit the chances of channel avulsion. Eleven Melrose Terrace residential buildings would be removed from the floodway and fluvial erosion hazard zone. The flood wall would pass near the

house on the upstream adjacent property so this property would likely need to be purchased and the building removed as part of this alternative.

The building removals would eliminate flood-prone structures from the location where the river is expected to be the most dynamic. Floodplain would be re-connected over 4.4 acres, and 140 feet of valley width would be re-connected to the channel.

This alternative further cuts into the available housing above previous alternatives and thus replacement of the existing units would be essential. This alternative would be a good path forward for a site-level redevelopment project where the combination of floodplain re-connection and new flood wall would create a safer housing setting to locate several structures.

The compromise between housing and reduced flood risks associated with this alternative is appealing. Although floodplain fill would likely take place and some flood hazards would remain, this alternative would be an important step in a positive direction to reduce local and downstream flood risks. Maintaining an open fluvial erosion hazard zone would likely lead to simplified permitting and gather support for the project at the local, state, and federal level. Removing buildings in the fluvial erosion hazard zone and constructing a new flood wall is the preferred alternative.

Alternative 5: Remove All Existing Buildings and Construct Large Residential Building Outside of the Floodplain

Removing all buildings in the floodway, fluvial erosion hazard zone, and 100-year floodplain and building a large residential building near the slope at the back of the project area would provide great benefits to flood and erosion risk reduction. Over 5.9 acres of floodplain would be reconnected and the channel would be able to safely occupy 315 feet of its valley, or nearly half of the natural valley width. Flood walls would not be needed since all flood-prone buildings would be removed and thus a large area for flood water and sediment storage would be established. This alternative would reduce downstream flooding.

Eliminating all existing housing units at Melrose Terrace is a negative aspect of this alternative. Beyond the proposed large building at the back of the property more units would need to be re-located to cover the housing need. An adjacent property along the slope may need to be purchased to provide adequate space for a building that is large enough to justify the development.

Although this alternative is excellent in terms of flood risk reduction, it is not preferred given the large loss of housing.

Alternative 6: Remove All Existing Buildings and Abandon Site

The alternative of abandoning the Melrose Terrace site is not recommended as there appears to be an area where a sound compromise of flood risk reduction and providing safe housing exists. Limited locations to provide housing in West Brattleboro illustrate the need to maximize use of

available space – as long as the space is expected to be acceptably safe from future flood damage.

Alternative 7: Enlarge George F. Miller Drive Bridge

The FEMA flood profile illustrates that the George F. Miller Bridge backs up water and elevates flood levels during the 50-, 100-, and 500-year floods. The bridge is located near several buildings in the floodway and floodplain that also constrict flow during flooding. The combination of the bridge and the floodplain development make this location especially prone to flood damage. No safe flood path exists once the bridge opening is filled with water, sediment, and debris during a flood.

Flood waters are elevated from the bridge to the upstream extent of the Melrose Terrace property. Widening the structure would reduce local flood levels and improve sediment transport. Bedrock exists around the bridge and the rock controls the channel bottom elevation so it cannot cut down even in its confined and undersized condition. Without the rock the bridge would be prone to scour.

It is not known if the expansion of George F. Miller Drive Bridge is a preferred alternative at this time given that it needs to be considered in the context of the primary preferred alternative at Melrose Terrace. What is clear is that the bridge should be enlarged in the future when it is replaced due to reaching the end of its engineering life or after failure.

Alternative 8: Enlarge Route 9 Bridge

The FEMA flood profile illustrates that the Route 9 Bridge near Melrose Street backs up water and elevates flood levels during the 50-, 100-, and 500-year floods. Flood waters are elevated from the bridge upstream to near the most downstream residential building in Melrose Terrace. Widening the structure would reduce local flood levels and improve sediment transport.

It is not likely that the expansion of the Route 9 Bridge near Melrose Street is a preferred alternative given that it appears to influence mostly downstream of the project site. Actions at that bridge need to be considered in the context of the primary preferred alternative at Melrose Terrace and with an understanding of possible downstream changes. Like George F. Miller Drive Bridge, the Route 9 Bridge should be enlarged in the future when it is replaced due to reaching the end of its engineering life or after failure.

<u>Hayes Court (See Figure 5 and Table 1)</u>

Alternative 9: No Action

The no action alternative maintains the current housing stock of seventy-two residential units, yet is not recommended due to the persistence of flood-prone conditions along Whetstone Brook described above. Hayes Court residential buildings are in need of renovation and the opportunity exists to move housing back from Whetstone Brook to reduce flood risks.

Alternative 10: Remove Two Buildings and Cul-de-Sac, and Re-Connect Low Floodplain (Preferred)

Removing the two lowest buildings that had flood waters adjacent to them during Tropical Storm Irene due to combined flow from Ames Hill Brook and Whetstone Brook would remove two flood-prone structures and allow for re-connection of 1.9 acres of floodplain. The valley width that the channel could safely occupy would be expanded by 108 feet. The two remaining residential buildings could remain, or site redevelopment could take place in areas located on existing fill. Ample space exists to site three to four large additional residential buildings. This alternative would move all development out of the fluvial erosion hazard zone. The proposed limit between re-connected floodplain and site redevelopment has been moved up-gradient to reduce risks based on site conditions at the confluence and patterns of flooding observed during Irene.

A portion of the remaining road and the buildings may be vulnerable to flood risks under this alternative due to the dynamic confluence area so it is likely that roadway reconfiguration would take place to move back from Ames Hill Brook as much as possible. Garfield Drive may need to be relocated away from Ames Hill Brook to limit future damage. Some filling may be necessary to elevate the portion of the site to be redeveloped outside of the floodplain where some fill already exists.

Weighing the positives and negatives at Hayes Court, including the likely need to create housing units in this location to replace more flood-prone units in Melrose Terrace, this alternative is preferred. From strictly a flood risk reduction point of view, more floodplain would be desired at this site to create safer and more natural conditions in this wide valley, deposition-prone area. However, the ability to provide housing opportunity in conjunction with floodplain re-connection outside of the currently mapped 100-year floodplain and fluvial erosion hazard zone is desired.

This alternative should be performed in conjunction with floodplain re-connection at the nearby farm fields off of Meadow Brook Drive that are conserved with the Vermont Land Trust. This large field has the potential to provide a large amount of storage during extreme flood events if at the appropriate elevation compared to the channel.

Alternative 11: Remove Two Buildings in Low Floodplain, Remove South Building Located in the Filled Area, and Re-Connect Portion of Historic Floodplain

Removing the three lowest buildings at Hayes Court would allow for re-connection of 3.3 acres of floodplain. The valley width that the channel could safely occupy would be expanded by 290 feet. The one remaining residential buildings could remain, or site redevelopment could take place in upland areas on the existing fill. Ample space exists to site three large residential buildings.

The flood risk reduction benefits are substantial for this alternative. The amount of the 1,080-foot wide natural valley that is occupied by improved property would drop from 39% to 13% providing a large space for flood water and sediment storage. Historic fill could be removed to re-connect substantial floodplain area in this flat sediment deposition-prone area.

The primary negative aspect of this alternative is the loss of existing developable lands that would likely only be flooded or eroded during very rare events such as those larger than Tropical Storm Irene.

This alternative is only recommended if other suitable locations are available to replace housing units from the project area to allow for a further increase in flood risk reduction.

Alternative 12: Remove All Buildings in Low Floodplain and Filled Area, and Re-Connect Majority of Historic Floodplain

Removing all existing buildings at Hayes Court would allow for re-connection of 3.9 acres of floodplain. The valley width that the channel could safely occupy would be expanded by 335 feet. Mapping and site observations indicate that this may be the historic floodplain extent prior to filling in the past for the existing development. Site redevelopment would take place in upland areas on the back edge of the existing terrace where some filling has taken place. Space would remain to site two large residential buildings.

Re-connecting the maximum floodplain area at Hayes Court would reduce flood and erosion risks the most in this area. The full valley width would nearly be opened back up for the river to flood and deposit sediment without damaging infrastructure. This alternative would reduce downstream flooding as long as the design considered the approach and possible flow paths at Glen Park.

This alternative limits the development potential at Hayes Court. Residential units would need to be replaced at other locations away from Whetstone Brook.

This alternative is only recommended if other suitable locations are available to replace housing units from the project area to allow for the maximal increase in flood risk reduction.

Glen Park (See Figure 6 and Table 1) and Mountain Home (See Figure 7 and Table 1)

Alternatives were also explored at Glen Park and Mountain Home given their flood-prone condition and proximity to Hayes Court and Melrose Terrace. Activities in these two locations should be coordinated with the alternatives discussed above, because both depend upon and influence actions taken at Hayes Court and Melrose Terrace. Alternatives may be viewed on maps and the matrix, and more details will be provided as necessary.

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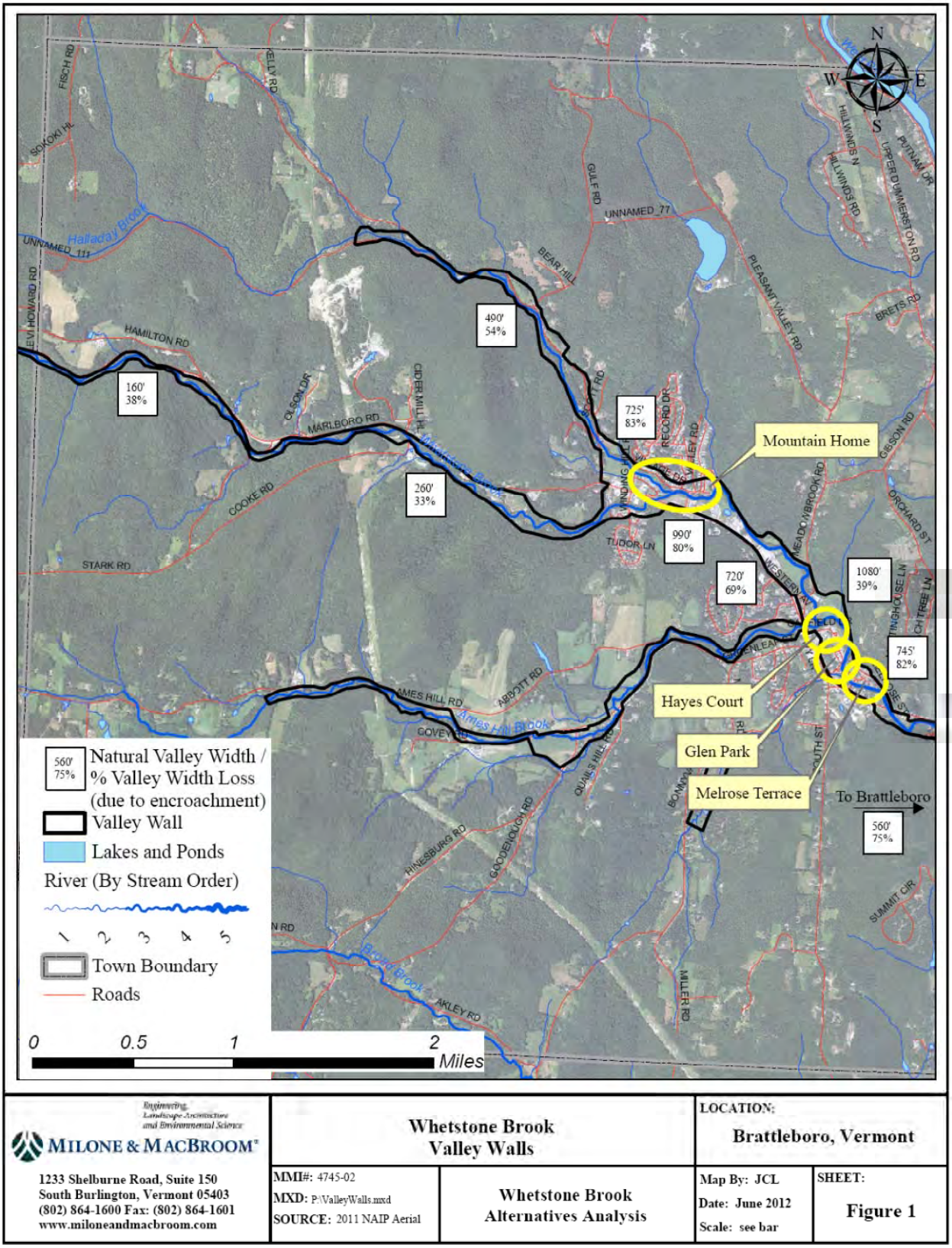
| | | | OBJECTIVES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | **ID** | **Alternative** | **Reduce Flood Risks** | **Reduce Erosion Risks** | **Eliminate Flood-Prone Structures** | **Maximize Housing Units** | **Flood Protect Structures** | **Re-Connect Floodplain** | **Constructability** | **Permitting** | **Cost** | **Notes** |
| Melrose Terrace | 1 | No Action | - | - | - | + | - | - | + | + | + | 80 existing residential units. |
| Melrose Terrace | 2 | Improve wall around perimeter of complex to make higher and complete. Tie to higher ground at upstream end of property. | - | - | o | + | o | - | - | - | o | Requires cooperation of abutting landowner. |
| Melrose Terrace | 3 | Remove seven (7) buildings in floodway, re-create floodplain in area near river, improve existing wall to tie to high ground to prevent avulsion at upstream end of property. | o | o | o | o | - | o | + | o | o | Requires cooperation of abutting landowner. |
| Melrose Terrace | 4 | Remove eleven (11) buildings in fluvial erosion hazard zone and re-create floodplain in area near river, improve existing wall to tie to high ground to prevent avulsion at upstream end of property. | o | o | o | o | - | + | + | + | o | Requires purchase of adjacent lot and removal of existing house. |
| Melrose Terrace | 5 | Remove all buildings, create new floodplain, and construct large residential building on back edge of floodplain at slope. | + | + | + | - | o | + | o | - | - | May require purchase of adjacent lot. |
| Melrose Terrace | 6 | Remove all buildings and abandon site for floodplain creation. All residential units to move to buildings at Hayes Court or other location. | + | + | + | - | + | + | + | + | o | |
| Melrose Terrace | 7 | Enlarge bridge on George F. Miller Drive. | + | o | - | - | - | - | o | o | - | |
| Melrose Terrace | 8 | Enlarge bridge at Route 9. | o | o | - | - | - | - | o | o | - | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hayes Court | 9 | No Action. | - | - | - | o | - | - | + | + | + | 72 units existing residential units. |
| Hayes Court | 10 | Remove two structures in low floodplain and cul-de-sac and re-connect floodplain. Construct three to four large residential buildings on existing fill. | o | o | o | + | o | o | + | o | - | |
| Hayes Court | 11 | Remove three structures to re-connect portion of historic floodplain. Blend new fill at back of floodplain with existing fill to create elevated land for three large residential buildings out of floodplain. | + | o | + | + | + | + | + | o | o | |
| Hayes Court | 12 | Remove all structures, remove fill to re-connect historic floodplain, build two large residential buildings out of floodplain. | + | + | + | o | + | + | + | + | + | |
| Glen Park | 13 | No Action. | - | - | - | + | - | - | + | + | + | 33 mobile homes, 11 lost in flood |
| Glen Park | 14 | Replace homes that were damaged during flood. Elevate fill or build flood wall to protect remaining homes. | o | - | - | + | - | - | o | - | o | |
| Glen Park | 15 | Remove fill and reconnect floodplain at sites where homes damaged. | o | o | o | - | o | o | + | + | + | |
| Glen Park | 16 | Remove all but last row of trailers at back edge of floodplain and construct larger residential building at edge of floodplain. | + | + | + | o | + | + | o | o | o | |
| Glen Park | 17 | Remove all trailers at back edge of floodplain and construct larger residential building at edge of floodplain. | + | + | + | - | + | + | + | + | o | All mobile homes in FEMA 100-year floodplain. |
| Glen Park | 18 | Re-Route Glen Street out of floodway towards back of floodplain. | o | + | + | - | - | - | + | o | o | |
| Mountain Home | 19 | No Action. | - | - | - | + | - | - | + | + | + | |
| Mountain Home | 20 | Continue channelization with berms and bank armoring to protect mobile homes. | - | - | - | + | o | - | + | - | o | Link existing berm segments. |
| Mountain Home | 21 | Remove twenty-one (21) mobile homes located in floodway of Halladay Brook and ten (10) mobile homes from floodway along Whetstone Brook to expand low floodplain. | o | o | o | o | o | o | + | + | + | |
| Mountain Home | 22 | Remove all floodway mobile homes, four (4) homes from the floodplain of Halladay Brook, and sixteen (16) homes from the low Whetstone Brook floodplain along Edgewood Drive and Woodvale Road. | + | + | + | - | + | + | + | + | + | Possible Town/State agreement? |

LEGEND: + good; o moderate; - poor

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| MMI#: 4745-02<br>MXD: P:\ValleyWalls.mxd<br>SOURCE: 2011 NAIP Aerial | **Whetstone Brook Alternatives Analysis** | Map By: JCL<br>Date: June 2012<br>Scale: see bar |
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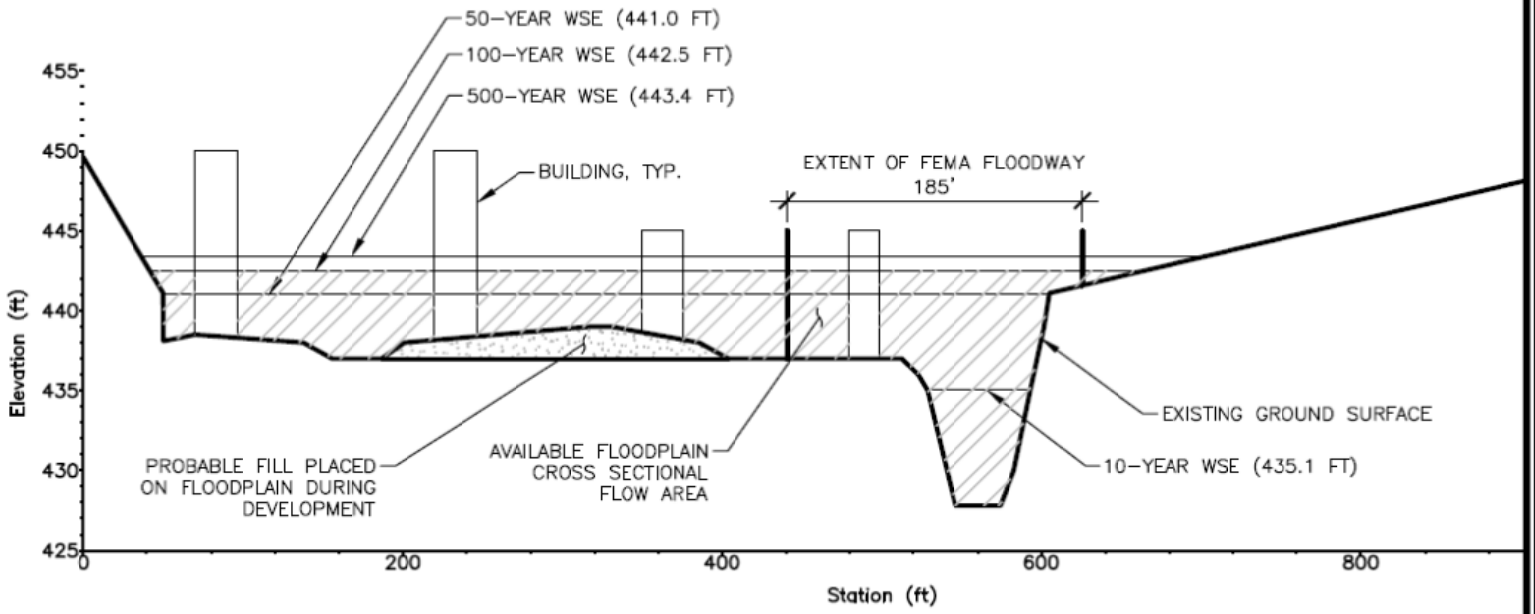


IMPACT OF FILL ON 100–YEAR FLOODPLAIN FUNCTIONS AT CROSS SECTION SHOWN THROUGH MELROSE TERRACE:
22 % OF CROSS SECTIONAL AREA FILLED (763 OF 3,404 SQ FT)
16 % OF WIDTH FILLED (98.5 OF 623 FT)

0' 50' 100'

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| | |
|---|---|
| DATE | 6/12/2012 |
| SCALE | H:1"=100' V:1"=10' |
| PROJ. NO. | 4745-02 |
| DESIGNED | JCL |
| DRAWN | JCL |
| CHECKED | RKS |

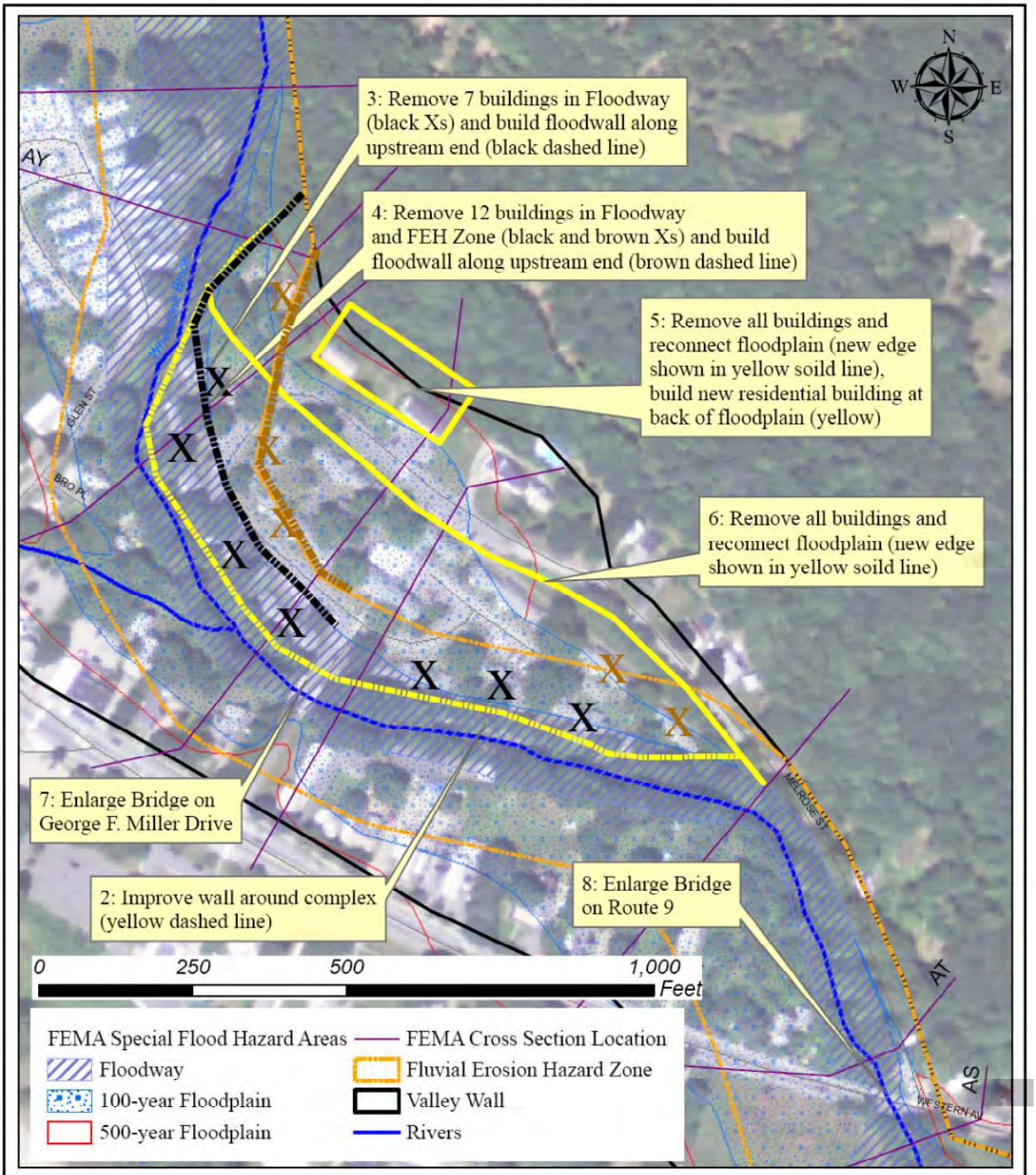
**TYPICAL FLOODPLAIN CROSS SECTION**
**WHETSTONE BROOK**
**BRATTLEBORO, VERMONT**

PROJECT PHASE: **ALTERNATIVES**
DRAWING NAME:
**FIG. 2**


Flood Heights, upstream end of Melrose Terrace Housing Development for the Elderly, West Brattleboro.


Flood Heights, mobile home in Glen Trailer Park, across Whetstone Brook from photograph above.

Figure 3: Predicted 100-year flood water surface (USACE, 1972).

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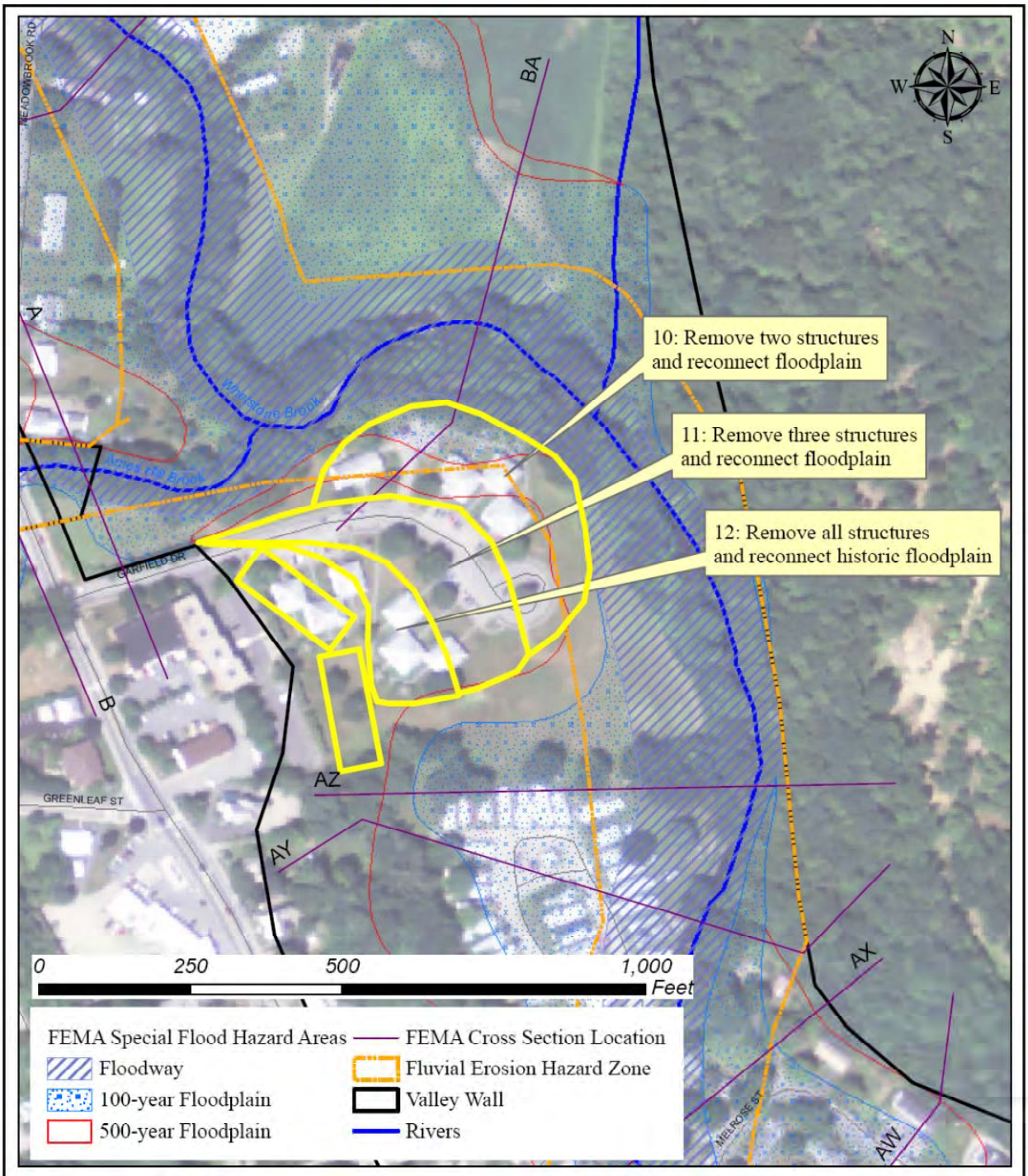
| MMI#: 4745-02<br>MXD: P:\Melrose.mxd<br>SOURCE: 2011 NAIP Aerial | **Whetstone Brook Alternatives Analysis** | Map By: JCL<br>Date: June 2012<br>Scale: see bar |
| | | SHEET:<br>**Figure 4** |

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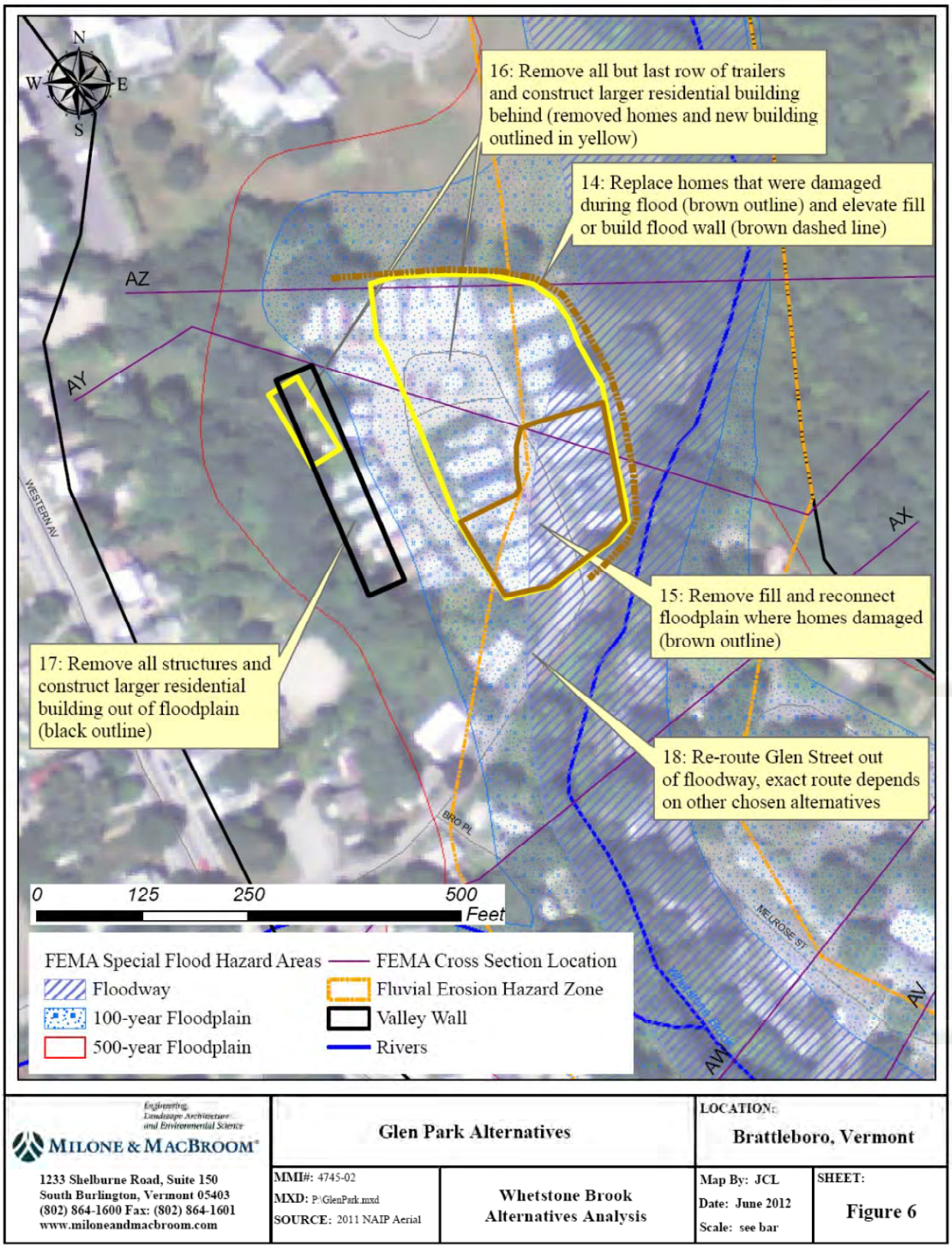
| MMI#: 4745-02<br>MXD: P:\Hayes.mxd<br>SOURCE: 2011 NAIP Aerial | **Whetstone Brook Alternatives Analysis** | Map By: JCL<br>Date: June 2012<br>Scale: see bar |
| | | SHEET:<br>**Figure 5** |

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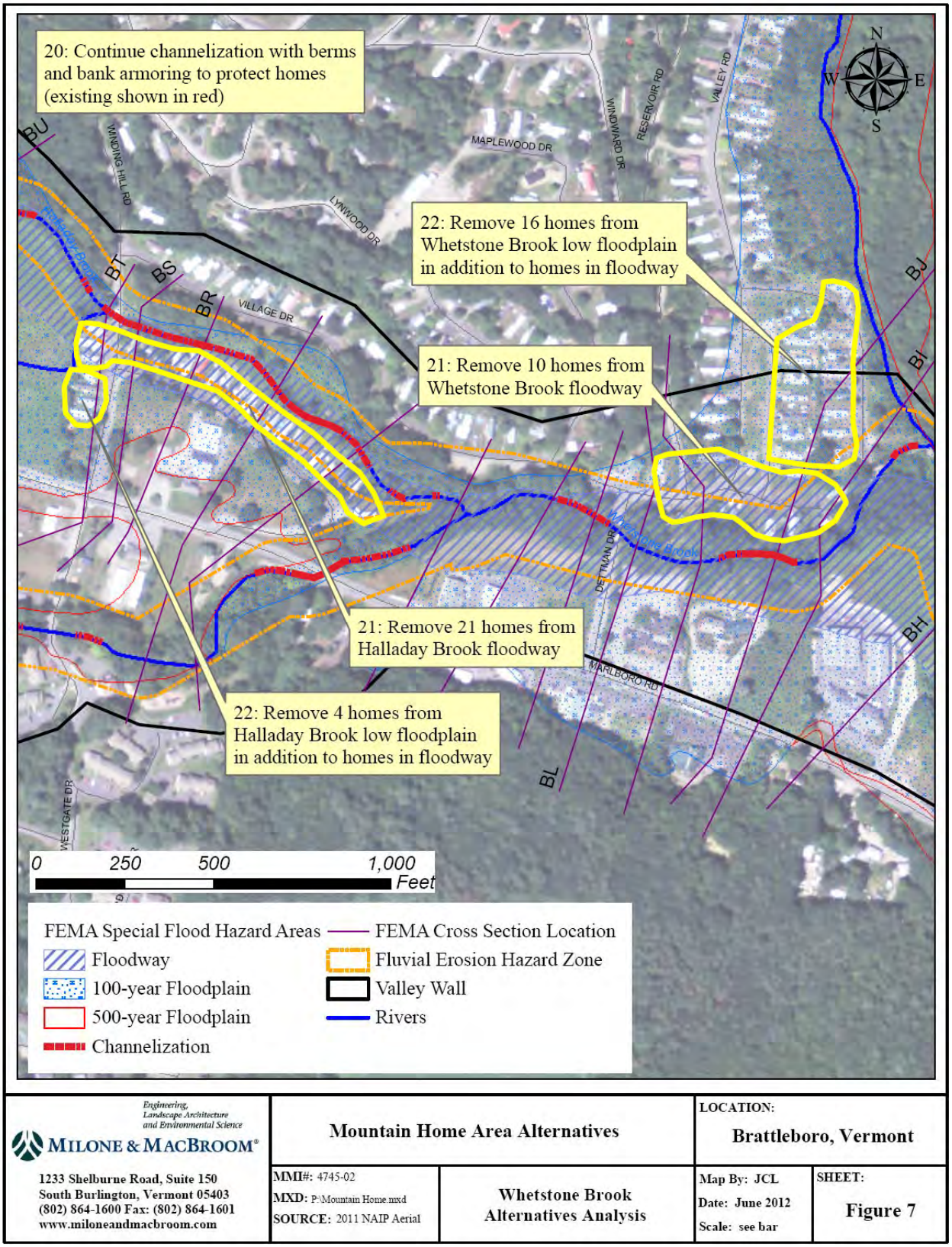
| MMI#: 4745-02<br>MXD: P:\GlenPark.mxd<br>SOURCE: 2011 NAIP Aerial | **Whetstone Brook Alternatives Analysis** | Map By: JCL<br>Date: June 2012<br>Scale: see bar |
| | | SHEET:<br>**Figure 6** |

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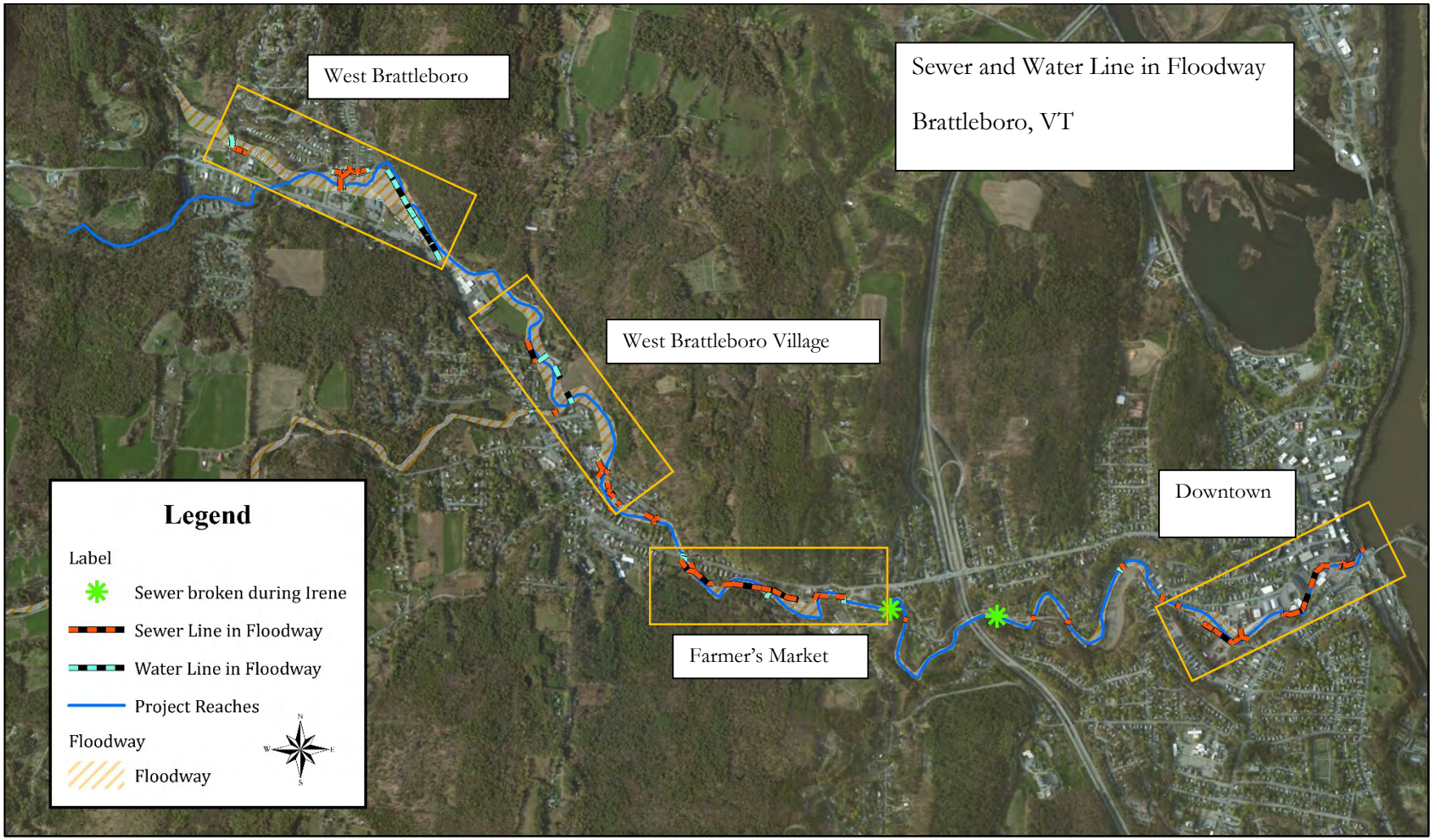
| MMI#: 4745-02<br>MXD: P:\Mountain Home.mxd<br>SOURCE: 2011 NAIP Aerial | **Whetstone Brook Alternatives Analysis** | Map By: JCL<br>Date: June 2012<br>Scale: see bar |
| | | SHEET:<br>**Figure 7** |

# Appendix L:

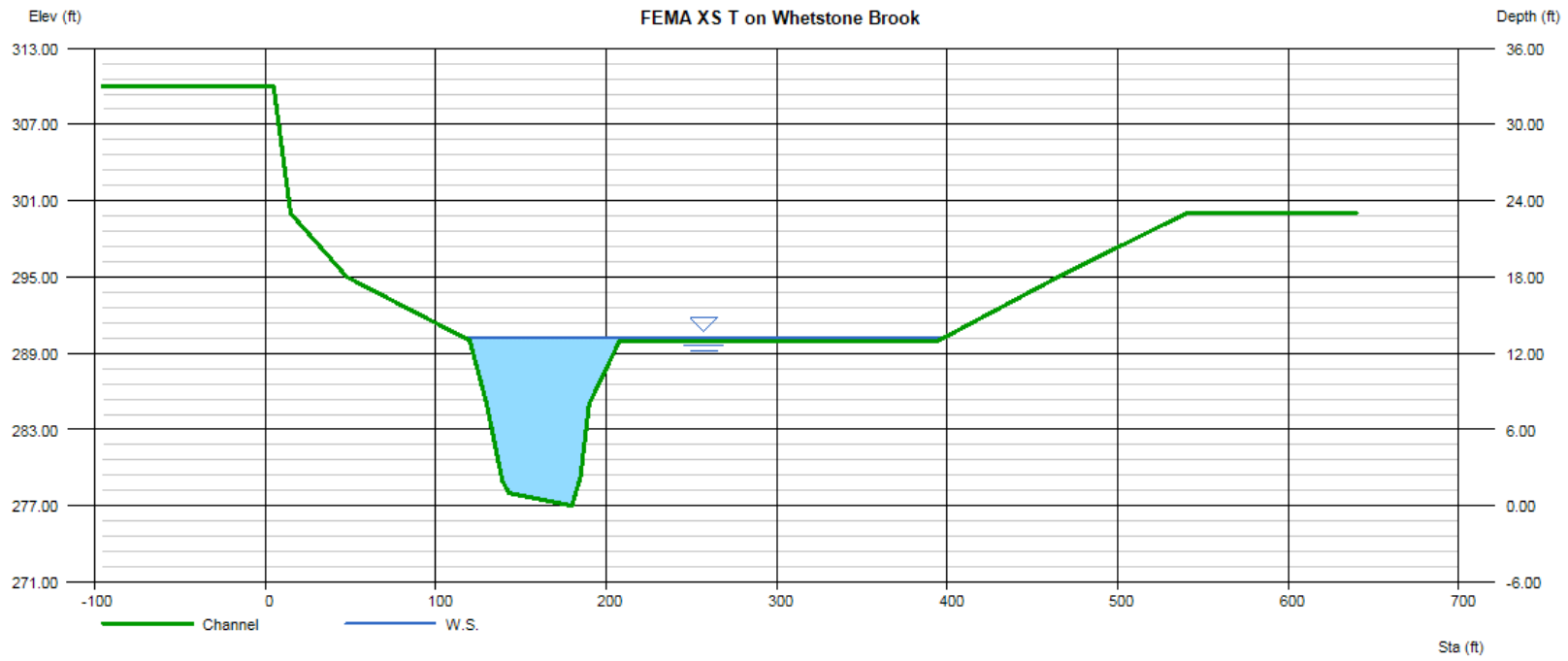
# Map of Sewer and Water Lines in Floodway

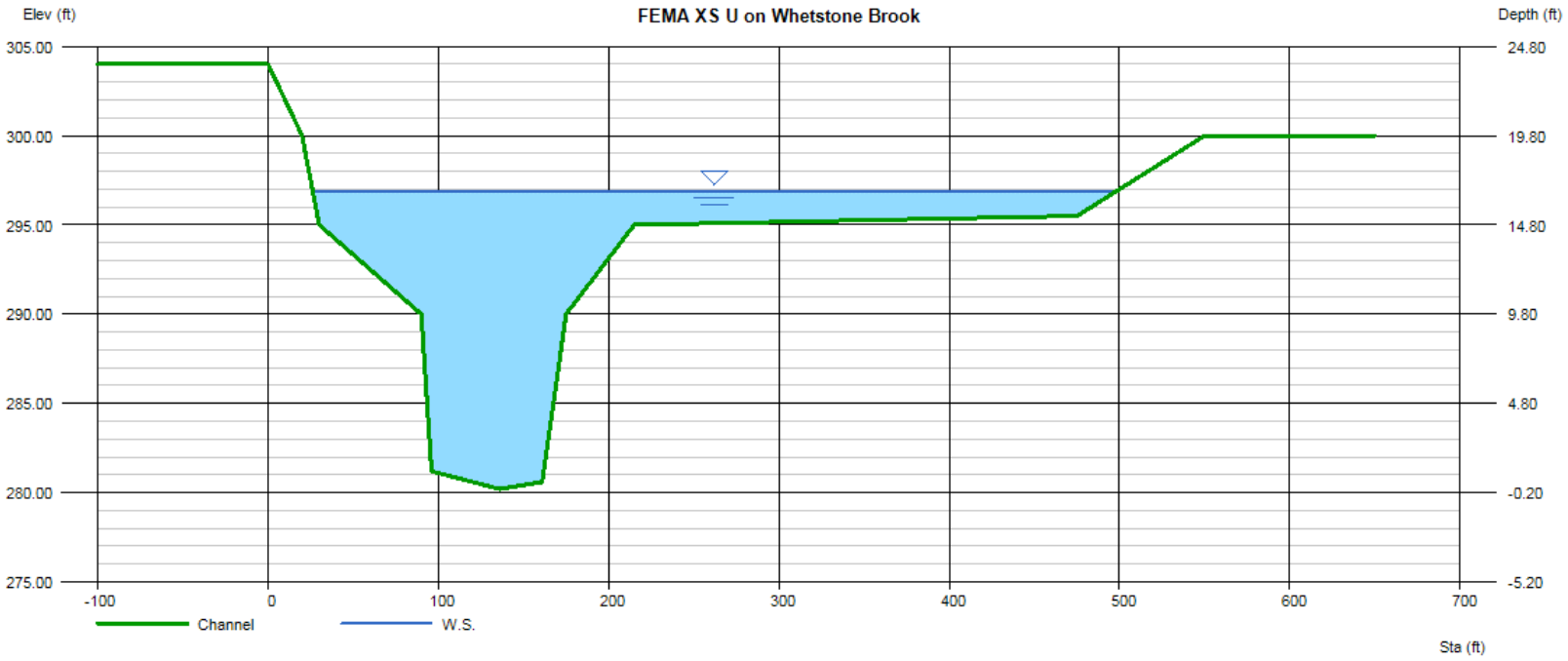

West Brattleboro
Sewer and Water Line in Floodway
Brattleboro, VT
West Brattleboro Village
Downtown
Farmer's Market
Legend
Label
Sewer broken during Irene
Sewer Line in Floodway
Water Line in Floodway
Project Reaches
Floodway
Floodway

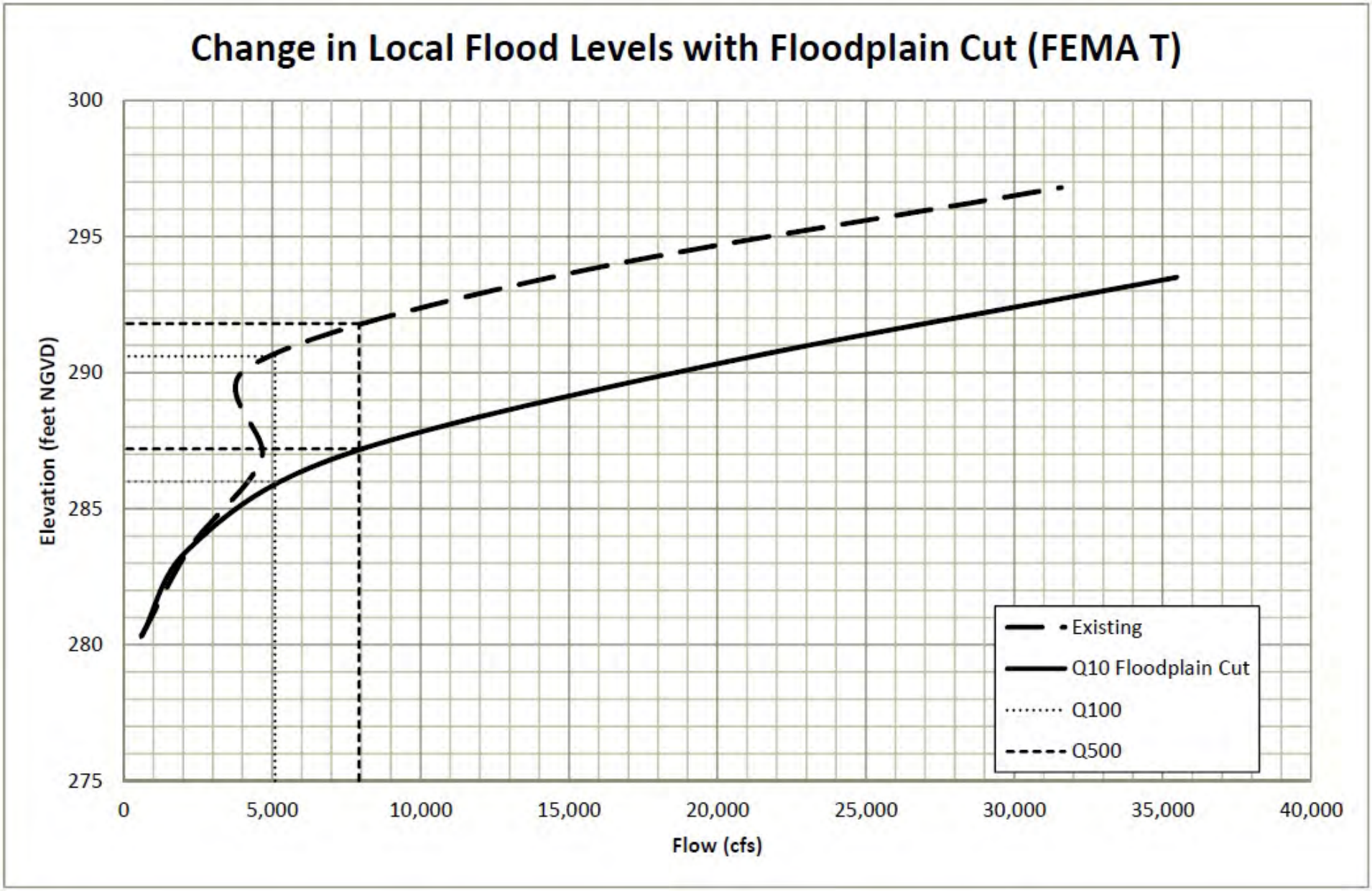
# Appendix M:

# FIRM Cross Sections and Change in Flood Level for Floodplain Restoration

Bankfull depth is estimated to be 3-4 feet (~280') at cross section T. If the floodplain were cut to the ten year flood elevation (3,300 cfs) it would reduce local flood elevations during major storm events by 4' to 5'. Additionally the eight acres of floodplain will store 40 acre feet or 217,800 $ft^3$ of water during 100 year floods. There will also be some upstream flood reduction with the creation of floodplain in this area. A hydrologic and hydraulic analysis is required to understand the full up and downstream benefits of the project.




FEMA XS U on Whetstone Brook
Elev (ft)
Depth (ft)
305.00
300.00
295.00
290.00
285.00
280.00
275.00
24.80
19.80
14.80
9.80
4.80
-0.20
-5.20
-100
0
100
200
300
400
500
600
700
Channel
W.S.
Sta (ft)


Change in Local Flood Levels with Floodplain Cut (FEMA T)
300
295
290
285
280
275
Elevation (feet NGVD)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
Flow (cfs)
Existing
Q10 Floodplain Cut
Q100
Q500

# Appendix N:
# Community Forum Meeting Notes

# Vermont Economic Resiliency Initiative (VERI)

# Community Forum – Town of Brattleboro

## MEETING NOTES

October 15, 2014 – 6:00 - 8:00 PM

### VERI Project Overview

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.

VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy.

### For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI

### Summary

19 community members, business owners, and homeowners from the Whetstone Brook catchment area in Brattleboro attended the Vermont Economic Resiliency Community Forum. The community identified five major flood hazard risks in Brattleboro – commercial and residential development in the floodplain (around Sunset Lake Road and the Melrose Housing Development), debris catchment and bridge sizing along Bridge 35 and the Main Street and Melrose Bridges, inadequate stormwater drainage capacity, and berming along the Elliot Street Bridge and Williams Street. Successful mitigation projects in the Brattleboro have included the acquisition of Locke Field to restore the floodplain and using green infrastructure and permaculture techniques to mitigate flood water risks at the Brattleboro Food Coop, the Farmer's Market and the Glen Mobile Home Park. Further analysis and technical assistance needs of the community emphasized a watershed approach to flood management, updated zoning regulations and standards to decrease development in the residential and rural residential zones, disaster preparedness and risk identification, business continuity of

operations planning, pervious technologies and water retention strategies, land acquisition, and active stream management to preemptively remove debris from waterways.

## Present

- Residents and Business Owners: Stan Lynde and Laura D'Angelo Lynde (Lynde Motorsports), Paul Normandeau, Nori and Vic Howe, Bill and Eric Daley (Vermont Country Deli), Jon Potter (Latchis Arts, Inc.), Joe Jewett (Jewett Plumbing and Heating), Cimbria Badenhausen, Naomi Shafer (New England Youth Theater), Ra Van Dyk (Brattleboro Area Farmer's Market), Michael Bosworth (West Brattleboro Association), Deb Zak (Windham-Windsor Housing Trust), Mary Durland (Tri-Park Cooperative Housing) Drew Adam, (VT Association of Conservation Districts)
- Technical Assistance: Amy Sheldon (Landslide Natural Resource Planning), Jolene Hamilton (Windham County NRCD
- Town of Brattleboro: Rod Francis
- Regional Planning Commission: Jeff Smith and Kim Smith (Windham Regional Commission)
- State of Vermont: Noelle MacKay (DHCD), Chris Cochran (DHCD), Wendy Rice (DHCD), Josh Carvajal (ANR), Molly Burke (VT House of Representatives)
- Media and Press: Kip Tewksbury (Brattleboro Community Television)

## Introduction

Rod Francis, Planning Director, Town of Brattleboro, convened the Vermont Economic Resiliency Initiative (VERI) Community Forum in Woodstock and he introduced Commissioner Mackay from the Vermont Department of Housing and Community Development.

Commissioner MacKay welcomed everyone and thanked people for participating in a first round of community forum presently being held in five Vermont communities state-wide. The Commissioner explained that the community forums are examining ways to improve economic resiliency for natural disaster impacted communities in the aftermath of Tropical Storm Irene. Through the Vermont Economic Resiliency Initiative, the State will analyze risks to public infrastructure, alongside economic activity, river corridor and flood data, to better mitigate future flood hazards and to and to ensure businesses rebound quickly. The Commissioner provided the audience with a VERI project overview and the findings of the first two phases of the project. After her introductory remarks, the Commissioner explained that the purpose of the meeting was to collect information about risks to infrastructure and economic activity observed during Irene, subsequent risk reduction, and suggested

improvements for long-term resiliency.

### Overview of the Riverine Study Area

The State has contracted with a team of river scientist and engineers to review the geomorphology (defined as the study of landforms interacting with flowing water), flood hazard risks, sediment deposition potential, and impacts to the built environment of select rivers and tributaries within each targeted VERI community. The scientists presented an overview of their work and initial observations in the river corridors at each of the community forums and provided technical assistance to the respective community throughout the meeting.

Notes

- Amy Sheldon of Landslide Natural Resources Planning discussed the river corridor study. They completed Phase 2 Stream Geomorphic Assessment (SGA) for Whetstone Brook in 2008, partnered with Windham County Natural Resources Conservation District (Jolene Hamilton); She described impacts and conflict areas in the study area between the river and the built environment.
- The corridor plan had 70 projects; The Windham County NRCD has worked toward implementation of the top "10" projects listed in the Corridor Plan with local and state partners as funding resources have been found and committed to these projects.
- The watershed is 16% developed; portions in town are 72% developed; typically, watersheds more than 10% developed are considered to be heavily altered.
- The Whetstone has a lot of ledge along the brook and the brook has been channelized/dredged. The result is the river velocity has increased but erosion is actually helping as it has increased floodplain capacity and is helping the channel to recover.

### For more information:

Whetstone Brook Watershed Corridor Plan. All Geomorphic Assessment Final Reports statewide can be found here. (https://anrweb.vt.gov/DEC/SGA/finalReports.aspx).

### Public Input

The DHCD Commissioner solicited input from forum participants with regard to flood risk and mitigation opportunities in Brattleboro. The questions posed were:

1) What are the hazards and risk areas in the town?
2) What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?
3) What still needs to be addressed in the interests of long-term security and sustainability?
4) What information should the final report include and how should this information be presented?

Identified hazards and risks will be further analyzed in Phases 3 and 4 of VERI.

### Identified Natural Disaster Hazards and Business Risks

What are the hazards and risk areas in the town?

Notes: Responses from the Public

- Irene impacted one to two percent of all structures in Brattleboro.
- The effort to repair and rebuild infrastructure in Brattleboro damaged by Irene took three years; normally that amount of work is done over 20 years by Public Works.
- *Floodplain:* Most of the upper watershed is steep; area around Sunset Lake Road has to absorb power from a lot of water; here and below along Rte. 9, was mostly floodplain and agricultural land, frequently floods, but has been developed (commercially zoned). Rod Francis noted that the town's Flood Hazard Bylaw overrides commercial zoning: new development must meet regulations but there is pre-existing development in floodway. Jeff Nugent noted a number of buildings in floodplain weren't damaged due to flood regulations requiring retrofitting during construction/remodeling.
- *Stormwater Drainage Systems:* Flash flooding, even from typical summer rainstorms, common due to outdated storm water systems which cannot adequately handle the volume of water.
- *Flat Street:* Flat Street is a low point along the brook and the grade of the street was raised which causes flooding to Lynde Motorsports. Flat Street also receives floodwaters flowing downstream from the form dry kiln along the brook all the way to Connecticut River.
- *Berming:*
    - Approximately 6 acres of floodplain was filled upstream of Elliot Street bridge (south side, former Dry Kiln storage areas) because the brook was bermed here, impeding free water flow. The floodwaters created new channel through there and re-entered

the brook across from Whetstone Arts Building, which was damaged. The berm had to be re-built after Irene.
    - There are concerns about Williams Street suffering more damage in future storms because of berming.
- *Bridges:*
    - Main Street Bridge: Debris catches here because the bridge is narrow and the water has to flow around an "S" curve. Water back flow affected the Wilder Building near here during Irene. The brook also has the remnants of a concrete dam at this location. It is unclear if this dam is hindering or enabling water flow. Some of the concrete in the channel does protect the Whetstone Interceptor (sewer pipe that runs in and along the Whetstone).
    - Area near Bridge 35 in Williams St (just above West St): creates separate channels after spring floods; after Irene debris built up and area was dredged; concern that the channel is very narrow here and floodwater could take out bridge; also old dam in this vicinity (but believed to be mostly gone).
    - All bridges upstream of and including Rte. 9 Bridge by Melrose Street are undersized. If Melrose Bridge goes, it will affect all of Rte. 9 west. That bridge carries 16,000 vehicles per day (state bridge on Class 1 town highway). What is the condition of this bridge?
- *Wastewater treatment:* Sewer pipe torn open below I-91 Bridge, and trestle carrying pipe across brook at head of Williams St damaged, breaking pipe.
- *Housing:* Melrose Terrace housing (includes elderly and low-income housing) buildings are located in floodway. Should the structures be removed and the floodplain restored? Note separate public discussions are occurring on this issue.
- *Debris removal:* Private landowner had 15 truckloads of debris removed from Halladay Brook; paid for with private funds but was performing a public service; can the landowner be compensated in any way?

### Effective Hazard Mitigation and Risk Reduction

What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?

Notes: Responses from the Public

- The acquisition of Locke Field (below Sunset Lake Road and behind Chelsea Royal Diner) has helped to conserve the floodplain. This was one of projects listed in SGA/corridor plan.
- No mobile homes remain in floodway at Glen Park. Irene destroyed the homes and/or homeowners removed the homes and pads. The total cost of Irene to the park was about $314,000; all of this money came out of the resident's pockets (cooperative mobile home park). The homeowner's association restored the area, re-contouring one acre to restore the floodplain. The cost of the rehabilitation was $25,000 paid for by cooperative homeowner's association. The association is also in the process of developing a mitigation plan and has had some consultant help for this. There is an ongoing need to relocate about 40 mobiles along brook for safety, but there is a lack of affordable housing elsewhere. The homeowner's association also contracted for a spray foam insulation to replace wet insulation on the mobiles.
- Brattleboro food coop project: designed with flooding in mind, storm water improvements using green infrastructure, parking lot, old building removed etc.
- Farmer's Market: up and running the following Saturday; grassed areas were relatively unaffected, but gravel areas damaged; stream bank restoration has been going on in the area.
- Branding and Economic Redevelopment: How do you breathe life into the economic fabric of the community after losing this economic base? VT Downtown Action Team looked more at the branding and marketing side of economic redevelopment in Brattleboro.

## Resiliency and Sustainability Planning

What still needs to be addressed in the interests of long-term security and sustainability?

Notes: Responses from the Public

- *Watershed Approach*: Need to look at the watershed as a whole to limit/reduce run-off upstream. Important to educate landowners to think about diffusing and draining water up-stream properties, through techniques such as permaculture.
- *Regulations and Zoning*: Update and revise subdivision and zoning regulations. Town looking at reducing allowed density in Residential and Rural Residential districts (most of far west end up town, upper watershed); trying to minimize roads, driveways, etc. and creating recommendations for constructing them to be flood resistant; looking at benefit cost analysis

to see cost and risk for emergency response services and to help steer how development should happen.

- *Resiliency Planning*:
    - Town can also develop response and resiliency strategies (such as identifying choke points, and understanding the economics of the choke points etc.)
    - Do long term resiliency planning using California's earthquake approach that integrates building codes/protocols and education (e.g. secure oil/propane tanks). Flooding is "normal;" it's going to happen again, and need to Ingrain principles of risk aversion and recovery management in Vermonters.
- *Business Continuity:*
    - Need to educate businesses and individuals to create a disaster preparedness plan; e.g. continuity of operations plan for businesses; need to know what they do to prevent damage, and practice strategies so they know how to use the plan.
    - What incentives should be used to get businesses to create a plan? What should be done to reach businesses? Require continuity of operations plans when applying for grants, assign outreach/case workers to businesses to explain the benefits of a COOP plan, Use VT Small Business Development Center, Chambers of Commerce, BDCC, Rotary, Downtown Alliance as outreach resources.
    - Case workers for businesses are needed: help with their long-term goals; should they close? Sometimes it is better to save the entrepreneur than save the business.
    - Business plans could include diversification, e.g. developing an on-line component etc.
    - Need to think about "interim operations" for businesses to operate in if they have lost their main physical location (e.g. a temporary location- Building? Food truck? "Pop-up" shops? Shipping containers?). For example, after Irene you couldn't find a cup of coffee in downtown Wilmington, the Green Cup in Waitsfield shifted to a temporary space. Could we plan for this? Could do inventory of vacant spaces, may need changes in zoning rules (applicable zones, business permitting, duration of permit; application process). Would need to pre- identify how to procure portable pop-up units (such as shipping containers) and how to connect them to utilities. Ideally each community would have a designated point person to set these up in an emergency situation. (Comparative example: Christchurch, NZ - http://www.youtube.com/watch?v=R3NyfO4PRAg).

- *Impervious Surfaces:* Minimize impervious surfaces especially in the downtown area. Look at Arizona for examples of how they are responding to extreme weather events or to St. Albans which did a flower garden water retention on Main St. and Taylor Park.
- *Housing:*
    - To benefit affordable housing and economic development: have a high density leased land housing cooperative.
    - Efficiency Vermont, Vt. Housing and Conservation Board, and High Meadows Fund developed Vermods, a modular unit that is being accepted across the state; same space requirements as a mobile home. Proposal: high density, leased land, energy efficient, maybe home built, using local lumber, designed locally (like First Day cottage/tiny house). But need more builders involved.
- *Education:* Need to teach business owners about new types of construction and the cost/benefit of "alternative infrastructure" and new technologies, to increase willingness to try innovative approaches; e.g. pervious concrete.
- *Emergency notification*: Improve notification of residents and businesses; we already have VT Alert http://vtalert.gov/ ; need to change the culture of people to listen to alerts, could use children as emissaries for this message.
- *Information Dissemination:*
    - Do information dissemination after event in multiple waves – people need psychological recovery before they can process information. Recovery takes years. Replicate outreach every few months.
    - Brattleboro has a business license system- helps maintain a database of all businesses, to plot in GIS, and to help determine risk.
    - After Irene, state agencies all took in economic data, but processed through distinct/separate systems. Data collections is now centralized to help track impact to businesses and homeowners over the continuum of recovery.
- Acquisitions:
    - Need to invest more in buy-out program (if building is repetitive loss, property is purchased and cleared), and try to do it pre-disaster; a lot of money upfront, but good mitigation effect later; Brattleboro has good records of flood loss going back to 1974, but process can be difficult—often difficult to get benefit/cost numbers to work; very few actual repetitive loss properties in VT, impacting opportunities for FEMA money.

    - Housing Conservation Fund- could this be used to create contiguous flood plain tracts of land?
- Stream management: Keeping streams debris free is critical. Obvious issues up along Route. 9. Does the state have a management program to clear debris, logs etc.?

## Information Sharing and Dissemination

What information should the final report include and how should this information be presented?

Notes: Responses from the Public

- Commissioner Mackay noted that recommendations and ideas will be incorporated into a draft report, and a second community forum will be held in January to review report and present some solutions.
- The report needs details on how the stream is changing, what impacts a project will have on neighboring properties, it should not emphasize engineered solutions natural river flow and whole watershed management approach.
- The report needs to be concise with a one to two page executive summary.
- Include information on how watersheds work, similar to stream geomorphology handout at forum. Model how the stream would look if the floodplains were restored as per the corridor plan.
- Change peoples' thoughts about keeping, retaining flood water on their upstream properties
- A schematic that shows how individual community members can mitigate their risk on their personal properties. Whetstone rises and falls more quickly after Irene→ additional support for this recommendation.
- Let people know how often they can expect a major flood event to incentivize them to become more resilient. A "100-year" flood has a likelihood of happening every 12 years.

# Vermont Economic Resiliency Initiative (VERI)

# Community Forum - Brattleboro

## MEETING NOTES

April 20, 2015 – 7:00 – 9:00 PM

### VERI Project Overview

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.
VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy.

### For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI/Brattleboro

### Summary

Twenty-five people were in attendance, including project team members, town officials, state officials, state representatives, and landowners, community members, and business owners from the Whetstone Brook. The forum showcased five high-priority projects and four policy and program recommendations which could significantly decrease flood risk for Brattleboro, if implemented. Community members were given the opportunity to ask questions, provide input, and rank the proposed projects. The projects which the community most supported included conserving the eight acre parcel just upstream from downtown, and removing the sediment plug under the Williams Street Bridge. Buyouts of at-risk properties also ranked high. The policy and program recommendations which the community most supported included regulating new development in both the flood hazard area and in fluvial erosion hazard areas. Continued participation in FEMA's Community Rating System and seeking a higher rating (to reduced flood insurance rates) also ranked high.

## Welcome and Overview

[Noelle MacKay, Commissioner of the Department of Housing and Community Development]

Noelle MacKay began by going over the agenda for the evening and emphasized the importance of community input on the proposed flood reduction projects. Starting off with the "big picture," Noelle said the Vermont Agency of Commerce and Community Development's role after Irene was post-disaster recovery and noted that while Irene impacted buildings and infrastructure, it was also a tremendous blow to the State's economy. The state applied for and received a grant from the US Economic Development Authority to help five Vermont communities build back stronger and take steps to protect their economy from future floods.

Noelle introduced the project team members and provided background information on a successful project in Bennington that created the model for this project. She also explained the process for selecting the five towns – each with high flood risk to economic activity and infrastructure.

Brattleboro was selected as a VERI pilot community because it is a state-designated downtown, is ranked number four of communities in Vermont for economic activity, and number six in terms of infrastructure vulnerable to flooding. Also because the community has made progress on flood resiliency planning, it successfully implemented a number of projects to reduce flood risks and it had a stream geomorphic assessment of the Whetstone Brook.

As part of this project, a team of river scientists and engineers were hired to further assess the Whetstone Brook, identify local threats to infrastructure and business and make recommendations to reduce the impacts of future floods.

The first Brattleboro Community Forum was held in October 2014, where Noelle sought input from attendees on three topics: what did they see happen during Irene, what have they done to prepare for the next flood, and what would they like state government, the town, and other agencies and organizations to do to help the community prepare for the next flood?

The VERI team combined this information and its analysis into a draft report that contains recommended projects and town-wide policy and program options to reduce flood risks. The projects were ranked by the consultants on whether they are effective, limited, or ineffective at reducing erosion risk, flood risk, and damage to businesses, infrastructure, and property. The ease of implementation, cost, and potential partners are also a factor.

Noelle stressed that this is a draft report, and that the team is eager to get comments from the public. The report will be up on the project web site until May 4th. She believes the report can serve as a road map for the community and provide a menu of options for what can be done to help protect the community. She noted that putting these projects into Brattleboro's Hazard Mitigation Plan is a good way to help fund them. The Agency of Commerce and Community Development will work with partners to help identify funding sources once priority projects are identified.

## Overview of Municipal Policies and Programs to Reduce Future Floods

[Jeff Nugent and Alyssa Sabetto, Windham Regional Commission]

Before presenting policy and program recommendations for the community, Jeff Nugent first noted some of the Town's accomplishment regarding flood resiliency. Brattleboro has three full-time planners on staff, and he worked with them on a number of issues post-Irene. The town plan identifies a number of important flood and erosion hazard goals. Brattleboro is one of only three communities in Vermont to be part of FEMA's Community Rating System, which not only recognizes the Town for their efforts in the National Flood Insurance Program and lowering flood risk, but also results in reduced flood insurance premiums for landowners. Jeff noted that a number of projects listed in the town's previous hazard mitigation plan have been completed, and that Brattleboro worked with the Vermont Downtown Action Team on efforts to speed economic recovery post-Irene.

Alyssa presented information on the Emergency Relief Assistance Program noting that Brattleboro has completed steps to receive a state aid rate of 12.5%. She listed the next steps required to increase this state aid to 17.5%.

Jeff then discussed specific policy and program recommendations developed by the team. Some of these recommendations are not easy, and not without controversy, and are presented to promote discussion. Four recommendations were considered high-priority by the team.

Alyssa spoke on the Community Rating System, and the recommendation that Brattleboro achieve a higher rating. Jeff presented three other recommendations:

- Identify areas for conservation (both the Whetstone and Crosby Brook corridor plans list such sites; conserving them reduces future development in flood-prone areas and allows natural stream functions to continue);
- Regulate development in fluvial erosion hazard areas (current regulations are directed at flood inundation areas, but may not be effective for erosion hazards); and,

- Regulate grading and clearing on slopes greater than 15% (keeping these areas vegetated and undeveloped helps reduce floodwater and erosion).

## Overview of Project Recommendations and Conceptual Designs

[Amy Sheldon, Landslide Natural Resource Planning, Inc.]

Before her involvement with the VERI project, Amy worked on the Whetstone Brook's Stream Geomorphic Assessment and River Corridor Plan, which was completed before Tropical Storm Irene. She visited immediately after the storm and toured the watershed with Brattleboro Town Planner, Rod Francis, to see the impacts.

Amy then provided some background on the watershed. First, she explained the terms floodway, floodplain, fluvial erosion hazard area, and river corridor. Second, she noted that 40% of the project area's floodplain and floodway is developed; for just the floodway alone, development is 18%. These numbers are quite high.

The team identified 18 site-specific projects and divided them into four categories: Building and Site Improvements, Channel and Floodplain Management, Infrastructure Improvements, and Public Safety Improvements. Five high priory projects were detailed and some had conceptual plans to help secure future grants and funding for implementation.

**1. Conserve 8 Acres of Floodplain Upstream of Downtown** (Channel and Floodplain Management):

Amy described how during Irene, the Whetstone Brook accessed the floodplain by breaking through a berm, and creating a flood channel through the site. The plan here is to excavate the area so that it would flood more frequently, and potentially reduce base flood elevations by 4-5 feet downstream. This is a very significant reduction. By conserving the parcel, there is the added benefit of preventing runoff from new development, and by preventing further restrictions to the brook accessing the floodplain.

> Notes and Responses from the Public: This parcel could be a resource for the community, perhaps in the form of an edible landscape. Amy noted that the soils here are mostly gravel.

**2. Williams Street Bridge** (Infrastructure Improvement):

The bridge itself is a long span—103 feet—with a center pier. This is greater than the bankfull width. However, half of the span is filled with sediment, and this sediment plug reduces the effective flow of

water. The proposed project is to remove the sediment to allow more water flow during flood events, thereby lessening potential damage to the bridge. This is a relatively easy and inexpensive project.

> Notes and Responses from the Public: 1) Many large rocks were removed from the Brook just upstream of this bridge following Irene. 2) Is there any economic value in the material being removed? Amy noted that there could be, but it's somewhat dependent on timing. If someone needs material at the time of removal, then certainly. A participant noted that these river materials may be appropriate for town roads.

**3. Route 9 Bridge by Cumberland Farms** (Infrastructure Improvement):

At this location, the brook and the bridge (or both) are not properly aligned. While the bridge is in good shape, the misalignment results in severe erosion to the bridge. Historically the brook was straightened in this area, and it's now trying to regain its meanders. Amy noted there is an existing flood chute with no buildings that could be reopened to better align the water flow and reduce risk to the bridge.

> Notes and Responses from the Public: Reopening this flood chute would straighten the brook, which conflicts with state guidance to allow rivers to move and reestablish their meanders. Implementing this change would increase the velocity of floodwaters downstream of the bridge with unknown consequences. Amy noted that yes, this seems to go against conventional thinking, but it is balance between protecting existing infrastructure and river science. Noelle thanked the participant for bringing this up and said this point will be acknowledged in the final report.

**4. Floodproof or Relocate Sewer and Water Lines** (Infrastructure Improvement):

There are four main areas where water and sewer lines are located in the floodway: downtown; near the Farmer's Market, in West Brattleboro village, and out near Marlboro Road. The lines cross the brook and either run in the brook or alongside of it. In total, 8,445 feet of sewer pipe and 4,881 feet of water line are at risk. There were two sewer line breaks during Irene.

> Notes and Responses from the Public: 1) The sewer pipes may be leaking. Rod noted that they would need to put a camera in to look for leaks. One business in West Brattleboro that was a big source of sewage in the brook is now closed. 2) What is the age of the sewer pipe, and what is its expected lifespan? Rod noted that most of the sewer lines in the Whetstone were installed in the 1950s and may be at the end of their reasonable life. All throughout

town, however, the water and sewer lines may be quite new, or very old; and some are still wood.

**5. Consider Buyouts or Relocation Strategies for At-Risk Properties** (Public Safety):

This is acknowledged as being expensive and complicated, but it will increase floodplain capacity and get people out of harm's way. The primary properties at risk are mobile home units.

Notes and Responses from the Public: 1) If mobile home units are removed from Glen Park, the road will still be in the floodway. Amy acknowledged that the road should and could be moved out of the floodway to provide access to the remaining units. 2) Every home that's removed in Mountain Home and Deepwood increases the bond payment (for the water and sewer infrastructure) for those who remain. Rod noted that these financial issues need to be resolved, and that relocation funds could be used to address this issue as well. Noelle added that this needs to be acknowledged in the report, and the needs of the people, the risk of the location and mobile home park's business model needs to be considered. Rod added that Brattleboro Housing Authority is ready to break ground on the 55-unit Red Clover Commons, which will accommodate residents relocated from the floodway at Melrose Terrace. At Melrose, twenty units will remain on-site, along with offices and maintenance buildings.

## Where to Get Help

[Noelle MacKay, Commissioner of the Department of Housing and Community Development]

The program and policy changes, along with the site-specific project, are directed at the community as a whole, including town government. Noelle shifted the discussion to what individuals can do address flooding.

She noted a number of case studies (available in the back of the room and online) that highlight mitigation measures on existing buildings, including historic buildings. One of these case studies documents the floodproofing of the New England Youth Theater in Brattleboro. Another case study shows how a historic home was floodproofed. The perception is that not much can be done to flood proof old buildings, but this isn't true. Grants for these types of projects don't commonly go to individuals, but Noelle said they will be looking into some creative funding sources for projects that involve businesses and individuals.

Noelle talked about the Brattleboro VERI web page, ACCD's Flood Resiliency web page, and the Flood Ready web site. Vermont's Small Business Development Center was also mentioned, especially their disaster recovery guide for businesses. FEMA is also planning to present a training on small business recovery in September, and the upcoming Vermont downtown conference will feature a session on floodproofing by local engineer Bob Stevens.

> Notes and Responses from the Public: It's important to remember that when we are talking about "businesses," we are talking about non-profits as well. It's important that non-profits understand that these resources are available to them as well.

## Project, and Policy and Program Prioritization

Sticky dots were handed out for people (six each) to place on the charts to prioritize project recommendations, and policy and program recommendations, in Brattleboro. The town's ranking of the high priority projects can help the town advance projects. Before ending the presentation, Noelle thanked everyone for coming, especially those who participated in the VERI forum for the second time.

The results of the project prioritization are below, in order of popularity - with number of sticky dots received in parenthesis.

1. Conserve 8 acres of floodplain and remove berm owned by Cersosimo Lumber upstream of downtown. (12)
2. Remove channel blocking sediment upstream of the downstream Williams Street Bridge. (9)
3. (tie) Remove sewer and water lines within the river channel at locations throughout the project area. (5)
3. (tie) Protect remaining undeveloped floodplain (7 acres south + 5 acres north of Whetstone Brook). (5)
3. (tie) Consider buyouts for at-risk properties; site 6. (5)
3. (tie) Work with businesses to decrease impervious surfaces and install rain gardens/green infrastructure. (5)
4. (tie) Consider buyouts for at-risk properties; site 4. (4)
4. (tie) Preserve existing undeveloped wetland corridor. (4)

The results of the policy and program prioritization are below, in order of popularity - with number of sticky dots received in parenthesis.

1. (tie) Consider prohibiting new development in mapped flood hazard areas. (9)
1. (tie) Consider prohibiting new development in fluvial erosion hazard areas. (9)
2. Continue to participate in the Community Rating System and work to achieve a higher rating. (5)
3. (tie) Educate landlords and contractors about flood resilience. (3)
3. (tie) Hazard Mitigation Plan goals should consider development of green infrastructure. (3)
3. (tie) Document damages from flood events. (3)

# Vermont Economic Resiliency Initiative [VERI]

## Consultant Team

DuBois & King inc.

Landslide
Linking people to their landscape
Natural Resource Planning
Community Involvement
Watershed Assessment
Project Coordination
GIS Mapping
Facilitation

Bear Creek Environmental

Fitzgerald Environmental Associates, LLC.
Applied Watershed Science & Ecology

Engineering, Planning, Landscape Architecture and Environmental Science
MILONE & MACBROOM

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

# Vermont Economic Resiliency Initiative [VERI]

## Enosburgh, VT

Draft Community Report

July 2015

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

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Vermont Agency of Transportation

- Joe Segale
- Jonathan Croft

Windham Regional Commission

- Jeff Nugent
- Kim Smith

Two Rivers-Ottauquechee Regional Commission

- Peter Gregory
- Pete Fellows

Rutland Regional Planning Commission

- Laura Keir
- Ed Bove
- Steve Schild

Central Vermont Regional Planning Commission

- Daniel Currier
- Gail Aloisio

Northwest Regional Planning Commission

- Bethany Remmers
- Taylor Newton

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- Bear Creek Environmental, LLC: Mary Nealon
- DuBois & King, Inc.: Matt Murawski
- Fitzgerald Environmental Associates, LLC: Evan Fitzgerald
- Landslide Natural Resource Planning, Inc.: Amy Sheldon
- Milone & MacBroom, Inc.: Roy Schiff

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Noelle MacKay, Commissioner of Housing and Community Development

# Table of Contents


Vermont Economic Resiliency Initiative (VERI): Enosburgh Executive Summary ..... i
List of Acronyms ..... v
Glossary of Terms ..... vi
Project Overview ..... 1
  Why was Enosburgh Selected? ..... 2
  Study Area ..... 2
  Research and Outreach ..... 4
Flood History and Town Accomplishments ..... 6
  Flood History and Risk ..... 6
  Town Accomplishments ..... 8
    Town Wide Flood Policy ..... 8
    Site Specific ..... 9
Strategies and Projects to Protect Enosburgh ..... 10
  Municipal Policy and Program Recommendations ..... 10
  Specific Project Recommendations ..... 12
    Channel and Floodplain Management ..... 14
    Infrastructure Improvements ..... 14
Conceptual Designs ..... 16
  Missisquoi River Berm Removal ..... 16
    Overview and Objectives ..... 16
    Data Collection and Alternatives Analysis ..... 16
    Conceptual Design ..... 17
    Steps for Project Implementation ..... 18
    Project Benefits ..... 18
  Tyler Branch Corridor Conservation ..... 18
    Project Overview and Objectives ..... 18
    Data Collection and Alternatives Analysis ..... 19
    Conceptual Design ..... 19
    Steps for Project Implementation ..... 19
    Project Benefits ..... 20
  Local Road Improvements on Detour Routes Used During Missisquoi River Flooding ..... 20
    Project Overview and Objectives ..... 20
    Data Collection and Alternatives Analysis ..... 20
    Conceptual Design ..... 21
    Steps for Project Implementation ..... 22
    Project Benefits ..... 22
Next Steps ..... 23
  Education and Outreach ..... 24
  What Can Individuals Do to Reduce their Risks? ..... 26
    Steps to Reduce Risks ..... 26
  What Can Businesses Do to Reduce their Risks? ..... 27
    Steps to Reduce Risks ..... 28
References ..... 30

## Figures and Tables

Figure 1: Project location map ..... 2
Figure 2: Broad Tyler Branch floodplain ..... 3
Figure 3: Bedrock gorge on Tyler Branch near West Enosburgh ..... 3
Figure 4: Old rock armor on the outside of the channel bend is common along most of Tyler Branch ..... 4
Figure 5: Chair of the Enosburgh Select Board Larry Gervais and DHCD Commissioner Noelle MacKay kick off the 1st Enosburgh Community Forum ..... 5
Figure 6: Deposited sediment and eroding banks upstream of Tyler Branch Road Bridge ..... 6
Figure 7: Tyler branch Road is threatened by erosion from the river and rock armoring is common along the embankment. ..... 7
Figure 8: Spring flooding on the Missisquoi River at Boston Post Road ..... 7
Table 1: How Enosburgh Town and Enosburg Falls Village Met Their ERAF Match ..... 8
Table 2: Categories of Municipal Policies and Programs ..... 11
Table 3: Project Types ..... 12
Figure 9: Flood, sediment, and wood storage area proposed for conservation in the upper Tyler Branch ..... 13
Figure 10: Undersized culvert on a tributary of the Missisquoi River at Hayes Farm Road ..... 13
Figure 11: Missisquoi River flooding at low spot on Boston Post Road looking downstream. Note the ice chunks on the floodplain indicating recent flood flow locations) ..... 14
Figure 12: Profile of VT Route 105 showing low spots where the 100-year flood, or base flood elevation (BFE) is above the road surface. ..... 15
Figure 13: Cross section of berm along Missisquoi River isolating floodplain. VT Route 105 is eight feet above the top of the berm. Berm removal is not recommended in this area. ..... 16
Figure 14: Cross section of berm along Missisquoi River isolating floodplain. VT Route 105 is one foot above the top of the berm. Berm removal is recommended in this area ..... 17
Figure 15: Undersized culvert on a tributary of the Missisquoi River at Davis Road ..... 21

## Appendices

Appendix A: Data Collection
Appendix B: Enosburgh Flood History and Summary of Damages
Appendix C: Adjusted FEMA 100-year Floodplain and the Vermont River Corridor
Appendix D: Common Road Closures and Detours
Appendix E: Enosburgh Flood Resilience Checklist
Appendix F: Municipal Policy and Program Recommendations
Appendix G: Table of Recommended Projects to Protect Businesses and Infrastructure
Appendix H: Maps Showing Recommended Projects to Protect Businesses and Infrastructure
Appendix I: Missisquoi River Berm Removal Concept Plan
Appendix J: Tyler Branch Corridor Conservation Project Concept Plan
Appendix K: Road Typical Section – Full Depth Reconstruction
Appendix L: Community Forum Meeting Notes
Appendix M: Map of Repetitive Damage in Enosburg

# Vermont Economic Resiliency Initiative (VERI): Enosburgh Executive Summary

In communities around Vermont, rapidly melting snow and torrential downpours bring nightmares of washed out bridges, closed roads, flooded basements and shuttered businesses. To calm these fears, Vermonters have been working to better understand the flood risks they face and identify and implement projects that reduce, avoid or minimize these risks. The goal: to protect lives, help businesses remain open and reduce costs to taxpayers for repetitive repair to infrastructure.

After Tropical Storm Irene, Governor Shumlin challenged us to "build back stronger than Irene found us." This project, the Vermont Economic Resiliency Initiative (VERI), is designed to help meet this challenge. It is modeled after a successful project in Bennington, Vermont that minimized business interruption and saved tax payers money by substantially reducing flood recovery costs, is designed to help meet that challenge (DHCD, 2015). With funding from the US Department of Commerce, Economic Development Administration (EDA), the Agency of Commerce and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched VERI to help ensure Vermont recovers quickly and remains open for business after disaster strikes.

In the first phase of the project, the VERI team evaluated and ranked areas where economic activity and associated infrastructure are at high risk of flooding. Based on this state-wide assessment, input from the team's economic steering committee and interest from local municipalities, five areas in seven communities (Barre City and Town, Brandon, Brattleboro, the Town of Enosburg and Enosburg Falls Village, and Woodstock) were selected for a more detailed analysis of the local flood risks to the community and businesses.

The Town of Enosburgh and Enosburg Falls Village were selected as a pilot community as they represent an agricultural-based economy that is impacted by flooding and erosion. The community has worked to identify flood and erosion risks and projects are regularly implemented to strengthen the transportation network that is essential to access local farms and move agricultural products to market.

The VERI team hosted two community forums and has worked directly with local leaders, municipal staff, local businesses and interested citizens to determine the locations of greatest risk and cost, identify potential projects and highlight the work communities have accomplished to date to reduce the impact of floods. Based on data collection and analysis, along with community insight, the team evaluated local flood and erosion risk to business and infrastructure and identified strategies and projects that Enosburgh can implement to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining the local economy.

This report summarizes the team's work and identifies town-wide policy and program recommendations and 11 site-specific projects in Enosburgh, including four projects deemed high priority by the team of river scientists and engineers.

## Municipal Policy and Program Recommendations

Top recommendations include the following:

- **Develop a Local Hazard Mitigation Plan for the Village of Enosburg Falls:** The Village of Enosburg Falls should begin drafting its local hazard mitigation plan and include top projects and strategies identified in this report. Having a hazard mitigation plan will make the Village eligible to apply for additional federal funding for infrastructure projects. It also qualifies the Village for additional state disaster aid from the Emergency Relief Assistance Fund (ERAF) – increasing state aid from 7.5% to 12.5% which reduces local costs.
- **Document Road, Sewer and Water Infrastructure Vulnerabilities in Municipal Plan and Develop Capital Plan:** Specific areas that were damaged, or have known vulnerabilities, should be documented so the communities can plan for their replacement in their long-term budgets, easing the impact on taxpayers. The Town and Village are encouraged to develop a capital improvement plan that incorporates the physical improvements recommended through the VERI project.
- **Update Policies to Prohibit Fill in Flood Hazard Areas:** Allowing landowners to fill low lying areas may help protect an individual property, but it can reduce the land's ability to slow and store flood water that can increase flood hazards to downstream property owners. The Town bylaws prohibit new fill except where necessary to elevate structures above the base flood elevation. The Village bylaws also prohibit fill but the language should be more explicit.

## High Priority Specific Project Recommendations

**Channel and Floodplain Improvements:** These are projects that lower the risk of flooding and erosion to properties along the river through the improvement of natural river and floodplain functions. High priority recommendations in this category include:

- **Remove Berm along the Missisquoi River:** Removal of a portion of the berm near the Enosburgh-Berkshire town line is recommended to allow flood waters to spread into farm fields and reduce flooding along VT Route 105. The state has experience in berm removal to reduce flood and erosion risks and thus a moderate ease of implementation is anticipated for this project. The project would likely costs between $100,000 and $200,000. The project could be implemented over the next five years and reduce risks to local farms, businesses, and the highway into the Village.
- **Conserve Land Upstream of Boston Post Road:** River corridor conservation in an area upstream of Boston Post Road is recommended along Tyler Branch to protect the beaver pond complex and floodplain area that stores sediment and large woody debris. This broad storage area improves downstream channel stability, limits side-to-side movement of the channel and protects farmland from erosion in the Tyler Branch valley. The proposed corridor conservation project is anticipated to have a moderate ease of implementation. The

project would likely cost between $50,000 and $100,000. The project could be implemented over the next five years.

**Infrastructure Improvements:** These are projects that lower the risk of flooding and erosion to utilities, roadways and other municipal or state-owned infrastructure. Top recommendations include:

- **Improve the Surface and Enlarge Undersized Culverts on Hayes Farm Road and Davis Road:** When the Missisquoi River floods, traffic detours to Hayes Farm Road and Davis Road, among others. This detoured traffic can quickly deteriorate rural roads making travel difficult and increasing repair costs for municipal budgets. Undersized culverts also exist along the roads, making the road susceptible to flooding and erosion. Upgrading the road surface and replacing culverts will help ensure this route remains open for business during and after flooding. Work to completely improve both roads would cost more than $1 million and the project could be implemented over the next five years. However, some of these repairs are planned or already under way and the community could decide to accelerate this work.
- **Install Overflow Bridge or Install a New Wider Bridge on Boston Post Road South of the Missisquoi River and Elevate Low Spots along Vermont Route 105:** When the Missisquoi River floods, one of the first locations to overtop is the low spot on Boston Post Road. During high water, several low spots along VT Route 105 flood as well. To keep this vital commercial corridor open, this project proposes an overflow bridge or a new wider bridge and elevating several low spots on VT Route 105. The additional bridge would likely cost over $1 million and elevating the low spots on Route 105 could cost over $200,000. The project could be implemented over the next five years.

The team prepared concept designs for three of the high-priority projects – Missisquoi River berm removal, Tyler Branch corridor conservation, and improvement of Davis and Hayes Farm Roads – to help Enosburgh take the next steps and to create model project designs to help other communities learn from the VERI project.

## Next Steps

As part of the ongoing community discussion regarding the VERI effort, the team recommends the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization.
- Prioritize one or two projects to pursue each year with assistance from the Vermont Department of Environmental Conservation and Northwest Regional Planning Commission staff to identify appropriate funding sources and partners.
- Apply for one or two grants each year to advance project development and designs.
- Implement projects as funding allows.
- Monitor project success.

Irene taught us many lessons -- a key one was that no one individual, business, organization, town or state agency can address and tackle large and complicated projects alone. Reducing the risk of future floods in Enosburgh will require partnerships, funding and time to implement. The Agency of Commerce and Community Development, its sister agencies and the Northwest Regional Planning Commission are committed to helping Enosburgh take the steps outlined in this report to save lives and protect jobs and its economy from future storms and floods. Flooding due to severe storms will happen again, the question is how can we best reduce the recovery costs to communities and ensure businesses remain open.

# List of Acronyms

**ACCD** – Vermont Agency of Commerce and Community Development

**ANR** – Vermont Agency of Natural Resources

**BFE** – Base Flood Elevation

**CRS** – Community Rating System

**DEC** – Vermont Department of Environmental Conservation

**DHCD** – Vermont Department of Housing and Community Development

**EDA** – US Economic Development Administration

**EPA** – United States Environmental Protection Agency

**ERAF** – Emergency Relief Assistance Fund

**FEA** – Fitzgerald Environmental Associates, LLC

**FEMA** – Federal Emergency Management Agency

**GIS** – Geographic Information System

**HMP** – Hazard Mitigation Plan

**LiDAR** – Light Detection and Ranging

**NFIP** – National Flood Insurance Program

**NRCS** – Natural Resources Conservation Service

**NRPC** – Northwest Regional Planning Commission

**SFHA** – Special Flood Hazard Area

**VERI** – Vermont Economic Resiliency Initiative

**VTRANS** – Vermont Agency of Transportation

# Glossary of Terms

Terms are bolded the first time they appear in the text.

**100-Year Floodplain** – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Flood Zone or 100-Year Flood Hazard Area.

**500-Year Floodplain** – The area that will be inundated by the flood event having a 0.2% chance of being equaled or exceeded in any given year. Also called 500-Year Flood Zone or 500-Year Flood Hazard Area.

**Base Flood Elevation** – The computed elevation to which floodwater is anticipated to rise during a 100-year flood.

**Berm** – An artificial ridge or embankment, e.g., a raised bank bordering a river that prevent flow out of the main channel.

**Community Rating System (CRS)** – Program that provides a flood insurance premium rate reduction based on a community's floodplain management activities. CRS recognizes community floodplain management activities that exceed the minimum NFIP standards. Besides the benefit of reduced insurance rates, CRS floodplain management activities enhance public safety, reduce damages to property and infrastructure, avoid economic disruption and losses, and protect the environment.

**Confluence** – The location where two or more river channels join.

**Cross Section** – A view or drawing that shows what a river channel or any other object looks like as if a cut has been made across it.

**Culvert** – A pipe or tunnel underground, usually under roads, that transports flowing water, sediment, debris and ice from one side to the other.

**Emergency Relief Assistance Fund** – This program allows towns in Vermont to increase the amount of state aid money they could receive as a match to federal aid for post-disaster recovery.

**Erosion** – The wearing away of rock or soil by flowing water.

**Fill** – A quantity of earth, stones, etc., for building up the level of an area of ground.

**Floodplain** – Area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge.

**Floodway** – The area immediately adjacent to the channel that must remain open to allow floodwaters to pass.

**Flood Resiliency** – The ability of individuals, communities, organizations and states to adapt to and recover from flooding hazards without compromising long-term prospects for development.

**Hamlet** – A small rural community.

**Hazard Mitigation Plan** – A document and planning process that provides actions to reduce the long-term risk to human life, property, and the economy from natural disasters.

**Large Woody Debris** – Large trees that find their way into a channel and are transported downstream and physically broken down. Large woody debris is typically removed from a channel

to reduce the risk of structure clogging, yet is important to leave in the channel to increase long-term channel stability and to maintain good fish habitat.

**LiDAR** – Elevation data generated by remote sensing the distance between a plane or satellite and the earth's surface.

**Mass Wasting** – The large-scale erosion of the valley wall that leads to large sediment loads in river channels that can remain active over long periods of time as the channel moves.

**Mitigation** – Any sustained action taken to reduce or eliminate the long-term risk to life and property from hazard events. It is an on-going process that occurs before, during, and after disasters and serves to break the cycle of repetitive damage and repair.

**National Flood Insurance Program** – A federally funded and locally implemented program to reduce the impacts of flooding through individual insurance policies and incentives for floodplain regulations.

**No-rise Certification** – A certification by an engineer that a project will not increase flood heights.

**Riparian Buffer** – Mixed composition, vegetated land adjacent to a stream separating it from other land uses.

**Riprap** – The application of rocks to reduce erosion and protect nearby infrastructure or private property. Also known as rock armoring.

**Special Flood Hazard Area** – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Flood Zone or 100-Year Flood Hazard Area.

**State River Corridor** – Area delineated by the Vermont Rivers Program adjacent to rivers and streams that provide functions that restore and maintain natural stability for a river. These areas are often at higher risk of erosion.

**Tributary** – A stream that flows into another, larger stream.

# Project Overview

In 2013 the Vermont Agency of Commerce and Community Development (ACCD) received disaster recovery funding from the US Economic Development Administration (EDA) for the Vermont Economic Resiliency Initiative (VERI). The objectives of VERI are to:

1. Analyze threats to areas of economic activity and their associated infrastructure;
2. Develop plans to reduce impacts and avoid future losses and costs; and
3. Identify projects that communities and businesses can implement that maximize opportunities for businesses to stay open.

The overarching project goal is to help businesses and communities bounce back quickly when disaster strikes, saving time and money in recovery costs.

**The primary objective of VERI is to develop strategies and projects to make businesses and communities more resilient to floods and other disasters.**

VERI is led by ACCD's Vermont Department of Housing and Community Development (DHCD) in partnership with the Vermont Agency of Natural Resources (ANR), Vermont Agency of Transportation (VTrans), and Vermont's Regional Planning Commissions, which in Enosburgh is the Northwest Regional Planning Commission (NRPC). Early in the VERI process, these agencies mapped places where flood and **erosion** risks intersect with areas of economic activity and infrastructure state-wide. Five pilot areas were selected for a detailed risk assessment – Barre City and Town, Brandon, Brattleboro, Enosburgh Town/Enosburg Falls Village, and Woodstock. A team of river scientists and engineers from five Vermont consulting firms – Bear Creek Environmental, LLC, DuBois & King, Inc., Fitzgerald Environmental Associates, LLC, Landslide Natural Resource Planning, Inc., and Milone & MacBroom, Inc. – was hired to assess the rivers and **floodplains** and assist in developing strategies and projects to reduce the vulnerability of infrastructure and businesses to flood damage.

A number of factors played a role in the selection of the five communities for more detailed assessments. First, the project team ranked towns across the state by flood risk, economic activity and infrastructure at risk. Then the team looked at the twenty highest ranking communities and removed any that had undergone or had funding for similar analysis (e.g., Bennington and Waterbury). Next, the team strived to select five areas that represented different economic profiles (e.g., agriculture, tourism, downtowns) as well as different sizes. Other considerations included risk of future damage, economic factors and level of community engagement and interest. Together, these factors helped determine the five pilot communities.

## Why was Enosburgh Selected?

Enosburgh was selected as a pilot community for the following reasons:

- Enosburgh has a farm-based economy located in the northwest corner of Vermont that is representative of the state's agricultural markets, dairy in particular;
- Flooding takes place along both Tyler Branch and the Missisquoi River impacting farming, the movement of agricultural goods, businesses and homes;
- Transportation infrastructure is threatened by flood and erosion risk in the area; and
- Previous efforts have been made by Enosburgh to identify flood and erosion risks.

## Study Area

Enosburgh Town, which includes the Village of Enosburg Falls and several **hamlets**, is located in Franklin County in northwestern Vermont (Figure 1). The Town covers an area of approximately 49 square miles and 4,977 people live in the Town according to the 2010 population census.

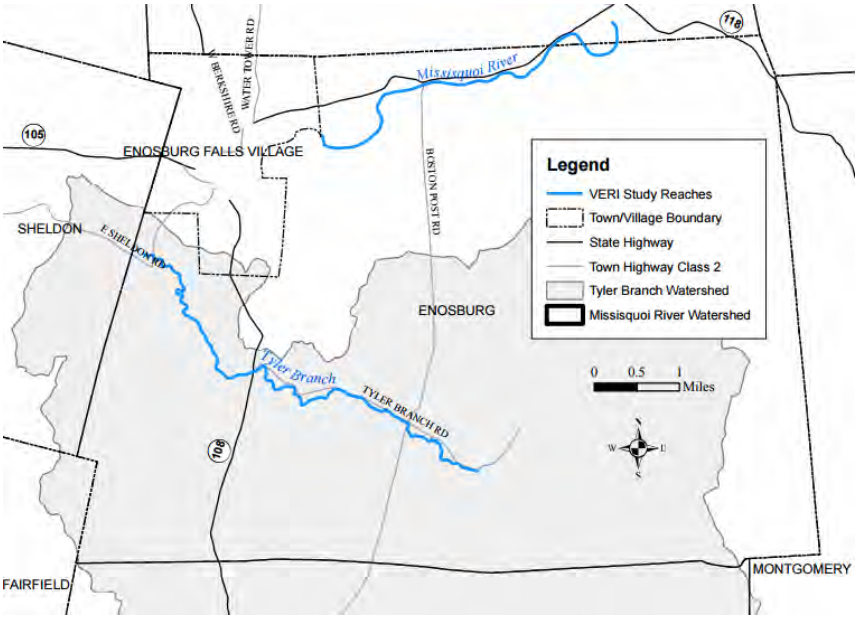


**Figure 1:** Project location map

Enosburgh is locally referred to as the "Dairy Capital of the World" given the dominance of farming. A quick drive along most roads reveals miles of farm fields divided by tree-lined rivers and streams with forested mountains in the backdrop to the east and Lake Champlain to the west. Fields are primarily used for dairy operations to graze cattle, produce hay, or produce silage. About half of the farm fields in the Town are conserved (4,167 acres according to the Vermont Land Trust) and thus will permanently remain in agricultural production.

Commercial development is concentrated in Enosburg Falls, with rural residential and commercial development spread out along roadways outside of the Village. A pocket of businesses exists along the Missisquoi River across VT Route 105 in the vicinity of the Dairy Center. The Village of Enosburg Falls contains businesses and homes. Homes and businesses are clustered along Tyler Branch near the intersection of Tyler Branch Road and Grange Hall Road in West Enosburgh.

Tyler Branch begins in the Cold Hollow Mountains in Bakersfield and Belvidere, and flows northwest through Enosburgh into the Missisquoi River. The 58 square mile watershed is mostly forested in the upper, steep areas (76%), agricultural fields in the flatter valley bottom areas (17%),

and pockets of developed lands (6%) (Troy et al., 2007). This project focuses on 5.3 miles of Tyler Branch from the **confluence** of Beaver Meadow Brook and Cold Hollow Brook downstream to the Enosburgh-Sheldon town line. Tyler Branch flows through broad floodplains with deposited river sediment (Figure 2) and narrow bedrock gorges (Figure 3) (Ruddell et al., 2009). Over the years, the river was **straightened** and moved towards the edges of its valley to create space for farm fields and roads. These changes, along with gravel dredging, have led to excessive sedimentation and channel instability in several locations. Generations of rock armor (i.e., **riprap**) are common on the outside bends of the river to limit its movement (Figure 4). Many of the flood and erosion risks identified in this and previous projects stem from placing infrastructure too close to the river and river management practices.

**Figure 2:** Broad Tyler Branch floodplain (Source: FEA, 2014)

The Missisquoi River is one of the larger rivers in Vermont, draining 1,200 square miles of northern Vermont and southern Quebec (Missisquoi River Basin Association). The river originates in the mountains of Lowell and then generally flows west for 88 miles before entering into Missisquoi Bay and Lake Champlain. Forestland on the steeper slopes is the most abundant land use (53%), while agricultural land dominates the valley bottom and floodplains as the second most abundant land use (24%) (VT stream geomorphic data).

**Figure 3:** Bedrock gorge on Tyler Branch near West Enosburgh (Source: FEA, 2014)

The Missisquoi River channel in this area is impounded behind the Enosburg Falls Dam owned by the Enosburg Electric Department. The water backs up behind the dam for about 2.5 miles under normal flow, or to approximately one mile downstream of the bridge at Boston Post Road. The ponded water leads to increased sedimentation in this area. The Missisquoi River channel has nearly 30% of its banks armored to protect infrastructure and farm fields. **Large woody debris** and ice jams are common in this area due to the low channel slope (0.02%) and the backed-up water behind the Enosburg Falls Dam.

Floodplain exists, yet some of it is separated from the channel with **berms** to prevent flooding and erosion of agricultural fields.

## Research and Outreach

A kick-off meeting took place in September 2014 to initiate the project and to share information. Following this meeting, the team reviewed existing information about the Town of Enosburgh, Enosburg Falls Village, Tyler Branch, and the Missisquoi River. Data included past river assessment data, local bylaws, floodplain and river corridor mapping, town plans, topography maps and aerial photographs (Appendix A). River scientists and engineers on the team conducted a site walk along the Tyler Branch project area, while a windshield survey with periodic site visits was conducted at the Missisquoi River project area. The primary objectives of the field work included to:

- Explore how the rivers have changed since past field work and assessments;
- Explore evidence of past flood and erosion damages;
- Identify businesses, infrastructure, and homes vulnerable to flood and erosion risks;
- Assemble a list of alternatives to protect businesses and infrastructure; and
- Collect data to create concept designs for high priority alternatives.

**Figure 4:** Old rock armor on the outside of the channel bend is common along most of Tyler Branch (Source: MMI, 2014)

DHCD and the NRPC hosted the first of two Community Forums at the Enosburgh Emergency Services Building on October 29, 2014 (Figure 5). Several community members, business owners and homeowners from the area attended the forum. Some background about the VERI study was provided by DHCD Commissioner Noelle MacKay and site information was provided by Roy Schiff of Milone & MacBroom, Inc., and then the floor was open for ideas and questions from community members, and discussion with the group.

Enosburgh community members highlighted successfully completed and ongoing flood resilience projects carried out by the Town, including:

- Tree plantings by the Missisquoi River Basin Association to stabilize the bank;
- Stream protection regulations based on river corridors;
- A new bridge at Boston Post Road;
- A conservation easement next to the Tyler Branch Road Bridge; and
- A **culvert** replacement on Boston Post Road.

Participants also highlighted areas of hazard and risk including:

- Spring flooding and woody debris;
- Annual Missisquoi River flooding along VT Route 105 that diverts traffic to smaller roads that get damaged;
- The Hopkins Road Bridge over the Trout River floods annually and regularly needs repairs; and
- Flooding and erosion at Boston Post Road and near Vaillancourt's Garage on Tyler Branch.

Community members also outlined the following potential projects to reduce flooding.

- The full length of Hayes Farm Road is in poor shape and needs repairs and culvert upgrades to handle detour traffic during Missisquoi River flooding;
- Landslide near Courser Road along Tyler Branch needs stabilization;
- Recreational vehicles stored for the year in the campground off of Sand Hill Road should be moved out of floodplain to prevent future losses;
- Continue cover cropping; and
- Possible berm removal along Tyler Branch near Grange Hall Road.


**Figure 5:** Chair of the Enosburgh Select Board Larry Gervais and DHCD Commissioner Noelle MacKay kick off the 1st Enosburgh Community Forum (Source: MMI, 2014)

The community specific strategies suggested by participants in the workshops and meetings, along with the research completed by the VERI team, were used to develop the recommendations outlined in this report to help the community prepare for, manage, and decrease risk, and reduce the economic costs of future losses due to flooding.

In the sections that follow, the team has outlined specific projects, as well as plan and bylaw updates, that can help ensure businesses remain open and infrastructure continues to function. The team included estimated costs, funding sources and impacts associated with implementing the suggested priority projects.

# Flood History and Town Accomplishments

Enosburgh Town experiences regular property and infrastructure damage from flooding along Tyler Branch and the Missisquoi River. With input from the NRPC and the community, the team has identified key flood risks in Enosburgh.

## Flood History and Risk

Minor flooding occurs nearly every spring in the project area, particularly along the Missisquoi River. Ice jams are common and tend to cause bank and field erosion. For example, an ice jam flood occurred in 2000 on the Missisquoi River that led to one to two feet of water on portions of VT Route 105 between Enosburg Falls and East Berkshire with an estimated $20,000 in damages (Appendix B).

The worst flood to date was in 1927 and many homes and barns were destroyed and livestock was washed away. The North Enosburgh Covered Bridge and electric power house at the dam were lost and many roads were inundated.

Missisquoi River stream gauge data document four 25-year floods in the past 20 years. The gauge data also show that more frequent and larger floods are likely to come (Collins, 2009; NMFS, 2011; Armstrong et al., 2012).

**Figure 6:** Deposited sediment and eroding banks upstream of Tyler Branch Road Bridge (Source: FEA, 2014)

The Flood Ready Vermont Summary Report for Enosburgh indicates that twenty-one buildings exist in the FEMA-mapped **Special Flood Hazard Area** (SFHA), of which only three (14%) have flood insurance (Appendix C). Agricultural fields occupy most of the **100-year floodplain** in Enosburgh.

Seven businesses and homes exist in the floodplain along Tyler Branch over the project site. Approximately 4,500 feet of Tyler Branch Road make up the edge of the 100-year floodplain (25% of the road length in the project area) and are vulnerable to erosion. The floodplain abruptly narrows at Tyler Branch Road Bridge located between Duffy Hill Road and VT Route 108, and excessive erosion is taking place in the area (MMI, 2008, 2009) (Figure 6).

Ten additional businesses and homes are within the Tyler Branch **state river corridor**, the area where the river is most likely to move on the valley floor (ANR, 2014a). One of these buildings is the Town Garage and sand/salt storage area. The town is considering ways to protect this asset in

the event of a large flood. The mapped river corridor contains 10,300 feet of Tyler Branch Road (40% of the road length in the project area).

The 100-year floodplain along the Missisquoi River in the project area contains portions of nine farm buildings and homes. Approximately 2,500 feet of VT Route 105 is in the floodplain between Enosburg Falls and East Berkshire (10% of the total road length between these two points). The river corridor contains an additional seven structures that are vulnerable along the Missisquoi River.

**Figure 7:** Tyler branch Road is threatened by erosion from the river and rock armoring is common along the embankment. (Source: FEA, 2014)

Flood and erosion risks at the Enosburgh VERI project area largely influence the rural transportation network in Enosburgh. The following issues were noted:

- Tyler Branch Road is threatened by erosion from the river and rock armoring is common along the embankment (Figure 7).
- VT Route 105 has several low spots and is prone to flooding every several years.
- Boston Post Road is susceptible to both local flood and erosion hazards (Figure 8).
- Duffy Hill Road is prone to flooding.
- Hopkins Bridge Road is prone to flood and erosion along the Trout River damages and is a location of repeat damages.

**Figure 8:** Spring flooding on the Missisquoi River at Boston Post Road (Source: NRCS, 2011)

Davis Road and Hayes Farm Road tend to deteriorate in spring thaw conditions when Missisquoi River flooding diverts traffic to them. During the first community forum, community members noted that spring flood detours (Appendix D) can deteriorate the smaller roads as they thaw. This requires expensive repairs that puts pressure on municipal budgets. These detours also extend the milk trucks routes and make it harder for people to get to work.

## Town Accomplishments

Enosburgh has worked hard over the past several years to gain a better understanding of flood and erosion risks, and to reduce the threats to businesses, farms, infrastructure, and homes. They have conducted assessments of the river and worked to implement recommendations outlined in these studies. The town protects its rivers and streams from development with regulations based on the state river corridors.

### *Town Wide Flood Policy*

In 2014, the State of Vermont established an **Emergency Relief Assistance Fund** (ERAF) to provide matching funding for federal assistance after federally declared disasters. This program allows towns in Vermont to increase the amount of state aid money they can receive as a match to federal aid for post-disaster recovery. By taking certain steps to become more prepared and resilient, a town can be eligible for increased state aid money. Certain damage costs from federally declared disasters are reimbursed 75% by federal money. The State of Vermont contributes a minimum of 7.5% of the total cost, but if a town takes additional steps, the state aid can increase to 12.5% or 17.5% of the cost, leaving less for the town itself to pay (State of Vermont, 2015).

Enosburgh's existing policies, plans and programs qualify the town to receive 12.5% state funding with the Village qualifying for 7.5 % (Table 1). A key next step for these communities is to protect river corridors or protect flood hazard areas from new encroachment and participate in the FEMA **Community Rating System** (CRS).

**Table 1: How Enosburgh Town and Enosburg Falls Village Met Their ERAF Match**

| ERAF Rating | Town 12.5% | Village 12.5% |
|---|---|---|
| Participate in the **National Flood Insurance Program** | Yes | Yes |
| Adopt 2013 State Road & Bridge Standards | Yes | Yes |
| Adopt Local Emergency Operations Plan | Yes | Yes |
| Adopt Local **Hazard Mitigation Plan** | Yes | No |
| **Step to increase State aid to 17.5% (one needed to qualify)** | | |
| Adopt no new development in a River Corridor | No | No |
| Adopt no new development in Flood Hazard areas and participate in the federal Community Rating System | No | No |
| **State ERAF Match** | **12.5%** | **7.5%** |

Other key bylaws that reduce risk and provide protection include:

- Stream buffer regulations to protect water quality and keep buildings and property a safe distance from flood waters (intermittent streams 25 feet; unnamed rivers and streams 50

feet; named rivers and streams 110 feet; and lakes and ponds 50 feet). The recommended buffer widths are based on the state river corridor.

- Six of the zoning districts in the Village of Enosburg Falls require setbacks from rivers and streams where no structures can be built. The setback is 50 feet in agriculture/rural residential, high-density residential zone, low-density residential and recreational zones. The setback is 100 feet in commercial and industrial zones.
- The town follows the minimum floodplain protection standards of the National Flood Insurance Program (NFIP). The village follows the minimum standards with the exception of allowing development in the **floodway** with a **no-rise certification.**

### *Site Specific*

Although widespread costly flood and erosion damages are not common in Enosburgh along Tyler Branch and the Missisquoi River, the Town has implemented practices to protect infrastructure and reduce risks to businesses and homes. A culvert was recently replaced on Stonehouse Road near the intersection with Howrigan Road that was prone to flooding. Rock armor was placed at the low spots along Boston Post Road near the Missisquoi River and at Duffy Hill Road near Tyler Branch to reduce erosion. The VT Route 108 Bridge over Tyler Branch was replaced and widened to pass more water. The old left bridge footing was left in place to minimize construction impacts and project cost, and the remnant footing does not increase flood and erosion risk.

Given the prevalence of flooding of farm fields, cover cropping and other agricultural practices such as crop rotation and no-till corn are helping reduce erosion potential and keeping the land productive and out of the river and lake. During the Community Forum, it was noted that the University of Vermont Extension is piloting a program to plant cover crops using a helicopter on some Enosburgh farms.

# Strategies and Projects to Protect Enosburgh

The team has developed a list of recommended strategies and projects to protect Enosburgh's businesses and infrastructure during future floods. Based on data collection and analysis, review of the town plan and bylaws, previous reports and community input, the team developed a list of flood **mitigation** objectives for Tyler Branch and the Missisquoi River to address town-specific flood damages. These objectives include:

1. Improving local roads to better accommodate detours from VT Route 105 when the Missisquoi River floods;
2. Removing berms where risk reduction will take place, such as reducing Missisquoi River flooding along VT Route 105 and reducing Tyler Branch ice jam flooding near Grange Hall Road; and
3. Conserving floodplain lands that reduce downstream flood and erosion risks to farm fields, businesses, infrastructure, and private property.

Strategies and projects for Enosburgh are summarized below, including municipal policy and program recommendations and site-specific project recommendations.

## Municipal Policy and Program Recommendations

Reducing the impacts of floods involves an ongoing process of evaluating and adjusting policies to minimize risks through protection, prevention and education. Accordingly, the VERI team first reviewed Enosburgh's Municipal Plan and land use regulations to identify the policies they contain and those that are absent. The team also reviewed related plans for capital improvements, conservation, emergency and preparedness and continuity of operations. These documents were reviewed with the goal of identifying gaps and opportunities to improve the flood preparedness, safety and resilience of residents, visitors, businesses and local government.

The team then used the US Environmental Protection Agency's (EPA) **flood resiliency** checklist that was developed from a study in the Mad River Valley in Vermont (US EPA, 2014). This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

The checklist review found that Enosburgh currently employs 28 of 56 items on the checklist including regulatory measures to limit development in areas subject to flooding, and utilizing steep slope development regulations (Appendix E).

The results of the review identified 13 planning or policy opportunities in Enosburgh and Enosburg Falls Village that were then organized into four groups: Regulations, Community Planning, Emergency Planning, and Education and Outreach. The distribution of opportunities to improve policy and program is show in Table 2.

| Table 2: Categories of Municipal Policies and Programs | | |
|---|---|---|
| **Category** | **Description/Overview** | **Policies or Programs** |
| Land Use Regulations | Avoid and minimize land use conflicts around watershed resources that help lower the risk of flooding and/or erosion to properties. | 3 |
| Community Planning | Develop long term goals, recommendations and budgets to improve flood resilience. | 3 |
| Emergency Planning | Specific projects for supporting mitigation and recovery actions for flooding and other hazards. | 4 |
| Education and Outreach | Programs targeted at critical businesses and vulnerable populations to educate them about flood risk, mitigation and recovery. | 3 |

The results of the plan and policy reviews were then combined and scored with either a one (ineffective), three (limited) or five (effective) using the following three objectives:

1. Reduces flood risk (proposed project lowers the flood level);
2. Reduces erosion risk (proposed project lessens the vulnerability to erosion); and
3. Protects businesses, infrastructure and property.

The three scores were added to provide a total score. Cost and ease of implementation, political realities and limitations as well as input from the community were also considered. To assist the town with implementation, potential partners and funding sources were identified. Each recommendation was further explained and next steps were identified. This information was compiled into easy to read charts found in Appendix F.

The highest ranked regulatory changes included developing adopting regulations to minimize conflicts between rivers and development. Recommended town plan updates included expanding the flood resilience element, documenting road, sewer and water infrastructure vulnerabilities, developing capital and hazard mitigation plans and identifying floodplain for conservation.

The top priority policy and program recommendations were presented at the community forum and local feedback was incorporated into the final prioritization, below.

- **Develop a Local Hazard Mitigation Plan for the Village of Enosburg Falls.** The Village of Enosburg Falls should begin drafting its local hazard mitigation plan (HMP) and include top projects and strategies identified in this report. Having a hazard mitigation plan will also make the Village eligible to apply for additional federal funding for infrastructure projects. It also qualifies the Village for additional state disaster aid from the Emergency Relief Assistance Fund (ERAF) – increased state aid from 7.5% to 12.5% which reduces local costs.

- **Document road, sewer, and water infrastructure vulnerabilities in municipal plan and develop capital plans.** Specific areas that were damaged or have known vulnerabilities should be documented so the communities can plan for their replacement in their long-term budgets, easing the impact on taxpayers. The Town is encouraged to develop a capital improvement plan that incorporates the physical improvements recommended through the VERI project.
- **Update policies to prohibit fill in flood hazard areas.** Allowing landowners to **fill** low lying areas may help protect an individual property, but it can reduce the land's ability to slow and store the extra flood water and it can increase flood hazards to downstream property owners. The Town bylaws prohibit new fill except where necessary to elevate structures above the **base flood elevation**. The Village bylaws also prohibit fill but the language should be more explicit.

Local stakeholders (residents, businesses, planning commission, Selectboard, etc.) are encouraged to review these recommendations and seek assistance from the identified partners and programs and take these steps to reduce flood risk over time.

## Specific Project Recommendations

Based on field data, analysis, existing information, and community input, the team prepared a list of recommended projects to protect businesses and infrastructure (Appendix G) along with accompanying maps (Appendix H). The projects were grouped into four categories based on their approach to mitigating risks (Table 3).

**Table 3: Project Types**

| Category | Description | Number of Projects |
|---|---|---|
| Building and Site Improvements | Lowers the risk of flooding and erosion to specific properties through improvements to the building and surroundings (e.g., sealing building to prevent water infiltration). | 1 |
| Channel and Floodplain Management | Lowers the risk of flooding and erosion to properties along the river through the improvement of natural river and floodplain functions (e.g., tree plantings along unstable river banks and berm removal to reconnect floodplain). | 5 |
| Infrastructure Improvements | Lowers the risk of flooding and erosion to roadways and other municipal or state-owned infrastructure (e.g., increasing the size of bridges and culverts to pass more flood waters and improving road surfaces for safer travel). | 5 |
| Public Safety Improvements | Lowers the risk of flooding and erosion to properties through the avoidance of future flood risks (e.g., FEMA buyouts of properties highly vulnerable to flooding). | 0 |

To begin, the team screened and prioritized each project. Each project received a score of one (ineffective), three (limited) or five (effective) for the three objectives:

1. Reduces flood risk (proposed project lowers the flood level);
2. Reduces erosion risk (proposed project lessens the vulnerability to erosion); and
3. Protects businesses, infrastructure and property.

The three scores were added to provide a total score, which was then weighted based on the importance of the project in the region. Projects that would result in a regional economic boost and help keep businesses open were given the greatest weight, while projects that would offer minimal economic benefit to the business economy were assigned a lesser weight. Many of the high priority projects are from the Infrastructure Improvements category, as those at-risk areas potentially affect the greatest number of community members and businesses.

Project partners and stakeholders, including representatives from DHCD, ANR, NRPC, and the Town of Enosburgh and Village of Enosburg Falls, provided feedback on a draft list of mitigation strategies and their priorities in April 2015. The feedback was incorporated into the final prioritization of projects. The eleven identified mitigation projects apply to nineteen distinct sites (See Appendix H). Below are brief descriptions of the high priority projects from each of the project categories described in Table 3. A summary of efforts to develop conceptual designs for two of the high priority projects follows, with additional supporting information provided in Appendices I and J.

**Figure 9:** Flood, sediment, and wood storage area proposed for conservation in the upper Tyler Branch (Source: FEA, 2014)

**Figure 10:** Undersized culvert on a tributary of the Missisquoi River at Hayes Farm Road (Source: FEA, 2014)

## *Channel and Floodplain Management*

**Remove Berm Along the Missisquoi River:** The berm is located one mile west of the intersection of VT Route 105 and VT Route 108, near the Enosburgh-Berkshire town line. The berm is approximately 3,000 feet long and varies in height between one and five feet. Removal of an estimated 950 feet would help spread flood waters and reduce VT Route 105 flooding. This would reduce flooding, protect local businesses, and limit the disruption of the movement of goods in Enosburgh.

The state has experience in berm removal to reduce flood and erosion risks and thus a moderated ease of implementation is anticipated for this project. An initial ballpark project cost is between $100,000 and $200,000. The project could be implemented over the next 5 years. (See the Conceptual Design Section for more details).

**Figure 11:** Missisquoi River flooding at low spot on Boston Post Road looking downstream. Note the ice chunks on the floodplain indicating recent flood flow locations (Source: Staci Pomeroy, ANR, March 29, 2006)

**Conserve Land Upstream of Boston Post Road:** River corridor conservation about 1,700 feet upstream of Boston Post Road along Tyler Branch would help protect the beaver pond complex and floodplain area that stores sediment and large woody debris (Figure 9). This broad storage area improves downstream channel stability, limits movement side-to-side and protects farmland from erosion in the Tyler Branch valley. Corridor conservation was recommended in past assessment work on Tyler Branch (Ruddell et al., 2009). Based on the current assessment, corridor conservation continues to be an important approach to reducing risks. This project should include stabilization of the Tyler Branch Road embankment that has some localized erosion in the proposed conservation area.

The proposed corridor conservation project is anticipated to have a moderate ease of implementation. The project would likely cost between $50,000 and $100,000. The project could be implemented over the next 5 years. (See the Conceptual Design Section for more details).

## *Infrastructure Improvements*

**Improve Hayes Farm Road and Davis Road:** When the Missisquoi River floods, the traffic detours to the Hayes Farm Road and Davis Road, among others. If detours take place during spring

thaw, the roads deteriorate making travel difficult and that require costly repairs that impact municipal budgets. Undersized culverts also exist along the roads (Figure 10) making the road susceptible to flooding and erosion. The improvement of these detour routes (i.e., upgrading the road surface and replacing culverts) was noted by the community as a way to maintain business activity during and after flooding.

The proposed road upgrades are anticipated to have a moderate ease of implementation as rural road construction is familiar practice in the state. The project to fully restore both roads would cost more than $1 million. The project could be implemented over the next five years, although some repairs have been under way and the community may be interested in prioritizing the completion of this work sooner. (See the Conceptual Design Section for more details).

**Install Overflow Bridge or a New Wider Bridge on Boston Post Road at the Missisquoi River and Elevate Lows Spots along VT Route 105:** When the Missisquoi River floods, one of the first locations to overtop is the low spot on Boston Post Road just south of the bridge over the channel. Both flood waters and ice chunks pass over the road (Figure 11). During high water on the Missisquoi River, several low spots along VT Route 105 get flooded after the Boston Post Road is wet (Figure 12). This project proposes a wider bridge or an overflow bridge, and elevating several low spots on VT Route 105 that would reduce flooding, protect local businesses and allow the movement of goods and workers to continue while flood waters safely pass downstream.

This project would be difficult to implement given the high cost and complex design for bridges. The existing bridge was built in 1928 and is very narrow and thus needs replacing. Perhaps the bridge could be lengthened to span the flood-prone area when it is replaced. Elevating the VT Route 105 low spots could take place as part of VTrans roadway resurfacing, yet hydraulic modeling is likely needed for design to be sure that elevating the road does not block floodplain and create additional flood risks. The additional bridge would likely cost over $1 million and the VT Route 105 elevation could cost over $200,000. The project could be implemented over the next five years.

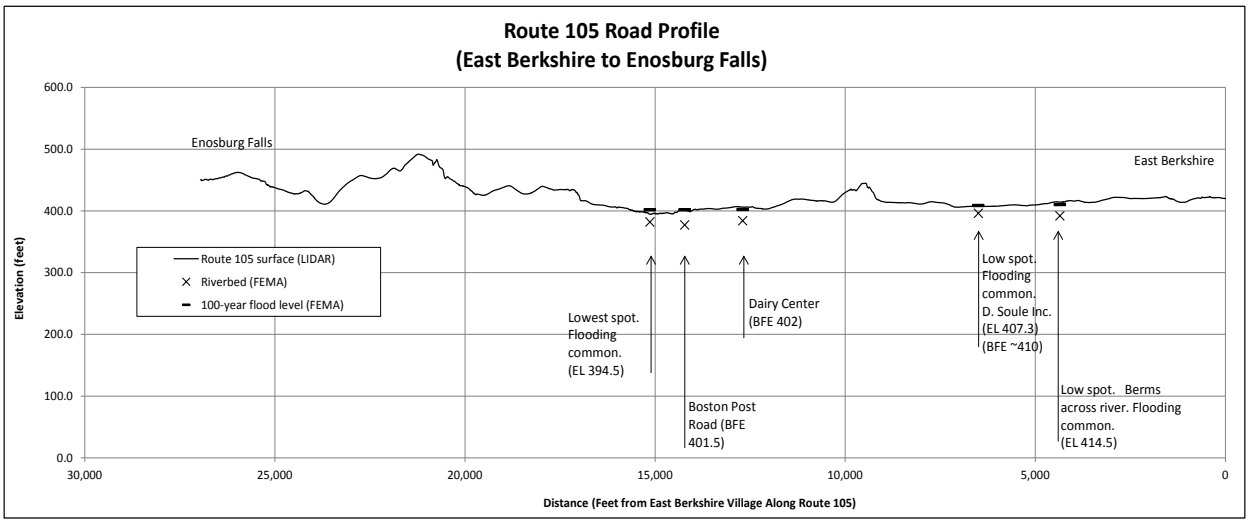


**Figure 12:** Profile of VT Route 105 showing low spots where the 100-year flood, or base flood elevation (BFE) is above the road surface.

# Conceptual Designs

Using input from the community and our team's professional judgment of priority flood mitigation projects that would provide multiple benefits to the community, the team developed conceptual designs for three high-priority projects. These projects include a floodplain reconnection through the removal of an old berm, the conservation of a river corridor in a storage area, and rural road improvements. The conceptual designs include enough detail to apply for most funding opportunities to advance the design toward implementation.

## Missisquoi River Berm Removal

### *Overview and Objectives*

There is a berm along the south bank of the Missisquoi River about one mile west of the intersection of VT Route 105 and VT Route 118. The berm begins to take shape on the western side of a large bend in the river where the channel is next to VT Route 105, and runs beneath a narrow tree line along the river. The berm appears to be blocking floodplain access along a portion of the Missisquoi River directing flood flows towards VT Route 105.

The objective of this project is to reduce flooding along VT Route 105 to allow local and regional businesses to function during small flood scenarios and increase flooding in the floodplain. However, if the town wanted to move forward with this, they should assess any erosion risks to the farm field located in the floodplain that would arise from berm removal. Such erosion could impact crops and farm income so should be considered.

### *Data Collection and Alternatives Analysis*

Due to site conditions, this concept design was prepared primarily using **LiDAR** data and distant field observations. This information will need to be updated with accurate field data in a future design phase.

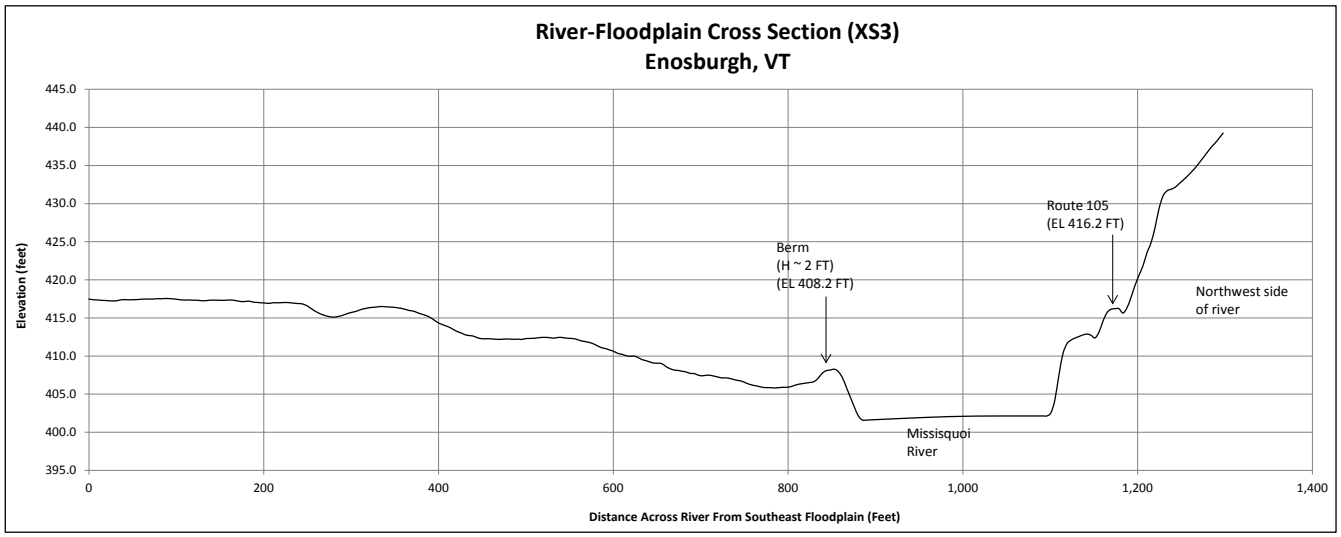


**Figure 13:** Cross section of berm along Missisquoi River isolating floodplain. VT Route 105 is eight feet above the top of the berm. Berm removal is not recommended in this area.

**Cross sections** were cut using the LiDAR elevation data to explore the shape and length of the berm (Appendix I). The berm is the usual trapezoidal shape with a height that varies between one foot and five feet (Figure 13). The base width of the berm typically varies between 20 feet and 40 feet. The estimated berm length is 3,000 feet.

The elevation of the top of the berm, the floodplain elevations on both sides of the river, and the elevation of VT Route 105 were used to initially identify the location and length of berm to remove. Berm removal is not recommended where the berm is small and where the road is much higher than both the berm and floodplain since the benefits do not justify the costs and construction impacts (See Figure 13). Where the road and top of berm approach the same elevation, berm removal and floodplain reconnection are cost-effective to reduce flood impacts and are recommended (See Figure 14).

The alternatives analysis to identify how much berm to remove resulted in a proposed removal length of approximately 950 feet. This number will be refined during future design.

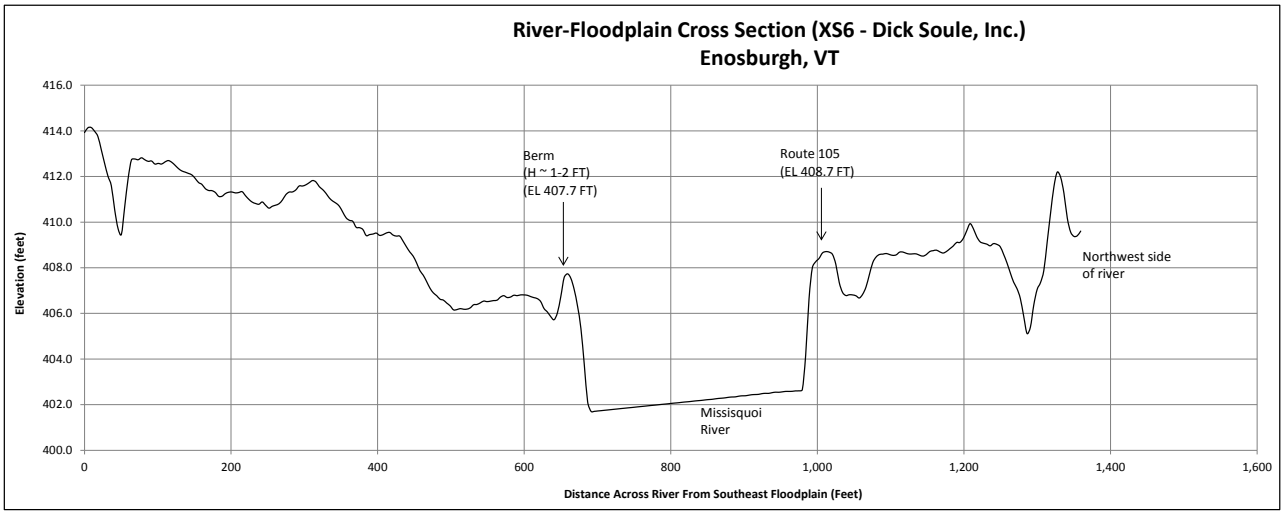


**Figure 14:** Cross section of berm along Missisquoi River isolating floodplain. VT Route 105 is one foot above the top of the berm. Berm removal is recommended in this area.

## *Conceptual Design*

Proposed berm removal would consists of clearing trees and excavating 950 feet of berm down to the elevation of the nearby floodplain, hauling the excavated fill to an upland disposal site, and replanting the disturbed area. Berm removal construction is easy to perform given that the work takes place out of the river channel and water control is not needed. Minimal sediment and erosion controls are needed since the site is located on flat ground. The primary precautions to take during construction include minimizing the length of time soils are exposed and being prepared to cover exposed material with erosion control fabric if an intense rain occurs.

This work could be completed by any contractor with a medium to large excavator and several dump trucks. A storage location for the excavated fill will be required. The berm removal is estimated to generate 3,300 cubic yard of material in addition to the cleared plant material. The

estimated cost that includes final design, permitting, bid assistance, construction, and construction oversight is $120,000.

A negative aspect of this project is the required removal of riverside trees that are located on the berm along the south bank of the Missisquoi River. The plantings that would take place following construction should include trees and shrubs that are commonly found in naturally vegetated **riparian buffers**. This will both filter overland flow towards the river channel and provide stabilization of surface soils when the river overtops its banks.

### *Steps for Project Implementation*

The following next steps are required to advance this project.

- Outreach to landowners – Explore willingness to implement berm removal and secure permission to access field. The landowner may want the fill and timber generated during the project and may have a suitable disposal site in the area.
- Survey, design and permit the project – Permits will likely include Vermont Construction General Permit and a local floodplain permit.
- Seek funding to implement the project – Possible funding sources for this work include ANR Ecosystem Restoration Program, FEMA hazard mitigation grant program, FEMA pre-disaster mitigation fund, US Fish and Wildlife Service, and Vermont Agency of Transportation.
- Bid project for construction.
- Construction.
- Monitor site to compare new flood patterns with predicted changes.

### *Project Benefits*

The implementation of this project is anticipated to provide increased floodplain access to the channel that will result in the following benefits:

- Lower flood levels along VT Route 105 that will reduce disruptions of business;
- A shorter duration of flooding that will allow a quicker return to business when a flood does take place;
- Improved movement of goods and services along VT Route 105; and
- Reduced flood risk to seven local businesses.

## Tyler Branch Corridor Conservation

### *Project Overview and Objectives*

The main recommendation from the past river assessment was to conserve the river corridor along Tyler Branch to allow the channel to reach a most stable state (Ruddell et al., 2009). This recommendation still applies. During the site walk for this project, a sediment and debris storage area with an unstable channel was identified near the upstream end of the project site (See Figure 9). The flood and sediment storage in this area is important to maintaining the stability of downstream

areas that have been straightened and armored in the past. The objectives of this project are to conserve the river corridor to reduce flood and erosion hazards along Tyler Branch where local farms and road infrastructure exist.

### *Data Collection and Alternatives Analysis*

A site reconnaissance walk was performed in the subject area and the migrating channel, stored sediment, stored woody debris, and a large floodable area were documented. Bank erosion and slides of valley wall material (i.e., **mass wasting**) occurs in this area. GIS parcel lines were reviewed to estimate the size of the conservation area. Three parcels would be involved in the project that would result in the conservation of 20 acres. The parcel on the north side of the river would conserve ten acres, the parcel on the south side of the river six acres, and to the parcel to the west four acres (Appendix J).

Some areas of the Tyler Branch Road embankment are eroding in this area and thus if conservation does take place, stabilization of the road embankment should be considered as part of this project since the road is located at the northern edge of the proposed corridor. The conservation project and road protection project can both be accomplished together.

### *Conceptual Design*

The conserved area would contain the river corridor and FEMA 100-year floodplain, as well as some areas just beyond the corridor where signs of flooding were observed in the field. The main objective of the conservation easement is to purchase development rights or hold an easement on the land to prevent any form of channel management or floodplain activity that could lead to channel encroachment. Were this to happen, stored sediment and debris would be forced downstream, activating channel movement that could threaten downstream farm fields, infrastructure and other property.

The estimated landowner payment for this easement is $20,000 (about $1,000 per acre) based on an initial calculation by ANR using the river corridor easement payment calculator. Other costs for establishing the easement for project scoping, preparing documents, survey, title search, and legal document filing could run $20,000 (personal communication, Staci Pomeroy, ANR). The total project cost is thus $40,000.

### *Steps for Project Implementation*

The following next steps are required to advance this project.

- Outreach to landowners to explore willingness to conserve parcels.
- Determine easement type and identify possible funding sources. Potential funders for a river corridor easement to protect downstream agricultural lands include Vermont Department of Environmental Conservation Rivers Program, Vermont Housing and Conservation Board, Vermont Land Trust, ANR Ecosystem Restoration Program, and the Natural Resources Conservation Service Conservation Reserve Enhancement Program.
- Secure easement.

- Monitor site and track conditions.

### *Project Benefits*

The implementation of this project will prevent development from ever taking place in the river corridor in this storage area along Tyler Branch and will provide the following benefits:

- Maintain downstream channel stability, reducing loss of farm land due to erosion;
- Control downstream risk to public infrastructure; and
- Control downstream risk to private property located near the river.

## Local Road Improvements on Detour Routes Used During Missisquoi River Flooding

### *Project Overview and Objectives*

Following concerns voiced at the first Community Forum about flooding along the Missisquoi River and deteriorated detour route conditions, the Enosburgh project area was expanded to include sections of both Tyler Branch and the Missisquoi River. The combination of flooding and poor local road condition impacts businesses and movement of goods. Although this alternative does not directly reduce flooding, if the detour roads were improved businesses would not be as impacted and would experience a quicker return to normal operations when the Missisquoi River floods.

The objective of this project is to improve the road surfaces of Hayes Farm Road and Davis Road, and replace two undersized culverts to improve local detour routes used when flooding along VT Route 105 takes place.

### *Data Collection and Alternatives Analysis*

The detour routes were mapped (see Appendix D) and the routes were travelled to investigate road surface and culvert condition. Site observations were made with heavy snowpack and plowed roads so the sites need to be revisited once the snow melts to confirm findings. The ideal time to finalize the road observations is spring to see how the roads function during thaw and mud season, when they are likely at their worst condition.

The surfaces of both Davis Road and Hayes Farm Road were deteriorated for most of their lengths. The surface of Davis Road is drained earth/gravel from Boston Post Road to west of Thompson Lane (6,100 feet) (E911 GIS roads layer). The road turns to gravel travelling west to the Enosburg Falls Village line (3,600 feet). In the Village, Davis Road is paved until it ends at Stonehouse Road and turns into Hayes Farm Road (570 feet). The paved portion of Davis Road has potholes, large areas of missing pavement, and cracks along the pavement edges. The unpaved portions have a rough surface and frost heaves. At a minimum the paved surface of Davis Road should be repaired. The complete rehabilitation of the road base and surface over its full two mile length would greatly improve travel in this area.

Hayes Farm Road is paved for its full length (2,800 feet). The entire road surface is in poor condition. Potholes and areas of missing pavement exist, especially in the vicinity of culvert

crossings where it appears that flow has overtopped the road. Resurfacing of the entire road is needed. Some road base improvements are also likely needed.

Undersized culverts exist along the roadways. A six foot corrugated metal pipe with mitered ends conveys a **tributary** of the Missisquoi River under Davis Road just west of Gervais Family Farm (Figure 15). Signs of flow overtopping the roadway exist. The drainage area at the culvert is 1.2 square miles and the design flow taken as the 25-year flood for local roads (VTrans, 2001) is 80 cubic feet per second (Olson, 2002). Structure width in Vermont is now initially set based on the channel bankfull width (Schiff et al., 2014; ANR, 2014b). The estimated bankfull width of the channel is 14 feet (DEC, 2006). The culvert width is 42% of the channel width. The undersized structure needs to be replaced to properly pass water, sediment, debris and ice.

A five foot wide by four foot tall concrete box culvert conveys a tributary of the Missisquoi River under Hayes Farm Road just west of the intersection with Stonehouse Road (See Figure 10). Signs of flow overtopping the roadway exist and chunks of loose pavement are located in the area. The drainage area at this culvert is 1.5 square miles. The design flow is 82 cubic feet per second (Olson, 2002) and the estimated channel bankfull width is 15.7 feet (DEC, 2006). The culvert width is 54% of the channel width. The undersized structure needs to be replaced.

**Figure 15:** Undersized culvert on a tributary of the Missisquoi River at Davis Road (Source: FEA, 2014)

## *Conceptual Design*

The conceptual design includes pavement resurfacing and sub-base improvements for the full length of Davis Road and Hayes Farm Road. The two undersized culverts are proposed to be upgraded to match the channel bankfull width.

This roadway improvement project is common transportation upgrade work that a range of contractors could complete. In all, two miles of Davis Road and half a mile of Hayes Farm Road will be improved. The design assumes that the portion of Davis Road with drained earth sub-base needs a full restoration (Appendix K). The team anticipates that some of the gravel portion of Davis Road, as well as some reclaimed pavement, can be used for sub-base so the cost for this section will be lower. A partial restoration of the Hayes Road sub-base is anticipated. The estimated cost to upgrade Davis Road and Hayes Farm Road to paved surfaces is $1 million.

Culvert upgrades would include two new structures. The culvert under Davis Road would have a width of 14 feet and a length of 40 feet. The estimated costs for this structure is $85,000, based on

current structure costs and similar recent projects in the state and region. The culvert under Hayes Farm Road would have a width of nearly 16 feet and a length of 40 feet. The estimated cost for this structure is $90,000. Adding the construction costs together and including final design, permitting, bid assistance, and construction oversight, the total estimated cost for the road improvement project is $1.5 million.

### *Steps for Project Implementation*

The following next steps are required to advance this project.

- Verify right-of-way outreach to land owners.
- Survey, design and permit the project. Permits will likely include Vermont Construction General Permit, a local floodplain permit, US Army Corps of Engineers General Permit for the culverts, and a VTrans permit. The design will need to explore the road sub-base condition to understand how much road base needs improvement.
- Seek funding for the project. Possible funding sources for this work include Better Back Roads, Vermont Agency of Transportation Local Transportation Enhancement Grant, US Fish and Wildlife Service for the culverts that will also improve fish passage, and the US Federal Highway Administration.
- Bid project for construction.
- Construct project

### *Project Benefits*

The implementation of this project is anticipated to improve Davis and Hayes Farm Roads that will result in the following benefits:

- Provide a safer detour route during Missisquoi River flooding to allow for business to carry on during semi-annual flooding;
- Improve local travel between farms and into Enosburg Falls;
- Improved movement of goods and services locally and in region; and
- Reduced flood risk to three farms.

# Next Steps

On April 30, 2015 the team hosted the second community forum to share the list of policy and project recommendations to decrease flood risk for the Town of Enosburgh and Enosburg Village. At the forum, community members asked questions, provided input and helped rank the proposed list of priority recommendations.

The projects that the meeting attendees ranked highest included improving the road surface and enlarging undersized culverts on detour routes used when the Missisquoi River floods. This includes improvements to the Davis Road, Hayes Farm Road, Perley Road and Longley Bridge Road. Conserving a wetland complex along the Tyler Branch upstream from the Boston Post Road also ranked high. The policy and program recommendations did not receive as many votes as the implementation projects but adopting river corridor protection bylaws and expanding riparian zones did receive interest from meeting participants.

Since the second community forum, both the Village and Town have made progress on implementing many of the recommendations. The Town integrated eight of the VERI implementation projects into their Local Hazard Mitigation Plan which has been submitted to FEMA for approval. The Town is also exploring mid/long-term options for relocating their town garage out of the Special Flood Hazard Area and securing their salt storage area. The Village has received Better Back Roads funding to complete an erosion inventory and capital budget. The Village is also seeking funding to develop a Local Hazard Mitigation Plan.

The tables included in Appendices F and G provide a comprehensive list of recommended priority projects for the Enosburgh to further discuss, explore, and advance as resources permit. The conceptual designs summarized above and in Appendices I and J are intended to provide examples for how to advance high priority projects to the next level and acquire funding for final design and implementation. As part of the ongoing community discussion regarding the VERI effort, the team recommends the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization.
- Prioritize one to two projects to pursue each year with assistance from DEC and NRPC staff to identify appropriate funding sources and partners.
- Apply for one to two grants each year to advance project development and/or designs.
- Implement projects as funding allows.
- Monitor project success.

Implementing these projects and updating related flood policies will, over time, help Enosburgh become safer and more resilient to future floods and there are a number of organizations and

programs that can help. For example, the NRPC can help gather and review sample bylaws, capital plans and hazard mitigation plans and help draft town specific language for review and local adoption. DHCD's Municipal Planning Grants http://accd.vermont.gov/strong_communities/opportunities/funding/overview/municipal_planning_grants , the Vermont Rivers Program http://www.anr.state.vt.us/dec/waterq/rivers.htm and www.floodready.vermont.gov can help support these efforts. The Vermont Land Trust http://www.vlt.org/ can assist landowner's protection of critical floodplain with easements. The State's Hazard Mitigation Grant Program http://vem.vermont.gov/mitigation can help implement projects identified in the Hazard Mitigation Plan. The Vermont Small Business Development Center http://www.vtsbdc.org/ has offered extensive disaster assistance to businesses as well as compiling a great guide for owners to navigate these programs. And several federal and state programs can assist in funding the recommendations outlined in the report. Working together we can reduce the risk and financial burden of future flooding events.

## Education and Outreach

Vermont has a long tradition of managing its rivers to limit or prevent flood damage including armoring riverbanks with rocks, moving or straightening river channels and building dams and berms. Despite these efforts, flooding is the most common natural disaster in Vermont (ANR). Tropical Storm Irene showed Vermonters that rivers and streams are powerful and tend to make their own way during a flood. Because we cannot reliably control flooding, educating citizens, business and property owners about rivers and potential flood risks within their communities is critical.

> *"We all have short memories when it comes to flooding. It's just human nature to think it couldn't happen here again anytime soon."*
>
> Chris Campany, Executive Director
> Windham Regional Commission

Ongoing community education and outreach is an important part of any effort to promote flood safety and to protect local business and economies. Ultimately, the better informed everyone in the community is about the behavior of local rivers and streams, the more likely it is that they will make sound decisions.

**Make Information Readily Available:** Easy access to river and floodplain information is an essential way to help citizens and businesses incorporate flood risks into decisions they make. Most communities offer printed information at the town office or library as well as on town webpages.

**Common Handouts or Webpage Information Includes:**

- Maps of the local flood hazard areas and the permitting requirements in the floodplain.
- Information about flood insurance and floodproofing buildings.
- Information about how rivers, streams and watersheds work.
- Benefits of green infrastructure and conservation of existing floodplain.

**Actively Engage:** Many communities work to increase the understanding of rivers and risks via email or by posting information on their local Front Porch Forum. Communities often include flood maps and permitting information in their town meeting reports and other municipal mailings like sewer and water bills. Others promote awareness of flood history and risk by placing high water lines on prominent buildings in the community.

However, education and outreach efforts should not be the sole responsibility of local governments, and community groups like chambers of commerce, downtown business associations, neighborhood groups, and watershed organizations are encouraged to partner with state, regional and local groups to offer local workshops and education sessions.

**Potential Workshop Topics and Partners and Presenters:**

- Flood Insurance and What You Need to Know (Department of Finance Regulation, Division of Emergency Management and Homeland Security, Vermont League of Cities and Towns )
- Developing a Continuity of Operations Plan (Small Business Development Centers, Regional Planning Commissions, Regional Development Corporations )
- Resilient Road Designs to Reduce Recurring Damage and Improve Water Quality (Agency of Natural Resources, Agency of Transportation)
- Planning for Resilience (Regional Planning Commissions)
- Flood Risk, Preparedness and Safety (Division of Emergency Management and Homeland Security, Regional Planning Commissions)
- Extreme Weather and Climate Change (Agency of Natural Resources, Vermont Natural Recourses Council )
- How Rivers, Streams and Watersheds Work (Agency of Natural Resources, Vermont Natural Resources Council, Vermont Land Trust )
- Low Cost Techniques to Reduce Flooding and Improve Water Quality (Agency of Natural Resources, Vermont Natural Resources Council, Regional Planning Commissions, Vermont League of Cities and Towns)

**Invest in Staff Training and Certification:** In many of Vermont's cities and towns, floodplain management is just one of many responsibilities of the local planning office or zoning administrator. Yet, administration of a floodplain ordinance is quite complex and the consequences of limited staff time and understanding of the regulations can easily allow inappropriate development in dangerous areas. The consequences of granting improper variances and not enforcing against violations may preclude the community from participating in the federal flood insurance program. Therefore, local government officials are strongly encouraged to support staff training and certification in floodplain management.

## What Can Individuals Do to Reduce their Risks?

Most of us remember to annually change the batteries in our smoke alarms to reduce the risk of fire, but few of us prepare for floods or disasters. Since 2000, Vermont has had more than one federally-declared disaster per year and floods have occurred nearly everywhere in the state (ANR, 2015). Buildings located in a 100-year floodplain have 1% chance of being flooded every year. In other words, over a 30 year period (length of most home mortgages), there is a 26% chance of a 100-year flood (USGS, 2015).

The good news is that there are many steps that individuals can take to reduce the risks, loss, disruption and costs associated with flooding. Understanding what the risks of flooding are for your home and family will help you:

- Make sure that you have the right amount of insurance coverage.
- Protect your home and take steps to limit potential damage.
- Prepare plans detailing how your family will respond if flooding looks likely.
- Practice so family members know what actions to take in the event of a flood or upon receiving a flood warning.

### *Steps to Reduce Risks*

- **Identify Flood Risk.** The first step is to identify your risk so you can plan appropriately. Floodplain maps are available at most town offices or click this link http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your home or apartment is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** Homeowners' or renters' insurance helps pay to repair or rebuild your home and replace personal property due to a covered loss, however it does not cover any damages caused by floods or your rent and living expenses while your home is rebuilt. All insurance policies have overall policy limits and specific limits for different types of coverage. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Fill Gaps in Your Insurance Coverage.** If your home is underinsured at the time of a loss, there is frequently a penalty or reduction in the amount the insurance company will pay for the loss. Property insurance also does not cover flood damages or your expenses if you cannot live in your home due to flood damages. All homeowners who live in flood-prone areas should carry flood insurance. Flood insurance is available for your home and personal property and can be obtained from your local agent.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about

building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

- **Plan Ahead.** Draft an emergency response and communications plan (family phone numbers) for your home and family. Use the process as an opportunity to bring family members together to discuss the roles needed during an emergency and how best to assign responsibilities. Make sure you have a designated place to meet other family members in the event of an emergency. Also, don't forget to plan for individuals with special needs like prescription medication and for your pets as many public shelters or hotels do not allow animals.
    - Pack an emergency kit and make sure family members know where it is located.
    - Keep copies of your insurance policy, computer data and other important documents like tax returns and financial information safe from flooding on upper floors or stored offsite.
    - Document your home and possessions with photos or video to help simplify the insurance claims process. Generally, the more detailed documentation (receipts, serial numbers, etc.) you can supply during the claims process, the fewer problems you will experience.

- **Train and Practice.** Many of us participate in fire drills at work or school, but few of us practice at home for disasters. Training and practicing your emergency response and communications plan will help assure the plan is workable and family members understand their roles and responsibilities.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. If you know a storm is headed your way, fill up your gas tank in case you must evacuate. (If the power is out, it is not always easy to find an operating gas station.) If you must evacuate, try to contact your employer and let them know your plans. Having a plan and a few extra minutes to evacuate can make a difference.

FEMA http://www.ready.gov/make-a-plan and the Vermont Division of Emergency Management and Homeland Security http://vem.vermont.gov/preparedness/hazards/floods both provide more detailed information on how to prepare and protect your home and family from disasters and floods.

## What Can Businesses Do to Reduce their Risks?

According to FEMA, nearly 40% of businesses do not reopen after a disaster and data from the US Small Business Administration indicates that over 90% of businesses fail within two years after being struck by a disaster.

It can take years to repair the damage to the building, furnishings, equipment and inventory. Disasters can also require businesses to relocate or cease operation temporarily, which may lead to canceled contracts and customers going elsewhere for goods or services. Even if the event does not

impact the business directly, severe weather from snow or rain or even extended power outages can strand employees at home and complicate deliveries.

Identifying your risk can significantly reduce potential damages and business recovery costs. Understanding what the risks of flooding are for your business will help you:

- Make sure that you have the right insurance coverage for business interruption.
- Plan ahead and take steps like developing a continuity of operations plan to limit potential damage.
- Train employees so they know what actions to take in the event of a disaster or after receiving a flood warning.

## *Steps to Reduce Risks*

- **Identify Flood Risk.** Since 2000, Vermont has had more than one federally-declared disaster per year and floods have occurred nearly everywhere in the state (ANR). Identifying your risk is a good place to start. Floodplain maps are available at most town offices or click here http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your business is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** Many types of disasters are not covered under normal insurance policies and funding or loans from government agencies is often too little and too late. All insurance policies have overall policy limits and specific limits for different types of coverage and any business located in a flood-prone area should carry flood insurance. Also check to make sure your insurance includes business interruption coverage and that it reimburses other unexpected costs (like service interruptions from lost power or Internet access, law suits and unemployment compensation claims filed by employees). Business interruption insurance compensates a business for lost income, expenses and profits if a disaster, such as a flood, closes your doors. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

- **Plan Ahead.** There are also a number of low-cost steps you can take to reduce the impacts of a flood. At a minimum, regularly back up computer data and store important tax and financial records and information such as your insurance policy details in a flood safe place.

Documenting your building, furnishings, equipment and inventory with photos or video can speed the insurance claims process.

All businesses should have a continuity of operations plan. A continuity of operations plan is a written document that outlines how your business will respond and recover from a flood or other disaster. At a minimum, your plan should include:

- A list of important contacts including your insurance company, key customers and vendors and evacuation contacts for staff.
- A map showing locations of important equipment to relocate (computers and servers) and where to shut off electricity, gas and other services.
- Procedures to protect your property and minimize business disruption – e.g. remote back up of computer files, a plan to relocate inventory or livestock.
- A back up location to conduct business while the building is being repaired.

Having a continuity of operations plan will help you identify and assign essential tasks that will help minimize the damage caused by flooding. Training and practice will help assure the plan is workable and employees are properly trained.

The Vermont Small Business Development Center http://www.vtsbdc.org and many of Vermont's Regional Development Corporations http://accd.vermont.gov/business/partners/rdc and Regional Planning Commissions http://www.vapda.org can also provide training and one-on-one assistance to help your business develop a continuity of operations plan.

CERF+ (Craft Emergency Relief Fund + Artists' Emergency Resources) offers tailored disaster guidance and recourses for artists (http://studioprotector.org/OnlineGuide/DisasterPlanning/DisasterSpecificPlanningResources.aspx ).

- **Train and Practice.** Employees need to understand flood warnings and what to do when they get one. This includes understanding the dangers of flooding and how to evacuate the building safely. Train all staff on procedures to shut down the business and how to deploy loss reduction measures like relocating equipment and inventory to upper floors and deploying door and window dams reduce flooding. Finally, remember that flooding can also affect employees' ability to work, as their priority may be to protect their home and family first.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. Having a continuity of operations plan and a few extra minutes to evacuate can save lives and your business.

The US Small Business Administration https://www.sba.gov/content/disaster-preparedness offers more detailed information on how to prepare and protect your employees and business and from disasters and floods.

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# Appendix A:

# Data Collection

| Name | Description | Source |
|---|---|---|
| Economic Assets | Mapping of local businesses and farm fields | Northwest Regional Planning Commission (NRPC) |
| Enosburgh and Enosburg Falls – Floodplain and River Corridor Regulation Overview | Summary of buffers, setbacks, and flood hazard regulations | NRPC |
| Tyler Branch Geomorphic Assessment | Data and maps of channel stability and aquatic habitat, and recommended actions to improve river stability and reduce flood hazards | (Ruddell et al., 2009); Vermont Agency of Natural Resources (ANR) |
| Missisquoi River Geomorphic Assessment | Data and maps of channel stability and aquatic habitat, and recommended actions to improve river stability and reduce flood hazards | ANR |
| Tyler Branch Bank Erosion Study | Information on alternatives analysis and ultimate conservation project near Tyler Branch Road Bridge | (MMI, 2008, 2009) |
| FEMA 100-year Floodplain | Mapping of 100-year floodplain digitized and adjusted with new topography for this project | (FEMA, 1980), NRPC, FEA |
| Vermont River Corridor | State-mapped erosion hazard area where river is most likely to be located | ANR, 2015 |
| LIDAR-Derived Contour Data for Franklin County | Aerial photography and GIS layers for contour lines | Upper Missisquoi Flight in 2010 |
| Flood Resiliency Projects | Information about completed projects and flood resiliency efforts initiated by the Town | Town of Enosburgh |
| Highway Map and Vermont Route 105 Pavement Conditions | Map showing all roads in town and condition of pavement on Vermont Route 105 | Vermont Agency of Transportation (VTrans) |
| Repeat Damage Maps | Mapping of repeat damage sites associated with FEMA-declared disasters | Vermont Agency of Commerce and Community Development (ACCD), FEMA |
| Aerial photographs | Current and historical aerial photographs | Accessed via Google Earth |
| Enosburgh Town Plan | Town guide | Town of Enosburgh |
| Photographs | Miscellaneous photographs of project area | NRPC, Internet, MMI, FEA |

# Appendix B:

# Enosburgh Flood History and Summary of Damages

# Enosburgh- Summary of Damages

- The Missisquoi River traverses through most of Franklin County. In Enosburgh, it runs through the northwest section of town. The Tyler Branch watershed, located in the foothills of the Cold Hollow Mountains, encompasses approximately 58 square miles in Franklin County and approximately 27 square miles in Enosburgh Town. It is a major tributary of the Missisquoi River. Tributaries of Tyler Branch include Bogue Branch, The Branch and Beaver Meadow Brook.

- Flooding is a natural occurrence. Minor flooding occurs nearly every spring, particularly along the Missisquoi River when melting snow combines with spring rainfall flows from the surrounding mountains, in combination with the influence of ice jams. Ice jams have not caused any major damage in Enosburgh, but they have contributed to field and overbank erosion.

- There are USGS gages on the Missisquoi River at it outlet in Swanton, downstream of Enosburgh Town and in East Berkshire, on the Town's northern border. Based on the USGS data, several floods events greater than 25 year discharge have occurred over the last 20 years including the year 1992, on July 15, 1997 and on January 8 and March 28, 1998.

- The worst natural flood of historic record occurred in November 1927. During that event, 3.2 inches of rain accumulated in 24 hours with 6.35 inches falling for the entire period. Many homes were destroyed. Barns and livestock were washed away. The North Enosburgh covered bridge was swept away and many roads were inundated. The Enosburg Falls dam had a crest of 16 feet above the top of the dam. The electric power house at the bridge was washed away[1].

- Other floods of minor impact occurred causing relatively minor damage to the community specifically in 1936 and 1940.

- A mentioned previously, the January 15, 1996 winter storm (FEMA 1101-DR) triggered flooding throughout the Town and County. The flooding damaged many roads throughout town.

- On July 4th, 1996 a heavy rain event again overwhelmed local drainages and damaged many town highways.

- During the night of July 14th through to the morning of July 15th, 1997, heavy rain fell continuously throughout eastern Franklin County (FEMA-1184-DR). Several roads,

[1] FEMA, 1980. Town of Enosburgh and Village of Enosburg Falls Flood Insurance Study. Federal Emergency Management Agency, Washington, DC.

bridges and culverts were damaged in Town. An estimated cost of repairs from FEMA reports and from interviews with the Town Road Foreman were approximately $4,530.

- A stalled cold front over Northern New England on February 28th, 2000 brought steady rain to the area. Ice jams formed along the Missisquoi River which produced 1 to 2 feet of water along Route 105 between Enosburg Falls and East Berkshire. Flooding receded on the 29th. There was an estimated $20,000 in damages.

- Based on interviews with local residents, there was also a relatively large flood event which occurred on June 5th, 2002. Several roads were flooded. There was an estimated $25,000 in property damages between the towns of Enosburgh, Richford and Montgomery.

- On September 23rd, 2004 a disaster declaration (FEMA-1559-DR) was declared due to severe storms and flooding from August 12th through September 12th, 2004. Franklin County was included in the disaster declaration. Flooding occurred as a result of heavy rain produced from Tropical Storm Francis. The town highway crew replaced one culvert on TH1 (Tyler Branch Road). Estimated cost of repairs from FEMA reports and testimony from the Road Foreman were approximately $7,050. Also, approximately $60,000 in State emergency funds was used to repair a bridge on TH2 (Boston Post Road).

- A powerful storm tracked northeast across Ontario and Quebec provinces on January 18, 2006. Ahead of this storm, brisk south winds caused temperatures to rise into the 40s creating snow melt. Widespread rainfall of 1.5 to 2.5 inches fell during the night and continued through the early afternoon of the following day. Increased run-off caused widespread field flooding and ponding of water on local roads. Localized ice jams along the Missisquoi River near East Highgate caused flooding and left large ice chunks along Route 78 and Route 105 between Enosburg and Berkshire. There was an estimated $10,000 in damages.

- On May 19th and 20th, 2006, heavy rains fell throughout the state resulting in 3.72 inches of rain in Enosburgh. The Town Highway Department recorded $23,975 in damages to local roads.

- A strong storm system tracked through the county on July 3rd, 2006 creating heavy rain throughout the town. The Town Highway Department recorded $51,356 in damages and repair to the local roads.

- On June 4, 2007 (FEMA-1698-DR) and August 24, 2007 (FEMA-1715-DR), Franklin County was on the edge of a strong frontal system that brought heavy rain which damaged road infrastructure along TH11 (Woodward Neighborhood Road), TH1 (Perley Road) and TH30 (Bogue Road). Franklin County was not part of the disaster declaration, but the Town of Enosburgh received funding from the State Better Back Roads Program to repair damage culverts, roads and bridges.

- A series of storms affected the entire state from June 14-17, 2008, (DR 1778). Stronger storms on Monday June 16 produced up to 1 inch hail. These storms also produced heavy rainfall, but were moving more quickly. No flooding resulted. On Tuesday June 17th strong thunderstorms produced pea sized hail and heavy rain in the Trout River basin in northwest Vermont. Flash flooding occurred in the eastern parts of Franklin County.

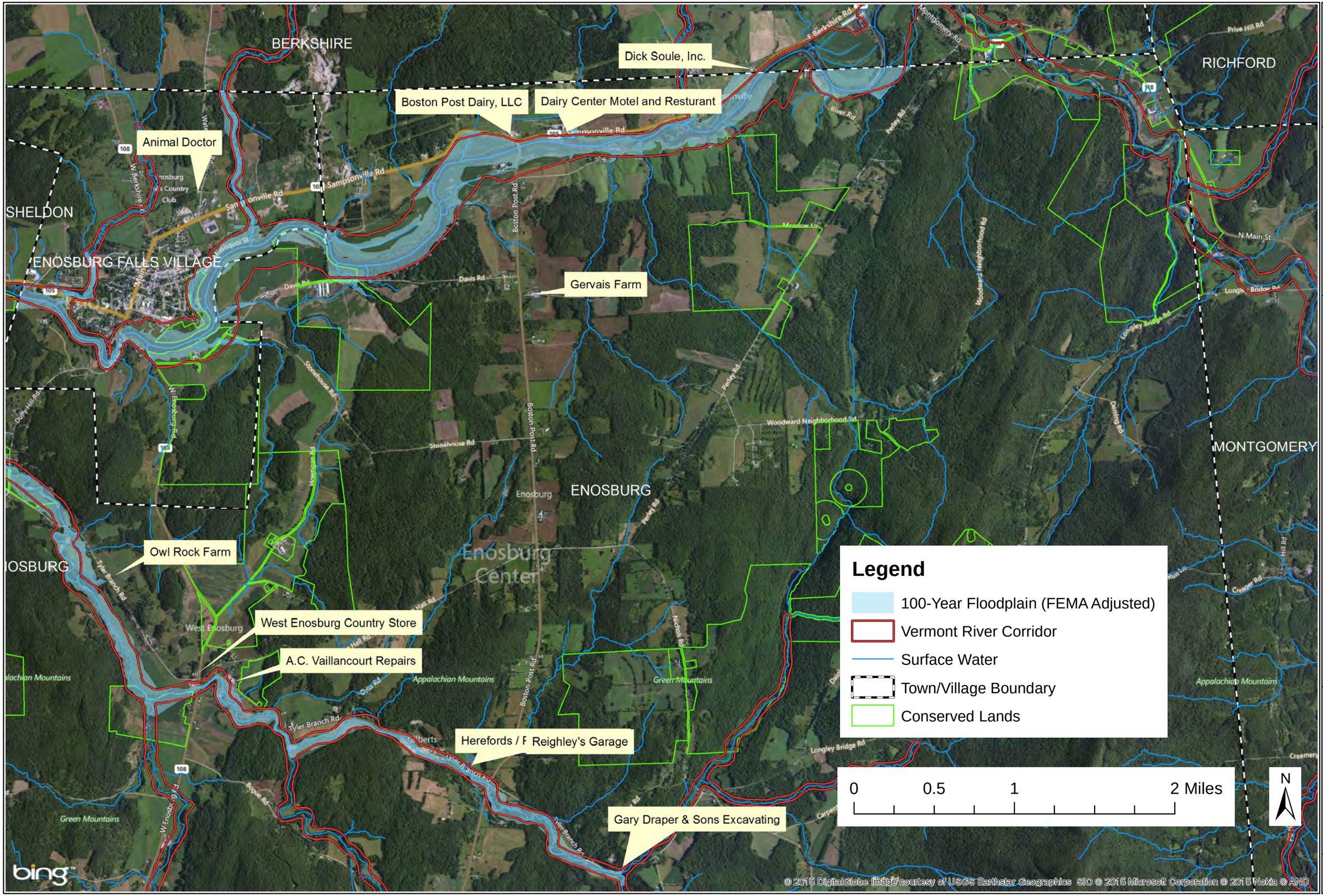
- The year 2011 was a record year for flooding in the state of Vermont. The first floods occurred over a two-week period in April and May of 2011 (DR 1995, 4043). These floods impacted the northern half of the state, including the counties of Addison, Chittenden, Essex, Franklin, Grand Isle, Lamoille, Orleans, Washington, and Windham. The damage totaled over$1.8 million in FEMA assistance. In the spring, heavy rains in late March/early April on top of a deep late season snowpack resulted in riverine flooding and sent Lake Champlain well over the 500-year flood elevation breaking the 140-year-old peak stage elevation. Additional spring runoff events resulted in Lake Champlain being above base flood elevation for more than a month. High lake levels coupled with wind driven waves in excess of 3 feet resulted in major flood damages for shoreline communities.

- Additionally, flooding and fluvial erosion caused by Tropical Storm Irene was catastrophic, destroying property and taking lives, and again eliciting a disaster declaration (DR-4022). The details and impacts of Tropical Storm Irene are provided in the Hurricanes/Tropical Storms section of this risk assessment. However, it is important to underscore that the majority of damages resulting from Tropical Storm Irene were due to flooding and fluvial erosion.

- In addition to free-flowing flood events, there is documented history of ice jams. On March 6, 1979 and ice jam event resulted in a flood elevation 3 feet above the November 3, 1927, flood. The impact of ice jams affects VT105 near Berkshire.
- Transportation facilities that parallel the Missisquoi River are subject to periodic flooding, such as the sections of State Route 105 near Berkshire. Public Utilities such as water mains and electric lines as well as bridge crossings are also vulnerable to flooding damages.

# Appendix C:
# Adjusted FEMA 100-Year Floodplain and the Vermont River Corridor

The 100 year floodplain (FEMA, 1980) was previously digitized by the Northwest Regional Planning Commission and then adjusted by Fitzgerald Environmental Associates during VERI using LiDAR-derived elevation data





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**SOURCE(S):**

FEMA Floodplain
Digitization by NRPC
Floodplain updates by FEA
Site Mapping by MMI
VCGI data
Bing Maps Aerial Photography

**FEMA 100-YEAR FLOODPLAIN AND VT RIVER CORRIDOR**

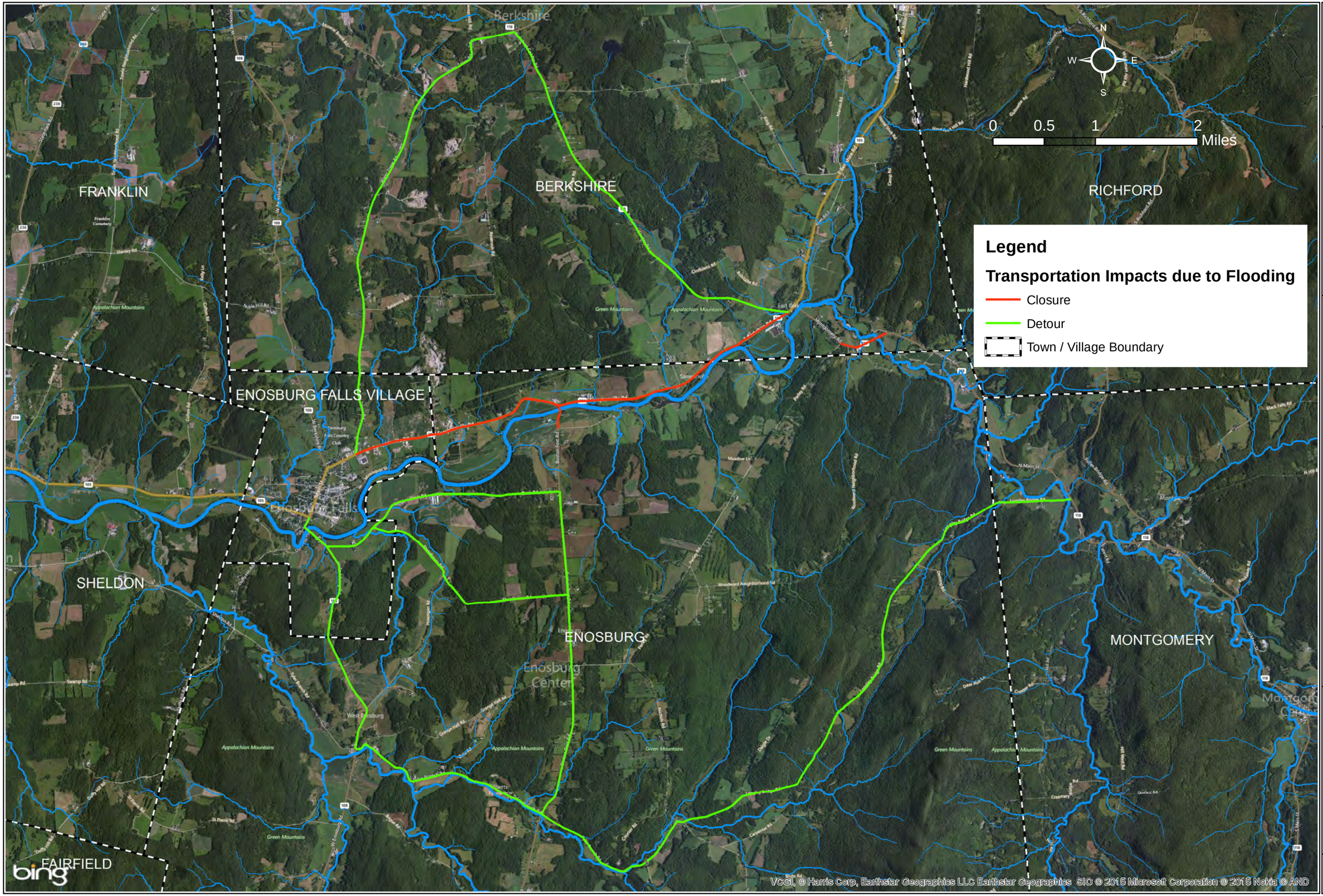
**VERMONT ECONOMIC RESILIENCY INITIATIVE (VERI)**

**ENOSBURGH, VERMONT**

**Map By:** RKS
**MMI#:** 5507-01
**MXD:** VERI_Enosburg_FEMA_RC.mxd
**1st Version:** March 3, 2014
**Revision:** March 6, 2015
**Scale:** See scale bar.

# Appendix D:

# Common Road Closures and Detours





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**SOURCE(S):**
Detour Analysis by NRPC
Vermont Center for Geographic Information
Bing Maps Aerial Photography

**ROAD CLOSURES OR DETOURS DUE TO FLOODING**

**VERMONT ECONOMIC RESILIENCY INITIATIVE (VERI)**

**ENOSBURGH, VERMONT**

**Map By:** RKS
**MM1#:** 5507-01
**MXD:** VERI_Enosburg_Transportation
**1st Version:** December 1, 2014
**Revision:** December 24, 2014
**Scale:** See scale bar

# Appendix E:

# Enosburgh Flood Resilience Checklist

# Flood Resilience Checklist

Is your community prepared for a possible flood? Completing this flood resilience checklist can help you begin to answer that question. This checklist was developed as part of the U.S. Environmental Protection Agency's Smart Growth Implementation Assistance project in the state of Vermont. More information about the project can be found by reading the full report, *Planning for Flood Recovery and Long-Term Resilience in Vermont*, found online at www.epa.gov/smartgrowth/sgia_communities.htm#rec1.

## What is the Flood Resilience Checklist?

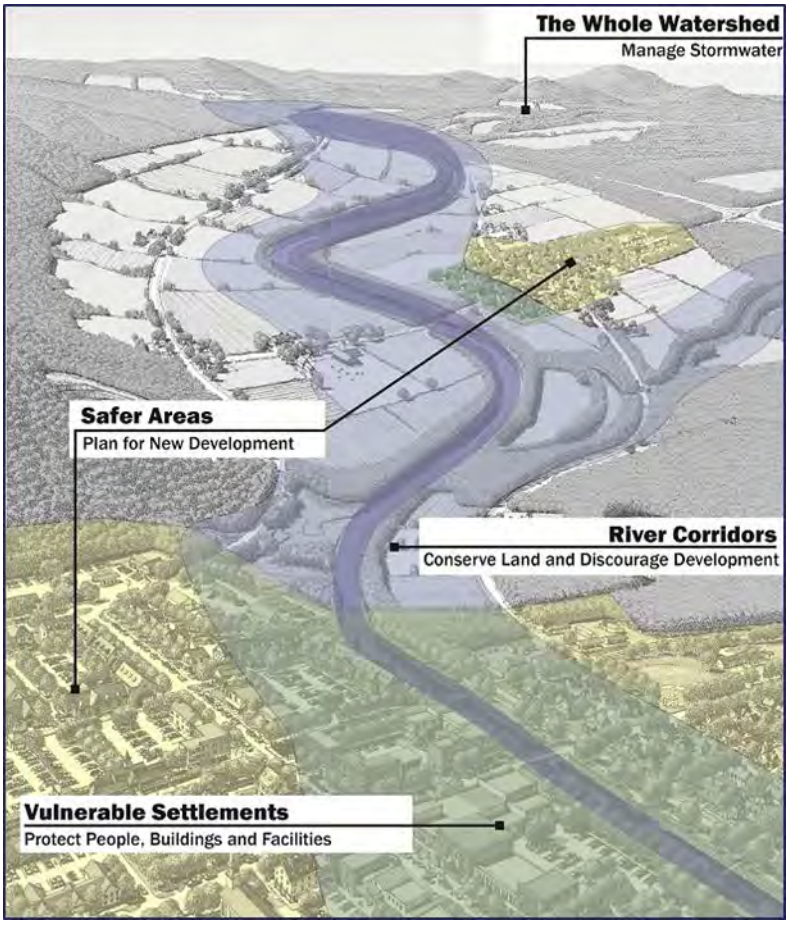
This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

## Who should use it?

This checklist can help communities identify opportunities to improve their resilience to future floods through policy and regulatory tools, including comprehensive plans, Hazard Mitigation Plans, local land use codes and regulations, and non-regulatory programs implemented at the local level. Local government departments such as community planning, public works, and emergency services; elected and appointed local officials; and other community organizations and nonprofits can use the checklist to assess their community's readiness to prepare for, deal with, and recover from floods.

## Why is it important?

Completing this checklist is the first step in assessing how well a community is positioned to avoid and/or reduce flood damage and to recover from floods. If a community is not yet using some of the strategies listed in the checklist and would like to, the policy options and resources listed in the *Planning for Flood Recovery and Long-Term Resilience in Vermont* report can provide ideas for how to begin implementing these approaches.




*This graphic illustrates the four categories of approaches to enhance resilience to future floods. Credit: Vermont Agency of Commerce and Community Development.*

# FLOOD RESILIENCE CHECKLIST

**Overall Strategies to Enhance Flood Resilience**
(Learn more in Section 2, pp. 9-11 of
*Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Does the community's comprehensive plan have a hazard element or flood planning section? | ☐ Yes | ☐ No |
| a. Does the comprehensive plan cross-reference the local Hazard Mitigation Plan and any disaster recovery plans? | ☐ Yes | ☐ No |
| b. Does the comprehensive plan identify flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas, if applicable? | ☐ Yes | ☐ No |
| c. Did the local government emergency response personnel, flood plain manager, and department of public works participate in developing/updating the comprehensive plan? | ☐ Yes | ☐ No |
| 2. Does the community have a local Hazard Mitigation Plan approved by the Federal Emergency Management Agency (FEMA) and the state emergency management agency? | ☐ Yes | ☐ No |
| a. Does the Hazard Mitigation Plan cross-reference the local comprehensive plan? | ☐ Yes | ☐ No |
| b. Was the local government planner or zoning administrator involved in developing/updating the Hazard Mitigation Plan? | ☐ Yes | ☐ No |
| c. Were groups such as local businesses, schools, hospitals/medical facilities, agricultural landowners, and others who could be affected by floods involved in the Hazard Mitigation Plan drafting process? | ☐ Yes | ☐ No |
| d. Were other local governments in the watershed involved to coordinate responses and strategies? | ☐ Yes | ☐ No |
| e. Does the Hazard Mitigation Plan emphasize non-structural pre-disaster mitigation measures such as acquiring flood-prone lands and adopting No Adverse Impact flood plain regulations? | ☐ Yes | ☐ No |
| f. Does the Hazard Mitigation Plan encourage using green infrastructure techniques to help prevent flooding? | ☐ Yes | ☐ No |
| g. Does the Hazard Mitigation Plan identify projects that could be included in pre-disaster grant applications and does it expedite the application process for post-disaster Hazard Mitigation Grant Program acquisitions? | ☐ Yes | ☐ No |
| 3. Do other community plans (e.g., open space or parks plans) require or encourage green infrastructure techniques? | ☐ Yes | ☐ No |

| FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Do all community plans consider possible impacts of climate change on areas that are likely to be flooded? | ☐ Yes | ☐ No |
| 5. Are structural flood mitigation approaches (such as repairing bridges, culverts, and levees) and non-structural approaches (such as green infrastructure) that require significant investment of resources coordinated with local capital improvement plans and prioritized in the budget? | ☐ Yes | ☐ No |
| 6. Does the community participate in the National Flood Insurance Program Community Rating System? | ☐ Yes | ☐ No |
| **Conserve Land and Discourage Development in River Corridors**<br>(Learn more in Section 3.A, pp. 14-19 of *Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Has the community implemented non-regulatory strategies to conserve land in river corridors, such as: | | |
| a. Acquisition of land (or conservation easements on land) to allow for stormwater absorption, river channel adjustment, or other flood resilience benefits? | ☐ Yes | ☐ No |
| b. Buyouts of properties that are frequently flooded? | ☐ Yes | ☐ No |
| c. Transfer of development rights program that targets flood-prone areas as sending areas and safer areas as receiving areas? | ☐ Yes | ☐ No |
| d. Tax incentives for conserving vulnerable land? | ☐ Yes | ☐ No |
| e. Incentives for restoring riparian and wetland vegetation in areas subject to erosion and flooding? | ☐ Yes | ☐ No |
| 2. Has the community encouraged agricultural and other landowners to implement pre-disaster mitigation measures, such as: | | |
| a. Storing hay bales and equipment in areas less likely to be flooded? | ☐ Yes | ☐ No |
| b. Installing ponds or swales to capture stormwater? | ☐ Yes | ☐ No |
| c. Planting vegetation that can tolerate inundation? | ☐ Yes | ☐ No |
| d. Using land management practices to improve the capability of the soil on their lands to retain water? | ☐ Yes | ☐ No |
| 3. Has the community adopted flood plain development limits that go beyond FEMA's minimum standards for Special Flood Hazard Areas and also prohibit or reduce any new encroachment and fill in river corridors and Fluvial Erosion Hazard areas? | ☐ Yes | ☐ No |

| FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Has the community implemented development regulations that incorporate approaches and standards to protect land in vulnerable areas, including: | | |
| a. Fluvial erosion hazard zoning? | ☐ Yes | ☐ No |
| b. Agricultural or open space zoning? | ☐ Yes | ☐ No |
| c. Conservation or cluster subdivision ordinances, where appropriate? | ☐ Yes | ☐ No |
| d. Other zoning or regulatory tools that limit development in areas subject to flooding, including river corridors and Special Flood Hazard Areas? | ☐ Yes | ☐ No |
| **Protect People, Buildings, and Facilities in Vulnerable Settlements**<br>(Learn more in Section 3.B, pp. 19-26 of *Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Do the local comprehensive plan and Hazard Mitigation Plan identify developed areas that have been or are likely to be flooded? | ☐ Yes | ☐ No |
| a. If so, does the comprehensive plan discourage development in those areas or require strategies to reduce damage to buildings during floods (such as elevating heating, ventilation, and air conditioning (HVAC) systems and flood-proofing basements)? | ☐ Yes | ☐ No |
| b. Does the Hazard Mitigation Plan identify critical facilities and infrastructure that are located in vulnerable areas and should be protected, repaired, or relocated (e.g., town facilities, bridges, roads, and wastewater facilities)? | ☐ Yes | ☐ No |
| 2. Do land development regulations and building codes promote safer building and rebuilding in flood-prone areas? Specifically: | | |
| a. Do zoning or flood plain regulations require elevation of two or more feet above base flood elevation? | ☐ Yes | ☐ No |
| b. Does the community have the ability to establish a temporary post-disaster building moratorium on all new development? | ☐ Yes | ☐ No |
| c. Have non-conforming use and structure standards been revised to encourage safer rebuilding in flood-prone areas? | ☐ Yes | ☐ No |
| d. Has the community adopted the International Building Code or American Society of Civil Engineers (ASCE) standards that promote flood-resistant building? | ☐ Yes | ☐ No |
| e. Does the community plan for costs associated with follow-up inspection and enforcement of land development regulations and building codes? | ☐ Yes | ☐ No |

| FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 3. Does the community require developers who are rebuilding in flood-prone locations to add additional flood storage capacity in any new redevelopment projects such as adding new parks and open space and allowing space along the river's edge for the river to move during high-water events? | ☐ Yes | ☐ No |
| 4. Is the community planning for development (e.g., parks, river-based recreation) along the river's edge that will help connect people to the river AND accommodate water during floods? | ☐ Yes | ☐ No |
| 5. Does the comprehensive plan or Hazard Mitigation Plan discuss strategies to determine whether to relocate structures that have been repeatedly flooded, including identifying an equitable approach for community involvement in relocation decisions and potential funding sources (e.g., funds from FEMA, stormwater utility, or special assessment district)? | ☐ Yes | ☐ No |
| **Plan for and Encourage New Development in Safer Areas**<br>(Learn more in Section 3.C, pp. 26-27 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Does the local comprehensive plan or Hazard Mitigation Plan clearly identify safer growth areas in the community? | ☐ Yes | ☐ No |
| 2. Has the community adopted policies to encourage development in these areas? | ☐ Yes | ☐ No |
| 3. Has the community planned for new development in safer areas to ensure that it is compact, walkable, and has a variety of uses? | ☐ Yes | ☐ No |
| 4. Has the community changed their land use codes and regulations to allow for this type of development? | ☐ Yes | ☐ No |
| 5. Have land development regulations been audited to ensure that development in safer areas meets the community's needs for off-street parking requirements, building height and density, front-yard setbacks and that these regulations do not unintentionally inhibit development in these areas? | ☐ Yes | ☐ No |
| 6. Do capital improvement plans and budgets support development in preferred safer growth areas (e.g., through investment in wastewater treatment facilities and roads)? | ☐ Yes | ☐ No |
| 7. Have building codes been upgraded to promote more flood-resistant building in safer locations? | ☐ Yes | ☐ No |

# FLOOD RESILIENCE CHECKLIST

**Implement Stormwater Management Techniques throughout the Whole Watershed**
(Learn more in Section 3.D, pp. 27-31 of
*Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Has the community coordinated with neighboring jurisdictions to explore a watershed-wide approach to stormwater management? | ☐ Yes | ☐ No |
| 2. Has the community developed a stormwater utility to serve as a funding source for stormwater management activities? | ☐ Yes | ☐ No |
| 3. Has the community implemented strategies to reduce stormwater runoff from roads, driveways, and parking lots? | ☐ Yes | ☐ No |
| 4. Do stormwater management regulations apply to areas beyond those that are regulated by federal or state stormwater regulations? | ☐ Yes | ☐ No |
| 5. Do stormwater management regulations encourage the use of green infrastructure techniques? | ☐ Yes | ☐ No |
| 6. Has the community adopted tree protection measures? | ☐ Yes | ☐ No |
| 7. Has the community adopted steep slope development regulations? | ☐ Yes | ☐ No |
| 8. Has the community adopted riparian and wetland buffer requirements? | ☐ Yes | ☐ No |

# Appendix F:

# Municipal Policy and Program Recommendations

**Municipal Policies and Program Recommendations:**
Reducing flood risk involves a continuous process of policy evaluation and adjustments to minimize risks through protection, prevention and education. The VERI team reviewed municipal policies, regulations and procedures looking for opportunities to protect people, businesses and infrastructure from flooding within Enosburg Falls and Enosburgh Town. This review aims to support ongoing community discussion on changes that enhance public safety, reduce damages to property and public infrastructure and avoid business disruptions.

The team review included Enosburg's municipal plan, hazard mitigation plan, and land use regulations to identify what flood-related policies they contain or lack. The review also land trusts, emergency training and preparedness programs and business operations plans. Local stakeholders (residents, businesses, planning commission, village trustee boards, selectboards, etc.) are encouraged to review these recommendations and seek assistance from the identified partners and programs and take these steps to reduce Enosburg's flood risk over time.

**Emergency Relief Assistance Fund (ERAF).**
This is a state program that outlines the steps communities can take to increase the state's share of disaster recovery assistance.

| | **Enosburgh Town** | **Enosburg Falls Village** |
|---|---|---|
| **Steps to increase State aid to 12.5%** | | |
| Participate in the National Flood Insurance Program | Yes-Effective 6/19/1996 | Yes-Effective 1/02/1981 |
| Adopt 2013 State Road & Bridge Standards | Yes- Adopted 3/18/2013 | Yes-Adopted 1/28/2014 |
| Adopt Local Emergency Operations Plan | Yes- Adopted 7/22/2014 | Yes- Incorporated into Town LEOP |
| Adopt Local Hazard Mitigation Plan | Yes- 2015 draft LHMP in process of securing FEMA approval | No |
| **Step to increase State aid to 17.5% (one needed to qualify)** | | |
| Adopt no new development in a River Corridor | No | No |
| Adopt no new development in Flood Hazard areas and participate in the Federal Community Rating System | No | No |
| **State ERAF Match** | **12.5%** | **7.5%** |

**Steps to increase state match to 12.5%:**

- **Participate in the National Flood Insurance Program (NFIP).**
- **Adopt Town Road and Bridge Standards** consistent with or exceeding those listed under the most current version of *Town Road & Bridge Standards in the* Handbook for Local Officials (also known as the "Orange Book"), published by the Vermont Agency of Transportation. The Standards were last updated on 1/23/2013.
- **Annually Update and Adopt Emergency Operation Plan (EOP).** During a disaster, having quick access to town contacts for all of the critical systems (water, sewer, electricity) and vulnerable populations is indispensable. The EOP should be updated and adopted annually after town meeting but before May 1st.
- **Develop a Local Hazard Mitigation Plan (LHMP)** that meets the provisions of 44 CFR § 201.6 that has been approved by the local community, and is approved or in the process of securing final approval by FEMA. LHMP should document past infrastructure damage, highlight vulnerabilities, list future municipal infrastructure mitigation projects and recommend changes to the municipal plan and bylaws that will enable implementation of hazard mitigation strategies.

**Steps to increase state match to 17.5%:**

- **Adopt river corridor protection areas.** Flood damage in Vermont also is caused by bank erosion from swollen rivers within river corridors. Stream banks can fail causing structures to be undermined or fall into the river. Consider prohibiting development in the mapped river corridor in the town and village zoning bylaws' flood overlay section, **or**
- **Adopt flood hazard protection areas and participate in the Federal Community Rating System (CRS) Program.** Consider prohibiting development in the mapped flood hazard areas in the town and village zoning bylaws' flood overlay section as well as joining the FEMA CRS Program. This program reduces flood insurance rates through discounts – which vary according to the community's efforts – reflect the reduced flood risk to property owners resulting from community plans, policies and procedures.

**Next Steps:**

- The Village of Enosburg Falls should begin drafting a Local Hazard Mitigation Plan and integrating mitigation strategies identified as part of the VERI project. NRPC can provide technical assistance in this effort. This would enable the Village to receive a 12.5% state ERAF match.
- The Town and Village should explore participation in the FEMA Community Rating System (CRS) so as to secure a discount on flood insurance. The NRPC and the Vermont ANR Floodplain Manager can help the communities evaluate the potential benefits and costs for CRS participation.
- Enosburgh Town and the NRPC should ensure that the mitigation strategies identified as part of the VERI project are incorporated into the current LHMP draft.
- Enosburgh's LEOP (including the Village) should be updated annually to maintain their current state ERAF match.

**Local Land Use Regulations:**
The review identified opportunities to improve local land use regulations (zoning bylaws) to reduce vulnerability to future floods. The Village and Town currently have separate land use regulations but anticipate merging their bylaws next year.

- **Encourage development outside of the floodway**. The floodway is the fastest moving part of the stream or river during a flood. Buildings and other objects in a floodway can be washed downstream, and cause culverts and bridges to clog with debris resulting in significant property damage. In Enosburgh Town, new structures are prohibited in the floodway, but substantial improvements to existing structures may be approved via conditional use approval. In the Village, development in the floodway "is prohibited unless a registered professional engineer certifies that the proposed development will not result in any increase in flood levels during the occurrence of the base flood." This is a difficult regulation to satisfy and it may essentially prohibit development in the floodway, but does leave open the possibility.
- **Encourage development outside of the flood hazard area**. New development in the floodplain puts owners at risk and reduces available floodplain. This can worsen flooding and puts emergency responders, the public and downstream property owners at risk. In the Town and Village bylaws, new structures in the Special Flood Hazard Area (100-year floodplain) are conditional. New and substantially improved structures are to be located above base flood elevation. The Town bylaws also specify that mobile homes are to be 1 ft. above base flood elevation while the Village bylaws do not include this regulation.
- **Update policies allowing fill in flood hazard areas.** Allowing landowners to fill low lying areas may help protect an individual property, but it can reduce the land's ability to slow and store the extra flood water and it can increase flood hazards to downstream property owners. The Town bylaws prohibit new fill except where necessary to elevate structures above the base flood elevation. The Village bylaws also prohibit fill but the language should be more explicit

**Next Steps**:

- The Town and Village anticipate merging their bylaws next year. This will be an opportunity to ensure consistency between the flood hazard and stream buffer regulations.
- The Town and Village should consider updating their flood hazard regulations to further restrict new development in the Special Hazard Flood Area and/or require new or substantially improved structures to be 1-3 ft. above the base flood elevation.

**Town Plans:**
Municipal plans and capital improvement plans can be updated to incorporate lessons learned and identify opportunities to reduce hazards and improve preparedness.

- **Expand flood resilience element in the municipal plan.** The Town and Village have a joint municipal plan that was adopted in March, 2015. The recommendations of the VERI project should be incorporated into the plan when it is next updated in 2020.
- **Document road, sewer, and water infrastructure vulnerabilities in municipal plan and develop capital plans.** Specific areas that were damaged or have known vulnerabilities should be documented so the communities can plan for their replacement in their long-term budgets, easing the impact on taxpayers. The Town is encouraged to develop a capital improvement plan that incorporates the physical improvements recommended through the VERI project.
- **Identify areas for conservation in the municipal plan.** The VERI team has highlighted the importance of protecting the river corridor along Tyler Branch upstream of the Boston Post Road. This corridor has an extensive beaver pond complex and floodplain that stores sediment and large woody debris which improves downstream channel stability, limits the lateral movement of the channel and protects farmland from erosion in the Tyler Branch valley. The need to conserve this corridor (and other intact floodplains) should be including incorporated in the municipal plan during the next update.

**Next Steps**:

- NRPC, Vermont League of Cities and Towns (VLCT) or consultants can help the Planning Commissions gather and review sample capital budgets and plans and help the town draft specific language for review and local adoption.
- The State's Municipal Planning Grants are designed to help towns and planning commissions hire experts to review and update plans and capital budgets. Annually the grants are due September 30.
- The Town with assistance from the NRPC, should update the bridge and culvert inventory to identify potential deficiencies and estimate replacement costs. Needed improvements should be incorporated into a Capital Improvement Plan.

**Emergency Planning:**

The review identified a number of opportunities to improve immediate emergency preparedness and recovery for the community (hazard mitigation and local emergency operation plans).

- **Incorporate VERI mitigation strategies into the Enosburgh Town Local Hazard Mitigation Plan (LHMP).** VERI mitigation strategies should be integrated into the Town's LHMP. This could enable the Town to receive state and federal funding for these projects.
- **Develop a Local Hazard Mitigation Plan for the Village of Enosburg Falls.** The Village of Enosburg Falls should begin drafting a LHMP and integrating mitigation strategies identified as part of the VERI project. Having a LHMP will also make the Village eligible to apply for additional federal funding for infrastructure projects and this would enable the Village to receive a 12.5% state ERAF match instead of their current rate of 7.5%.

- **Encourage regional revolving loan funds** to modify lending terms to reduce (or eliminate) interest for loans distributed to help businesses recover from declared disasters.
- **Incorporate VERI strategies and implementation recommendations into the Comprehensive Economic Development Strategy (CEDS) for the Northern Vermont Economic Development District (NVEDD).** The NVEDD is in the process of developing a CEDS for the northern tier of Vermont. VERI implementation recommendations will be evaluated and integrated into the CEDS as appropriate.

**Next Steps**:

- The State's Hazard Mitigation Planning Grant http://vem.vermont.gov/hmgp_11.2.12 are designed to help towns and planning commissions update their mitigation plan as well as implement the projects described within it. The grants are available when federal disaster funds have been earmarked for Vermont and are due on a rolling basis. NRPC can provide technical assistance to help the Village draft a Local Hazard Mitigation Plan.
- For several years after a declared disaster, state and federal funding is available from USDA and HUD in addition to FEMA. The Community Development Block Grant program has a Disaster Recovery sub grant that can help towns rebuild infrastructure.
- The NRPC will evaluate their Brownfield Revolving Loan Fund to identify opportunities to link the funding to projects that promote or enhance resiliency.

**Education and Outreach:**

- **Promote and educate property owners on the value of flood insurance**. Homeowners' insurance does not pay for any flood related damage. Only flood insurance through the National Flood Insurance Program does. FEMA's National Flood Insurance Program as September 30, 2014, the Town of Enosburgh has four policies in force and the Village of Enosburg Falls has three policies in force. This represents about 30% of the structures estimated to be in the Special Flood Hazard Area.
- **Help businesses plan for disasters**. If a home is damaged or washed away, occupants can go stay in a hotel, with friend or family, or find a rental. When a business is flooded, it is much harder or impossible to relocate. Continuity of operations plans outlines the steps business can take during and after a disaster to reduce disruption and losses.
- **Educate landlords and contractors about local regulations:** Many landlords and contractors may not understand the requirements for rebuilding after a flood. Specific standards must be met to maintain eligibility for flood insurance and other federal grants.

**Next Steps**:

- The Small Business Administration offers loans and refinancing of existing loans to consumers as well as businesses and non-profits after disasters The Vermont Small

Business Development Center has offered extensive disaster assistance to businesses as well as compiling a great guide for owners to navigate these programs.

- The state's Flood Ready website for information about local flood hazards and regulations for each community as well as
    - River corridor and flood hazard maps
    - Examples of Town Plans, Local Emergency Operations Plans and Hazard Mitigation Plans
    - Flood data compiled by community and region including:
        - The number public buildings in the Special Flood Hazard Area (SFHA)
        - The number of buildings in the flood hazard area that have insurance

## Enosburgh and Enosburg Falls

**Town-wide Policy and Program Options**

**Vermont Economic Resiliency Initiative (VERI)**

**Legend**

● Effective ◒ Limited ○ Ineffective

* Priority rating based on degree of community benefit

| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Land Use Regulations** | | | | | | | | | | |
| Encourage development outside of the floodway. | **High** | ● | ● | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | The floodway is the fastest moving part of the stream or river during a flood. Buildings and other objects in a floodway can be washed downstream, and cause culverts and bridges to clog with debris resulting in significant property damage. In Enosburgh Town, new structures are prohibited in the floodway, but substantial improvements to existing structures may be approved via conditional use approval. In the Village, development in the floodway "is prohibited unless a registered professional engineer certifies that the proposed development will not result in any increase in flood levels during the occurrence of the base flood." This is a difficult regulation to satisfy and it may essentially prohibit development in the floodway, but does leave open the possibility. | Contact Town Planner and Planning Commission |
| Encourage development outside of the flood hazard and ANR mapped river corridor areas | **High** | ● | ● | ● | Moderate | < $10K | DEC River Management Program, RPC, VLCT, Consultant | MPG | New development in the floodplain puts owners at risk and reduces available floodplain. This can worsen flooding and puts emergency responders, the public and downstream property owners at risk. In the Town and Village bylaws, new structures in the Special Flood Hazard Area (100-year floodplain) are conditional. New and substantially improved structures are to be located above base flood elevation. The Town bylaws also specify that mobile homes are to be 1 ft. above base flood elevation while the Village bylaws do not include this regulation. | Contact Town Planner and Planning Commission |
| Update policies allowing fill in flood hazard areas. | **High** | ● | ○ | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | Allowing landowners to fill low lying areas may help protect an individual property, but it can reduce the land's ability to slow and store the extra flood water and it can increase flood hazards to downstream property owners. The Town bylaws prohibit new fill except where necessary to elevate structures above the base flood elevation. The Village bylaws also prohibit fill but the language should be more explicit | Contact Town Planner and Planning Commission |
| **Town Plan** | | | | | | | | | | |
| Expand flood resilience element in the municipal plan. | **High** | ● | ● | ● | Moderate | < $10K | RPC, VLCT, Consultant | MPG | The Town and Village have a joint municipal plan that was adopted in March, 2015. The recommendations of the VERI project should be incorporated into the plan when it is next updated in 2020. | Contact Town Planner and Planning Commission |
| Document road, sewer, and water infrastructure vulnerabilities in municipal plan and develop capital plans. | **High** | ○ | ○ | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | Specific areas that were damaged or have known vulnerabilities should be documented so the communities can plan for their replacement in their long-term budgets, easing the impact on taxpayers. The Town is encouraged to develop a capital improvement plan that incorporates the physical improvements recommended through the VERI project. | Contact Town Planner and Planning Commission |
| Identify areas for conservation. | **Medium** | ● | ● | ● | Easy | < $10K | DEC River Management Program, RPC, Consultant | DEC-ERP | The VERI team has highlighted the importance of protecting the river corridor along Tyler Branch upstream of the Boston Post Road. This corridor has an extensive beaver pond complex and floodplain that stores sediment and large woody debris which improves downstream channel stability, limits the lateral movement of the channel and protects farmland from erosion in the Tyler Branch valley. The need to conserve this corridor (and other intact floodplains) should be including incorporated in the municipal plan during the next update. | Contact Conservation Commission |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

## Enosburgh and Enosburg Falls

**Town-wide Policy and Program Options**

**Vermont Economic Resiliency Initiative (VERI)**

**Legend**

● Effective ◓ Limited ○ Ineffective

* Priority rating based on degree of community benefit

| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Emergency Planning** | | | | | | | | | | |
| Encourage regional revolving loan funds | **High** | ○ | ○ | ● | Difficult | ?? | Chamber, local churches, committees | EDA grants | Towns will recover much more quickly after a disaster if they create a local fund to address urgent needs as federal and state money are slow to arrive. Towns could offer loans to modify lending terms to reduce (or eliminate) interest for loans distributed to help businesses recover from declared disasters. | Work with local committee |
| Incorporate VERI mitigation strategies into the Enosburgh Town Local Hazard Mitigation Plan (LHMP). | **High** | ● | ● | ● | Easy | < $10K | RPC, town | HMGP grants | VERI mitigation strategies should be integrated into the Town's LHMP. This could enable the Town to receive state and federal funding for these projects. | Work with town Emergency Management Director. |
| Develop a Local Hazard Mitigation Plan for the Village of Enosburg Falls | **High** | ● | ● | ● | Easy | < $10K | Schools, RPC, Town | HMGP grants | The Village of Enosburg Falls should begin drafting a LHMP and integrating mitigation strategies identified as part of the VERI project. Having a LHMP will also make the Village eligible to apply for additional federal funding for infrastructure projects and this would enable the Village to receive a 12.5% state ERAF match instead of their current rate of 7.5%. | Work with town Emergency Management Director. |
| Incorporate VERI strategies and implementation recommendations into the Comprehensive Economic Development Strategy (CEDS) for the Northern Vermont Economic Development District (NVEDD) | **Medium** | ○ | ○ | ● | Moderate | < $10K | Homeowners Associations | HMGP grants | The NVEDD is in the process of developing a CEDS for the northern tier of Vermont. VERI implementation recommendations will be evaluated and integrated into the CEDS as appropriate. | Work with NVEDD and local CEDS steering committee |
| **Education and Outreach** | | | | | | | | | | |
| Promote and educate property owners on the value of flood insurance. | **High** | ○ | ○ | ● | Easy | < $10K | Chamber, Homeowners Associations | HMGP grants | Homeowners' insurance does not pay for any flood related damage. Only flood insurance through the National Flood Insurance Program does. FEMA's National Flood Insurance Program as September 30, 2014, the Town of Enosburgh has four policies in force and the Village of Enosburg Falls has three policies in force. This represents about 30% of the structures estimated to be in the Special Flood Hazard Area | Gather NFIP informational materials for distribution, and reach out to real estate agents. |
| Help businesses plan for disasters. | **Medium** | ○ | ○ | ● | Easy | < $10K | Chamber, Rotary | EDA grants | If a home is damaged or washed away, occupants can go stay in a hotel, with friend or family, or find a rental. When a business is flooded, it is much harder to relocate. Continuity of operations plans outlines the steps business can take during and after a disaster to reduce disruption and losses. | Offer continuity of operations planning training for businesses. |
| Educate landlords and contractors about local regulations. | **High** | ○ | ○ | ● | Moderate | < $10K | Realtors | HMGP grants | Many landlords and contractors may not understand the requirements for rebuilding after a flood. Specific standards must be met to maintain eligibility for flood insurance and other federal grants. | Reach out to landlords and contractors. |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

# Appendix G:

# Table of Recommended Projects to Protect Businesses and Infrastructure

# Enosburgh

**Recommended Projects to Protect Businesses and Infrastructure**
**Vermont Economic Resiliency Initiative (VERI)**
**March 31, 2015**

**Legend**
● Effective ◒ Limited ○ Ineffective

* Priority rating based on objectives and potential business impact

| | | | | OBJECTIVES | | | FEASIBILITY | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| **Building and Site Improvements** | | | | | | | | | | |
| Move Town Garage, create secure salt storage area, or improve river bank and channel stability **(see site 10)** | Town Garage, stored equipment, and stockpiled materials | Local highway operations essential for all businesses | Medium | ○ | ◒ | ● | Difficult | $100K-$200K | 2-5 years | Town garage is in the 100-year floodplain and river corridor. Alternative location desired so maintenance vehicles and materials not prone to damage and loss Setting is chronic water quality issue as materials wash into river with runoff. Improve bank stability to reduce erosion risk. |
| **Channel and Floodplain Management** | | | | | | | | | | |
| Berm removal along the south bank of the Missisquoi River about 1 mile west of intersection of Routes 105 and 118 **(see site 20)** | Route 105 and Dick Soule, Inc. | 7 businesses, about 50 employees, several farms, and regional connection to Village | **High** | ◒ | ● | ◒ | Moderate | $100K-$200K | 2-5 years | Berm located along the south bank of the Missisquoi River adjacent to farm field / floodplain. Berm increases flood levels along Route 105 and the frequency of road overtopping. Removal of ~ 950 feet of berm would reduce flooding. |
| Corridor conservation about 1,700 feet upstream of Boston Post Road **(see sites 2 and 3)** | Valley bottom farm land, Town roads, private drives, homes | Downstream farmland and homes | **High** | ◒ | ● | ◒ | Moderate | $50K-$100K | 2-5 years | The number one recommendation in the geomorphic assessment (RC, 2009) was conserve the corridor to allow for a stable channel and less erosion. This site is the best corridor conservation location with a lot of sediment and large wood stored in the area that is important to protect downstream farm land and roads in most of the valley. |
| Berm removal about 1,000 feet upstream of the intersection of Tyler Branch Road and Grange Hall Road to spread flood flows **(see site 7)** | Tyler Branch Road and Vaillancourt Repairs | 2 businesses, 3 farms, 10 employees, and homes | Medium | ◒ | ● | ◒ | Easy | $50K-$100K | 2-5 years | A berm is located along the north bank to try and protect a hayfield. The berm confines flows, and increases erosion potential. Berm removal would reduce erosion potential and minimize erosion risk along Tyler Branch Road. Active bank failures would likely reduce. |
| Expand cover cropping and other best practices on valley bottom farmland along the Missisquoi River and Tyler Branch to reduce potential damages due to flooding and erosion | Soil and crop loss on farm fields | Local farm operations | Low | ○ | ◒ | ◒ | Moderate | $100K-$200K | 2-5 years | Cover cropping taking place in the watershed due to UVM extension projects. Methods need refinement to reduce soil loss and protect agriculture fields. Timing of cover crop application was the primary implementation challenge. |
| Targeted sediment dredging at road crossings and confluences with high sediment buildup **(see sites 6, 8, and 12)** | Adjacent property and infrastructure | Several local businesses, farms, and homes | Low | ○ | ○ | ○ | Moderate | $100K-$200K | 1-2 years | Sediment backed up at crossings, constrictions, and tight bends and the channel is most unstable in these locations. Sediment removal in these locations would result in short-term risk reduction , yet long-term risks would be created due to increased erosion hazards locally and over a larger section of the channel. |

[1]**Reduces Flood Risk** - The proposed project/strategy lowers the flood level.
[2]**Reduces Erosion Risk** - The proposed project/strategy slows flood waters and lessons vulnerability to erosion.

# Enosburgh

**Recommended Projects to Protect Businesses and Infrastructure**
**Vermont Economic Resiliency Initiative (VERI)**
**March 31, 2015**

**Legend**
● Effective ◒ Limited ○ Ineffective

* Priority rating based on objectives and potential business impact

| | | | | OBJECTIVES | | | FEASIBILITY | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| **Infrastructure Improvements** | | | | | | | | | | |
| Improve road surfaces and enlarge undersized culverts on detour routes used when the Missisquoi River floods (e.g., Davis Road, Hayes Farm Road, Perley Road, and Longley Bridge Road) **(see sites 23, 24, and 25)** | Movement of goods and access to farms and Village | Three farms and regional connection to Village, about 70 employees | **High** | ◒ | ◒ | ● | Moderate | >$200K | 2-5 years | Key operational concern in Town and Village. When Missisquoi River floods traffic detoured to dirt roads during wet / thaw periods. Roads get damaged complicating travel. Structures on these roads are undersized (structure width is about 50% of the channel width). Road surfaces are deteriorated. The flood / winter road damage connects the strategies along Tyler Branch to those along the Missisquoi River annually or semi-annually. (See road closure and detour map.) |
| Install overflow structure on Boston Post Road at approach to bridge over the Missisquoi River that regularly floods and elevate low spots on Route 105 near edge of valley **(see site 21)** | Movement of goods and access to farms and Village | 6 businesses, several farms, and regional connection to Village | **High** | ○ | ○ | ● | Difficult | >$200K | 2-5 years | Missisquoi River floods every one to two years leading to road closures and traffic detours. An overflow culvert could be installed on Boston Post Road south of the existing bridge over the Missisquoi River to reduce closures. Pavement condition along Route 105 is mostly poor in this location so the low spots (see road profile) could be elevated during anticipated resurfacing. Note that only spots along the valley wall should be elevated in order to not further confine flooding. |
| Improve road and river stability and realign channel upstream of bedrock gorge near intersection of Tyler Branch Road and Grange Hall Road **(see site 9)** | Tyler Branch Road, businesses, farms, and Town Garage | 2 businesses, 3 farms, 10 employees, and homes | Medium | ○ | ◒ | ● | Moderate | $100K-$200K | 1-2 years | Tyler Branch Road and Grange Hall Road are at risk due to flow hitting the road embankments. Some protection already exists yet some is failing. Provide appropriate channel width and stabilize bank. Heavily travelled roads for area and active channel with erosion history. Could include realigning the channel. |
| Improve bridge alignment over Tyler Branch about 3,500 feet upstream of Duffy Hill Road **(see site 13)** | Bridge, Tyler Branch Road, and farm land | Several farms and connection to Village | Medium | ◒ | ● | ◒ | Difficult | >$200K | >5 years | Skewed bridge in area leading to sediment buildup and unstable channel. Channel movement anticipated in near term that would strand eroded bank in field. Buffer planting and river corridor easement exist in this location. |
| Stabilize utility poles in river corridor **(see sites 1, 4, 5, and 11)** | Power and communications | Several local businesses, farms, and homes | Low | ○ | ◒ | ◒ | Easy | $50K-$100K | 2-5 years | Several poles located along river are vulnerable to erosion damages. One pole downstream of The Branch apparently serves a sugar house. Other poles run along Tyler Branch Road. One pole upstream of Boston Post Road is undermined and in danger of erosion. |
| **Public Safety Improvements** | | | | | | | | | | |
| None. | | | | | | | | | | |
| **Update Town Bylaws** | | | | | | | | | | |
| Adopt river corridor protection bylaws | Farm fields and future businesses and homes | Local businesses, farms, and homes | High | ◒ | ◒ | ● | Difficult | $10K-$50K | 2-5 years | Update existing buffer regulations to limit use in floodplains to agriculture, open space, and recreation, unless otherwise approved through regulatory measures. |
| Update flood hazard regulations to further limit floodplain development | Farm fields and future businesses and homes | Local businesses, farms, and homes | High | ◒ | ◒ | ◒ | Difficult | $10K-$50K | 2-5 years | Limit development in the 100-year floodplain in the Town and prohibit all development in the mapped floodway. FEMA mapping needs to be updated with new data. |
| Maintain and expand riparian zone protection to reduce bank erosion potential and conflicts | Farm fields and future businesses and homes | Local businesses, farms, and homes | High | ◒ | ◒ | ● | Difficult | $10K-$50K | 2-5 years | Protect the water quality of the Missisquoi River and its tributary streams by promoting riparian zone management to aid in the prevention of bank erosion. |

# Appendix H:

# Maps Showing Recommended Projects to Protect Businesses and Infrastructure

| Site Number | Site Description | Notes |
|---|---|---|
| 1 | Along Tyler Branch Road, East of Boston Post Road | Stabilize Utility Pole |
| 2 | Floodplains East of Boston Post Road | Floodplain Conservation |
| 3 | Floodplains East of Boston Post Road | Floodplain Conservation |
| 4 | Along Tyler Branch Road, West of Boston Post Road | Improve Stability of Channel, Bank, and Utility |
| 5 | Along Tyler Branch Road, East of Ovitt Road | Improve Stability of Channel, Bank, and Utility |
| 6 | Confluence of Tyler Branch and Bogue Branch | Sediment Removal |

Vaillancourt Farm

Commercial Site

Herefords / Pattee Family Farm

Reighley's Garage

Ovitt Rd

Tyler Branch Rd

Boston Post Rd

Pine Ln

ENOSBURG

Appalachian Mountains

Green Mountains

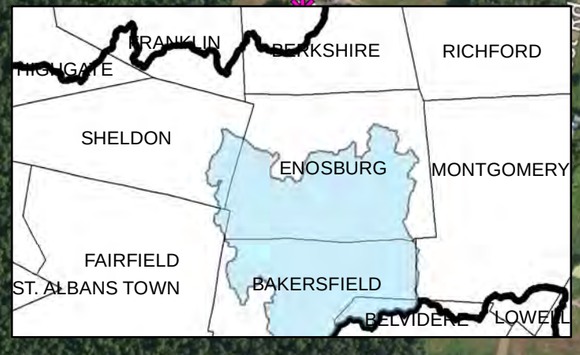
Appalachian Mountains

## Legend

- Local Economic Asset
- Mitigation Site
- Surface Water
- Vermont River Corridor
- 100-Year Floodplain (FEMA Adjusted)
- Conserved Lands
- Town/Village Boundary

0 0.125 0.25 0.5 Miles

N



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**SOURCE(S):**
Field Data Collected by MMI and FEA
Site Mapping by MMI
Economic Assets by NRPC
Vermont Center for Geographic Information
Bing Maps Aerial Photography

**PROJECTS TO PROTECT BUSINESSES AND INFRASTRUCTURE**

**VERMONT ECONOMIC RESILIENCY INITIATIVE (VERI)**

**ENOSBURGH, VERMONT**

**Map By:** RKS
**MMI#:** 5507-01
**MXD:** VERI_Enosburg_site map.mxd
**1st Version:** December 1, 2014
**Revision:** March 5, 2015
**Scale:** See scale bar.

**Map 1**

| Site Number | Site Description | Notes |
|---|---|---|
| 7 | Floodplain upstream of Grange Hall Road | Berm Removal |
| 8 | Upstream of Grange Hall Road | Sediment Removal |
| 9 | Upstream of Grange Hall Road | Improve River Stability and Realign Channel |
| 10 | Downstream of Route 108 | Move Town Garage, Improve River Stability |
| 11 | Floodplain between Tyler Branch Road and Route 108 | Stabilize Utility Pole |
| 12 | Upstream of Tyler Branch Road Bridge | Sediment Removal |
| 13 | Tyler Branch Road Bridge | Adjust Bridge Alignment |




## Legend

- Local Economic Asset
- Mitigation Site
- Surface Water
- Vermont River Corridor
- 100-Year Floodplain (FEMA Adjusted)
- Conserved Lands
- Town/Village Boundary

0 0.125 0.25 0.5 Miles

N



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**SOURCE(S):**
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**PROJECTS TO PROTECT BUSINESSES AND INFRASTRUCTURE**

**VERMONT ECONOMIC RESILIENCY INITIATIVE (VERI)**

**ENOSBURGH, VERMONT**

**Map By:** RKS
**MMI#:** 5507-01
**MXD:** VERI_Enosburg_site map.mxd
**1st Version:** December 1, 2014
**Revision:** March 5, 2015
**Scale:** See scale bar.

**Map 2**

| Site Number | Site Description | Notes |
|---|---|---|
| 20 | Missisquoi River near East Berkshire Village | Berm Removal and Elevate Road |
| 21 | Boston Post Road South of Missisquoi River Bridge | Elevate Road and Install Overflow Culvert |
| 22 | Route 105 to the West of Boston Post Road | Elevate Road |
| 23 | Davis Road | Improve Road Surface and Enlarge Culvert |
| 24 | Hayes Farm Road | Improve Road Surface and Enlarge Culvert |
| 25 | Longley Bridge Road (Trout River, Not pictured here) | Improve River Bank and Channel Stability |

Dick Soule, Inc.

20

Coyote Customs Auto

Boston Post Dairy, LLC

Dairy Center Motel and Resturant

22

21

Richard Green Inc.

Enosburg's Nutshell Storage

Animal Doctor

ENOSBURG FALLS VILLAGE

The Leach Family, Inc.

McDonald's Restaurant

ENOSBURG

Gervais Farm

23

Garden Gate Matting and Framing

Stephan Harrness Barn

24

## Legend

- Local Economic Asset
- Mitigation Site
- Surface Water
- Vermont River Corridor
- 100-Year Floodplain (FEMA Adjusted)
- Conserved Lands
- Town/Village Boundary

0 0.25 0.5 1 Miles

N




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**SOURCE(S):**
Field Data Collected by MMI and FEA
Site Mapping by MMI
Economic Assets by NRPC
Vermont Center for Geographic Information
Bing Maps Aerial Photography

**PROJECTS TO PROTECT BUSINESSES AND INFRASTRUCTURE**

**VERMONT ECONOMIC RESILIENCY INITIATIVE (VERI)**

**ENOSBURGH, VERMONT**

**Map By:** RKS
**MMI#:** 5507-01
**MXD:** VERI_Enosburg_site map.mxd
**1st Version:** December 1, 2014
**Revision:** February 13, 2015
**Scale:** See scale bar.

**Map 3**

# Appendix I:

# Missisquoi River Berm Removal Concept Plan

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**SOURCE(S):**
Field Data Collected by MMI and FEA
Phase 2 SGA Part 1 - The Johnson Company
Phase 2 SGA Part 2 - Redstart Consulting
River Corridor Plan - Redstart Consulting
Vermont Center for Geographic Information
Bing Maps Aerial Photography

# MISSISQUOI RIVER BERM REMOVAL

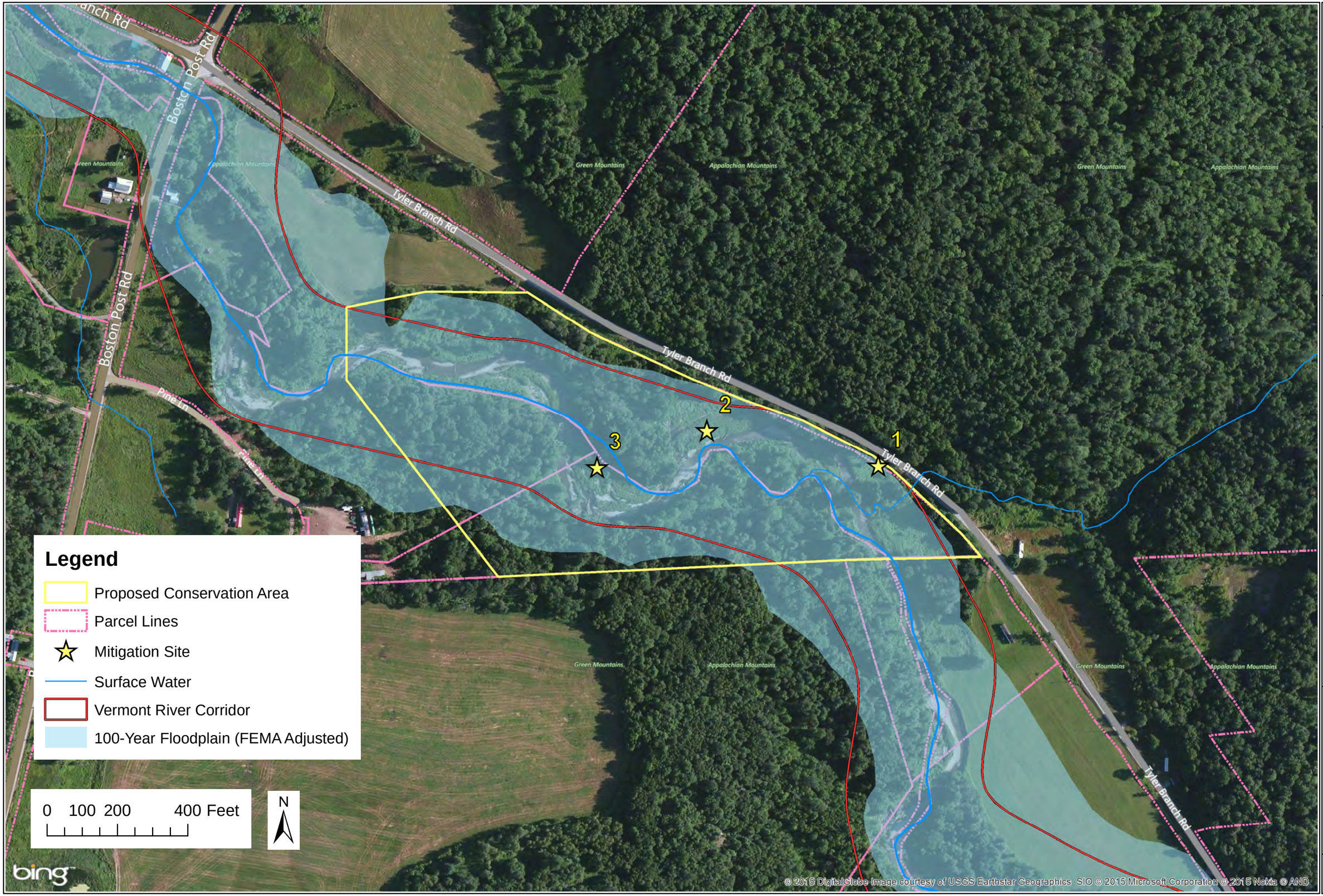
## VERMONT ECONOMIC RESILIENCY INITIATIVE (VERI)

## ENOSBURGH, VERMONT

**Map By:** RKS
**MMI#:** 5507-01
**MXD:** VERI_Enosburg_MissBermRemoval.mdx
**1st Version:** October 6, 2014
**Revision:** March 5, 2015
**Scale:** See scale bar.

# Appendix J:

# Tyler Branch Corridor Conservation Project Concept Plan




**SOURCE(S):**

Field Data Collected by MMI and FEA
Site Mapping by MMI
Economic Assets by NRPC
Vermont Center for Geographic Information
Bing Maps Aerial Photography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**TYLER BRANCH RIVER CORRIDOR CONSERVATION PROJECT**

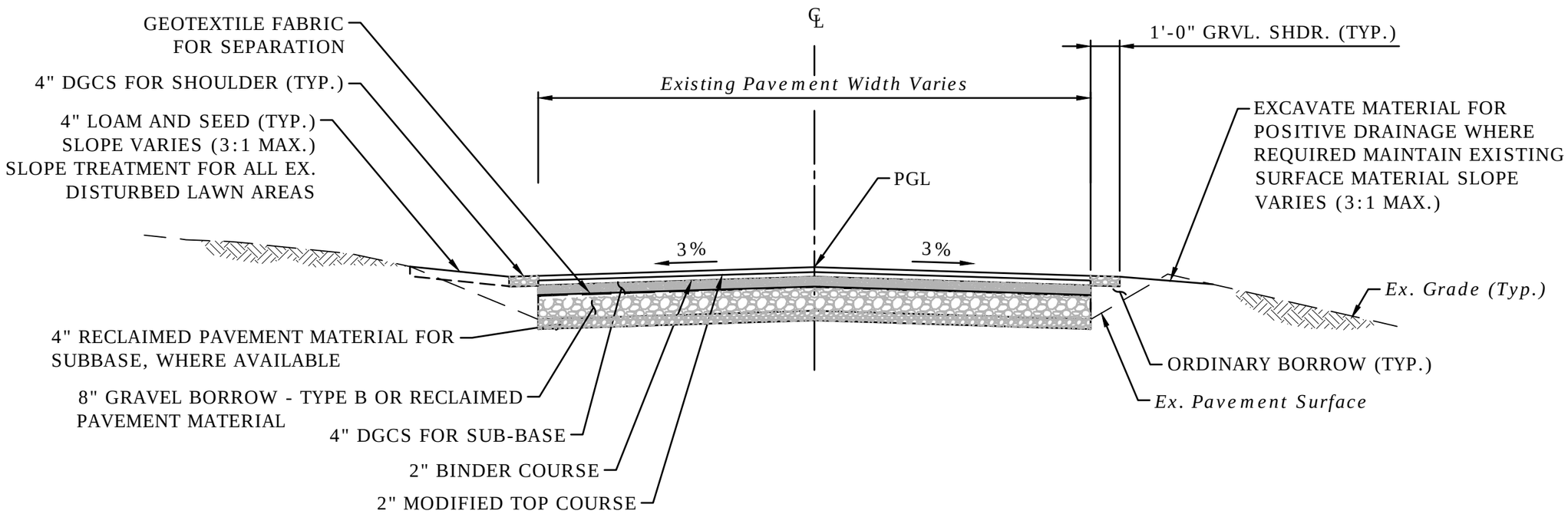
**VERMONT ECONOMIC RESILIENCY INITIATIVE (VERI)**

**ENOSBURGH, VERMONT**

**Map By:** RKS
**MMI#:** 5507-01
**MXD:** VERI_Enosburg_ConservationProject.mxd
**1st Version:** December 1, 2014
**Revision:** March 5, 2015
**Scale:** See scale bar.

# Appendix K:

# Road Typical Section – Full Depth Reconstruction




# ROAD TYPICAL SECTION
# FULL DEPTH RECONSTRUCTION

SCALE: 1/4" = 1'

0' 0.5' 1'
0 1/8" 1/4"

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REVISIONS

CONCEPT DESIGN

TYPICAL SECTION- FULL DEPTH RECONSTRUCTION

VERMONT ECONOMIC RESILIENCY INITIATIVE (VERI)

ENOSBURGH, VERMONT

| FWW DESIGNED | FWW DRAWN | TC CHECKED |
|---|---|---|

SCALE: 1/4"=1'

DATE: MARCH 6, 2015

PROJECT NO.: 5507-01

SHEET NO.: 01

# Appendix L:
# Community Forum Meeting Notes

# Vermont Economic Resiliency Initiative (VERI)

# Community Forum – Town Of Enosburgh and Enosburg Falls

## MEETING NOTES

October 29, 2014 – 6:00 – 8:00 PM

### Project Overview

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development (DHCD) launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes. DHCD is partnering with the Agencies of Natural Resources (ANR) and Transportation (VTrans) and the Regional Planning Commissions on this effort.

VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy.

### For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI

### Summary

Eight community members, business owners and homeowners from Enosburgh Town and Enosburg Falls attended the Vermont Economic Resiliency Community Forum. The community identified numerous river and flooding problems along the Missisquoi River and Tyler Branch. There is regular flooding of the Missisquoi River along VT Route 105 between the Boston Post Bridge, Dairy Center, and East Berkshire. When VT Route 105 is closed, traffic is diverted onto local roads which are not designed for heavier traffic, especially during mud season. Flooding also occurs on the Tyler Branch near the intersection with Grange Hall Road. Ice jams and excessive sedimentation of the stream bed exacerbate the flooding issues. Successful mitigation projects in Enosburg have included integrating buffer regulations into the bylaws, bridge and culvert resizing, use of conservation easements to dissipate flood waters, and tree planting along the river corridor. Further analysis and technical assistance needs of the community emphasized minimizing flood impacts, particularly scouring, to farm lands, planting and managing trees in the buffer zone, assessing risks to the many recreational vehicles parked along the river, and improving flood detour routes.

## Present

- Community Members and Business Owners: Wendy Scott (Enosburg Conservation Commission), Polly Rico (Enosburgh Selectboard), Larry Gervais (Enosburgh Selectboard, Dairy Farmer), Pierre Letourneau (Enosburgh Selectboard), Andre Viens (A.V. Construction), Patrick Hayes (Wood Meadow Market), Jon Elwell (Village Manager), and Wendell R. Bashaw (Poulin Lumber)
- Technical Assistance: Roy Schiff (Milone & MacBroom)
- Regional Planning Commission: Bethany Remmers and Amanda Holland (Northwest Regional Planning Commission)
- State of Vermont: Commissioner Noelle MacKay and Wendy Rice (DHCD) and Staci Pomeroy (ANR- DEC Rivers Program)

## Introduction

Larry Gervais, Enosburgh Selectboard Chair, welcomed attendees and introduced Commissioner Mackay from the Vermont Department of Housing and Community Development. Commissioner MacKay welcomed everyone and thanked people for participating in a first round of community forums being held in the five VERI pilot communities. The Commissioner explained that the community forums are examining ways to improve economic resiliency for natural disaster impacted communities in the aftermath of Tropical Storm Irene. Through the Vermont Economic Resiliency Initiative (VERI), the State will analyze risks to public infrastructure, alongside economic activity, river corridor and flood data, to better mitigate future flood hazards and to ensure businesses rebound quickly. The Commissioner provided the audience with a VERI project overview and the findings of the first two phases of the project. After her introductory remarks, the Commissioner explained that the purpose of the meeting was to collect information about risks to infrastructure and economic activity in recent flooding, subsequent risk reduction, and suggested improvements for long-term resiliency. She noted that though Enosburg was not impacted from Irene as towns in southern Vermont, the community has been impacted by past flooding events and the December 2013 ice storm.

## Overview of the Study Area

The State has contracted with a team of river scientist and engineers to review the geomorphology (defined as the study of landforms interacting with flowing water), flood hazard risks, sediment deposition potential, and impacts to the built environment of select rivers and tributaries within each targeted VERI community. The scientists presented an overview of their work and initial observations in the river corridors at each of the community forums and provided technical assistance to the

respective community throughout the meeting. The river scientists selected sections of the Tyler Branch and Beaver Meadow Brook in Enosburg to analyze.

Notes

- Roy Schiff described the 5.25 mile study area. It includes the Tyler Branch from the Sheldon/Enosburgh town line, upstream to the confluence with Cold Hollow Brook. It also includes the Beaver Meadow Brook from the confluence with the Tyler Branch, upstream about 1 mile.
- A geomorphic assessment was completed 5-6 years ago in this watershed. The assessment measured the dynamics of the stream and landform (sediment size, deposition areas, broad floodplain or narrow gorge, etc.) to determine where there may be potential issues.
- Overall, there have not been significant changes in the stream since the State's initial geormorphic assessment. Many sections of the stream are armored, especially of the outer banks of meanders.
- Upstream the river gets narrower and there are a couple of rock gorges that influence the river system. This includes the section adjacent to Tyler Branch Road near the Grange Hall Road. Upstream of this gorge area, there is significant armoring and berming. This is creating a potentially hazardous situation.
- Upstream on Beaver Meadow Brook, there is a system of beaver ponds and wetland areas. This area is providing significant sediment and woody debris storage that is protecting agricultural lands downstream.
- Throughout the watershed, many bridges are skewed to the direction of flow and could be vulnerable to erosion. There are also some valley walls with "mass failings."
- Roy Schiff will draft a list of potential project areas based on the field work and identified problem areas. The list will also identify what businesses would be impacted in these problem areas. Damage to the road means good and services are not moving properly- particularly relevant for perishable agricultural goods.
- Community members asked why the river team selected the Tyler Branch for the study rather than other rivers/streams in town (notably the Missisquoi River). It was noted that the Tyler Branch was partly selected because of having past geomorphic assessment which identified vulnerabilities at bridge crossings and failures along the banks.

### For more information on past river studies

This area has had a river study completed in the past and the consultants are incorporating this past work in to the VERI project. That study can be found here: https://anrweb.vt.gov/DEC/SGA/finalReports.aspx.

### Forum Public Input

Commissioner MacKay solicited input from forum participants with regard to flood risk and mitigation opportunities in Enosburg. Those questions were:

1) What are the hazards and risk areas in the town?
2) What has been done already to mitigate flooding risks?
3) What are the potential projects to address long-term resiliency?
4) What information should the final report include and how should this information be presented?

### Identified Natural Disaster Hazards and Business Risks

What are the hazards and risk areas in the town?

Notes: Responses from the Public

- In the **spring** there is regular **flooding**. Significant debris comes down in the flood water including **trees and potential contaminants** from cars parked near the river.
- There are places where **old trees** may need to be cut because they could fall into the river causing **erosion or debris issues**.
- The Missisquoi River along VT Route 105 from the Dairy Center to East Berkshire (2-3 miles) floods regularly (almost every year). This results in **closures on VT Route 105** which diverts traffic onto local roads (Hurley Road and Davis Road). Most of these roads are not designed for heavier traffic, especially during mud season. Ice jams are an issue in this area as well.
- The **Hopkins Bridge Road** floods regularly and has to be repaired by the Town at least once a year. The flooding is exacerbated by recent berming on the Trout River.
- It was asked how many farms have generators. It was felt that most have their own but they may not be sized properly nor are they regularly maintained. A preparedness strategy may be to have generators that are not dependent upon charge from a tractor, as the tractors may be unmovable with felled trees in a disaster.

- The **town garage's** location was identified by the State as a potential area of concern because it is adjacent to the Tyler Branch and partially in the flood plain. The Town noted that they have not had issues with flooding at that location because it is built-up from the stream and the bank is armored. It was unknown if there is floodproofing at the garage and the winter salt storage in the floodplain may be an issues during a flood event.
- **Ice jams** are an issue on the Tyler Branch particularly near the Boston Post Road and Vaillancourt's Garage.

### Effective Hazard Mitigation and Risk Reduction

What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?

Notes: Responses from the Public

- Some CREP projects on the Missisquoi and Trout River have been lost because of flooding.
- The Missisquoi River Basin Association has done a number of **tree plantings** in the area and there is GIS data recording the locations.
- Enosburgh Town integrated **buffer regulations in their bylaws**. The buffers are based on the fluvial erosion hazard data that was collected during the geomorphic assessments. The buffers do not allow new development but the group did not know if fill was allowed.
- There is a **new bridge** on the Boston Post Road near the intersection with Tyler Branch Road. While the bridge may be slightly wider, the original stone abutment was not removed. The bridge was completed under VTrans' accelerated bridge construction program. That could be the reason the abutment was not removed.
- A **conservation easement** bought land from Mr. Welch for a portion of his property along the Tyler Branch. It will allow water to flow more freely and there may be an opportunity to do easements in other places where the riprap has to be replaced regularly.
- A **culvert** is being replaced on Boston Post Road.

### Resiliency and Sustainability Planning

What still needs to be addressed in the interests of long-term security and sustainability?

Notes: Responses from the Public

- There are infrastructure issues on Hayes Farm Road in Enosburg Falls. The whole road is in bad shape and needs to be rebuilt along with replacing several culverts. Enosburg Falls had funding

earlier to deal with the culverts but the grant funds had to be redirected to a bridge that was close to being condemned. This is a major detour route when VT Route 105 is closed because of flooding.

- Off of Tyler Branch there is another landslide on the property with a little log cabin near Courser Road.
- The campground on Sand Hill Road is in the flood plain. There are many RVs next to the stream and some a stored there through the winter.
- It was asked how there can be less scouring in the fields? There are some cost sharing for cover cropping, but this was done with a helicopter and has not seeded well due to scheduling issues. There is a narrow window of time where seeding should be done and it has been difficult to get the contractor during that time. Jeff Sanders at UVM agriculture extension is heading up this program.
- It was noted that while trees are good for stream bank stability, it has to be balanced with having adequate visibility on roads.
- It is important to address the berms along Tyler Branch near Grange Hall Road.

### Information Sharing and Dissemination

What information should the final report include and how should this information be presented?

Notes: Responses from the Public

- It should be proactive.
- It should outline the emergency response during an event to best protect a business during and after a disaster.
- It should include a list of things to consider such as staffing capacity and the local political climate.
- Identify where conservation easements should be placed and how this would benefit the whole community.
- Include a prioritization of projects and identify potential funding opportunities.

# Vermont Economic Resiliency Initiative (VERI)

# Community Forum - Enosburgh Town and Enosburg Falls

## MEETING NOTES

April 30, 2015 – 6:00 – 8:00 PM

### VERI Project Overview

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.
VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy.

### For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI/Enosburgh

### Summary

Nineteen people were in attendance, including project team members, town officials, state officials, landowners, community members and business owners from the Enosburg community. The forum outlined four high-priority implementation projects and three policy/program recommendations which could significantly decrease flood risk for Enosburgh, if implemented. Community members were given the opportunity to ask questions, provide input, and rank the proposed projects. The projects that the meeting attendees ranked highest included improving the road surface and enlarging undersized culverts on detour routes used when the Missisquoi River floods. This would include the Davis Road, Hayes Farm Road, Perley Road and Longley Bridge Road. Conserving a wetland complex along the Tyler Branch approximately 1,700 feet upstream from the Boston Post Road also ranked high. The policy and program recommendations did not receive as many votes as the implementation projects but adopting river corridor protection bylaws and expanding riparian zones did receive interest from the forum participants.

### Welcome and Overview

[Noelle MacKay, Commissioner of the Department of Housing and Community Development]

Noelle MacKay began outlining the agenda for the evening and emphasized the importance of community input on the proposed flood reduction projects. Starting off with the "big picture," Noelle said the Vermont Agency of Commerce and Community Development's role after Irene was post-disaster recovery and noted that while Irene impacted buildings and infrastructure, it was also a tremendous blow to the State's economy. The state applied for and received a grant from the US Economic Development Authority to help five Vermont communities build back stronger and take steps to protect their economy from future floods.

Noelle introduced the project team members and provided background information on a successful project in Bennington that created the model for this project. This project re-established floodplain and resized culverts which made the community more resilient during Irene and saved the town an estimated $700,000 to $800,000 in repair costs.

Noelle explained the process for selecting the five towns – each with high flood risk to economic activity and infrastructure. Enosburgh and Enosburg Falls were selected as a VERI pilot community because of its strong agricultural economy, flood history and past stream geomorphic assessments in the Tyler Branch Watershed.

As part of this project, a team of river scientists and engineers were hired to further assess the Tyler Branch, identify local threats to infrastructure and business and make recommendations to reduce the impacts of future floods. The study area initially included 5.3 miles of Tyler Branch from the confluence of Beaver Meadow Brook and Cold Hollow Brook downstream to the Enosburgh-Sheldon town line. Based on community input, the study was expanded to examine flooding issues along the Missisquoi River upstream from the Boston Post Road.

The first Enosburgh Community Forum was held in October 2014, where Noelle sought input from attendees on three topics: what did they see happen during the 2011 spring flooding and other historical floods, what have they done to prepare for the next flood, and what would they like state government, the town, and other agencies and organizations to do to help the community prepare for the next flood?

The VERI team combined this information and its analysis into a draft report that contains recommended projects and town-wide policy and program options to reduce flood risks. The projects were ranked by the consultants on whether they are effective, limited, or ineffective at reducing erosion risk, flood risk, and damage to businesses, infrastructure, and property. The ease of implementation, cost, and potential partners are also a factor.

Noelle stressed that this is a draft report, and that the team is eager to get comments from the public. The report will be up on the project web site until May 14th. She believes the report can serve as a road map for the community and provide a menu of options for what can be done to help protect the community. The Agency of Commerce and Community Development will work with partners to help identify funding sources once priority projects are identified.

## Overview of Municipal Policies and Programs to Reduce Future Floods

[Bethany Remmers, Northwest Regional Planning Commission]

Before presenting policy and program recommendations for the community, Bethany Remmers noted some of the Town's and Village's accomplishment regarding flood resiliency. Both municipalities participate in the National Flood Insurance Program (NFIP) and have flood hazard bylaws. Both communities have also integrated stream buffers/setbacks into their zoning bylaws. Enosburgh Town has completed 11 of the 15 high priority projects in its 2008 Local Hazard Mitigation Plan and is almost done with a comprehensive update of that plan.

Bethany also presented information on the Emergency Relief Assistance Program (EFAF). ERAF is a state program that covers part of the required 25% local match needed for FEMA Public Assistance (PA) projects. Enosburgh Town qualifies for 12.5% state match because they have taken the required flood resiliency steps: adopted *2013 Town Road and Bridge Standards*, participate in the National Flood Insurance Program (NFIP), submitted an annual Local Emergency Operations Plan (LEOP) and have prepared a Local Hazard Mitigation Plan (LHMP) that is being submitted to FEMA. Enosburg Falls currently qualifies for 7.5% state match because the community does not have a LHMP though the other three requirements have been met. Bethany noted that the communities could increase their state match to 17.5% if they adopted river corridor protection bylaws that prohibited new development in the corridor or participate in the Community Rating System (CRS).

Bethany outlined specific policy and program recommendations that were developed by the team. Three recommendations were considered high-priority by the team.

- Update policies to prohibit fill in flood hazard areas
- Develop a Local Hazard Mitigation Plan for the Village of Enosburg Falls
- Document road, sewer, and water infrastructure vulnerabilities in municipal plan and develop capital plans pay for improvements

## Overview of Project Recommendations and Conceptual Designs

[Roy Schiff, Milone & MacBroom]

The team identified 11 site-specific projects and divided them into three categories: Building and Site Improvements, Channel and Floodplain Management and Infrastructure Improvements. There were no projects identified in the Public Safety Improvements category. Five high priory projects were presented to the group. The team completed conceptual plans on a portion of these projects to help secure future grants and funding for implementation.

1. **Remove berm along the Missisquoi River** (Channel and Floodplain Management)

Project would include removing berm along the Missisquoi River about a mile west of the intersection of VT 118 and VT 105 to restore access to the flood plain and reduce flooding downstream. The berm is one to two ft. tall in some spots and up to six ft. tall and twenty ft. wide in other areas. There are trees and other vegetation growing on the berm. The team estimated that 3,000 yards of soil would be removed from the berm at a cost of $120,000.

> Notes and Responses from the Public: There was discussion of whether the berm was man-made or a natural feature created by the river. Roy reasoned that it was probably constructed to protect the adjacent fields. River flooding could have deposited additional sediment onto the berm. There was some concern that removing the berm would cause flooding and erosion of the farm fields. Because VT 105 regularly floods in that area, VTrans may be interested in contributing to the project. The Hazard Mitigation Grant Program and the Ecosystem Restoration Program may be potential funding sources.

2. **Conserve land along Tyler Branch upstream of Boston Post Road** (Channel and Floodplain Management)

The project would conserve land along the Tyler Branch that includes a nice complex of beaver ponds and stores significant woody debris and sediment. It is a critical storage area that protects infrastructure downstream. There are some high slope failures in the area but they appear to be re-vegetating. The team estimated that the cost of conserving the river corridor through an easement on three parcels would be $40,000.

> Notes and Responses from the Public: It was asked if the easement would be town funds or a grant. It could be both. A participant asked if the project would include a road and bank

stabilization. Roy noted it is currently not an issue but it could be a problem in the future and the project could include protecting the roadway.

3. **Improve Hayes Farm Road and Davis Road** (Infrastructure Improvements)
   The team evaluated detour routes that are used when there is flooding and evaluated what roads could be upgraded to accommodate the detoured heavy truck traffic. The Hayes Farm Road and Davis Road corridor is one of those important detour routes. The culverts along with route are undersized, with their widths about 40-50% of the stream's width. There are visible signs that the stream has jumped the road in certain locations. The project would include installing properly sized culverts, paving the dirt/gravel sections and repaving the other sections. The project would cost about $1 million but could be broken into smaller sections and done over time.

   Notes and Responses from the Public: Joey Clark was asked if ice and debris jams were an issue along this corridor. He said they were not.

4. **Install overflow bridge on Boston Post Road at the Missisquoi River and elevate low spots along Vermont Route 105** (Infrastructure Improvements)
   The overflow bridge would be installed on the low portion of Boston Post Road where there is regular flooding and ice jam issues. The team identified sections of VT 105 that would have reduced flooding if they were raised.

   Notes and Responses from the Public: The group discussed whether it would be better to wait until the bridge needs to be replaced and make sure the new bridge has a longer span. A new bridge could have two sections with a center pier. The current bridge might have floated down the river in the 1927 flood and pulled back to the original site in 1928. Roy noted that the slope of the river is almost flat in this area and there might be influenced by the dam downstream.

   It was reported that when there is an ice jam at this location, the barn on the right side near the bridge can get flooded in 20 minutes. Noelle noted that the Department of Agriculture might be able to help develop strategies for evacuate costs from this barn during flooding. Noelle also recommended the area farm and businesses have a continuity of operations plan to help prepare for potential flooding. The team will recommend floodproofing this barn and store as a potential strategy in the project report.

## Where to Get Help

[Noelle MacKay, Commissioner of the Department of Housing and Community Development]

Noelle highlighted next steps for the project and additional resources for the community. She noted the Enosburgh VERI webpage, ACCD's Flood Resilience webpage and the Vermont Flood Ready site are great resources . She explained that Vermont's Small Business Development Center is a resource for helping businesses plan for disaster including continuity of operations planning. FEMA is also planning to hold a training on small business recovery in September, and the upcoming Vermont downtown conference will feature a session on floodproofing.

Noelle explained there could be multiple pots of money to implement the project recommendations because they cross many areas including water quality, transportation and emergency management/flood resiliency. A funding directory was available for forum participates to take home along with many other guides and resources. Noelle reported that after May 15th, she will be meeting with state agencies to strategize on how to fund some of these projects. She also suggested the community reach out directly to VTrans and legislators for support.

## Project, and Policy and Program Prioritization

Sticky dots were handed out to forum participants (six each) to place on the charts to prioritize project recommendations, and policy and program recommendations. Before ending the presentation, Noelle thanked everyone for coming, especially those who participated in the VERI forum for the second time.

The results of the project prioritization are below, in order of popularity - with number of sticky dots received in parenthesis.

1. Improve road surfaces and enlarge undersized culverts on detour routes used when the Missisquoi River floods. (12)
2. Corridor conservation about 1,700 feet upstream of Boston Post Road. (8)
3. Berm removal along the south bank of the Missisquoi River about 1 mile west of intersection of VT 105 and VT 118. (6, tie)

3. Install overflow structure on Boston Post Road at the approach to the bridge over the Missisquoi River-Changed to install new bridge with longer span. (6, tie)

4. Improve road and river stability and realign channel upstream of bedrock gorge near intersection of Tyler Branch Road and Grange Hall Road. (2, tie)

4. Expand cover crossing and other best practices on valley bottom farmland along the Missisquoi River and Tyler Branch. (2, tie)

5. Improve bridge alignment over Tyler Branch about 3,500 feet upstream of Duffy Hill Road. (1, tie)

5. Berm removal about 1,000 feet upstream of the intersection of Tyler Branch Road and Grand Hall Road to spread flood flows. (1, tie)

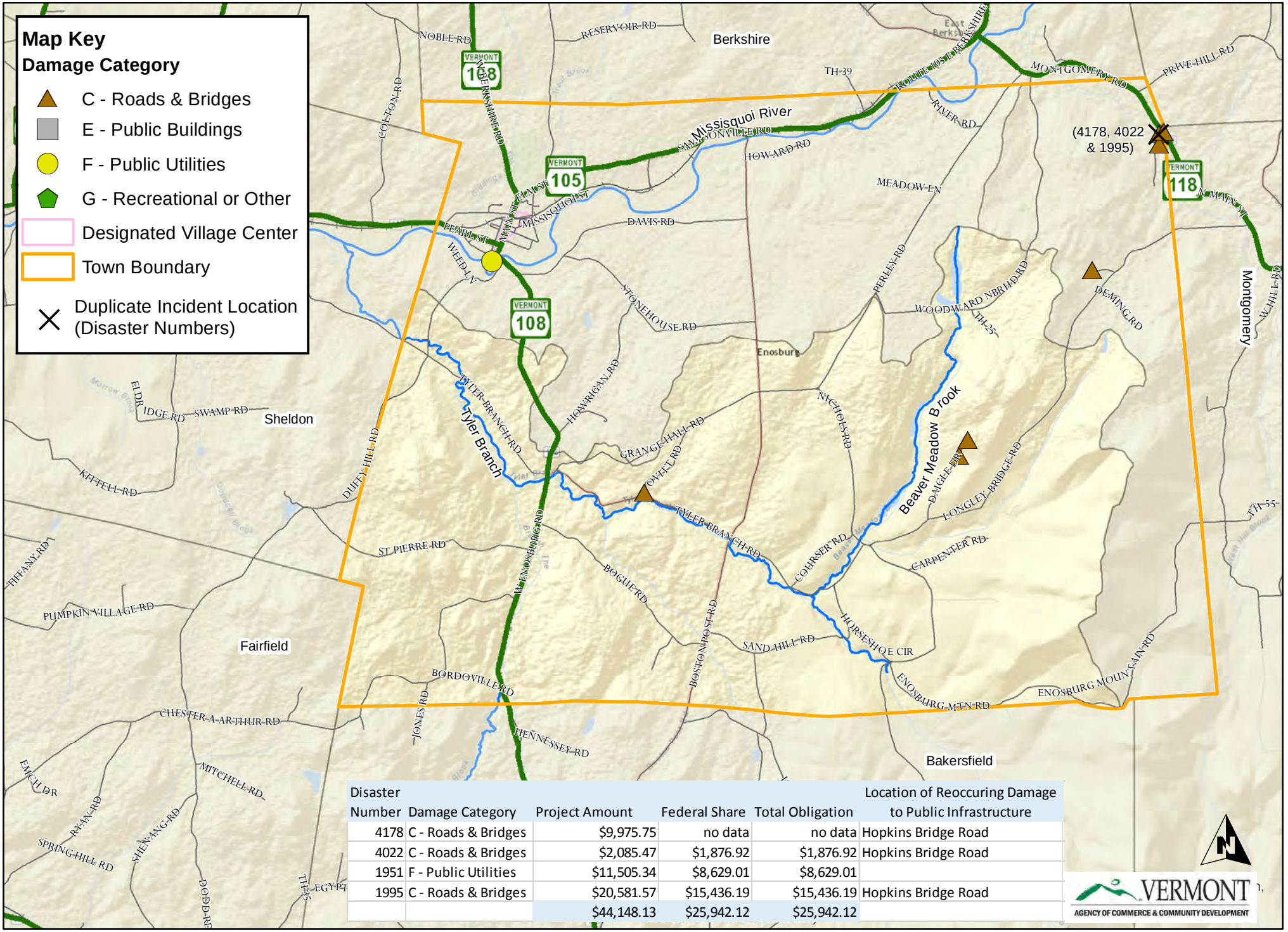
The results of the policy and program prioritization are below, in order of popularity - with number of sticky dots received in parenthesis.

1. Adopt river corridor protection bylaws. (3)
2. Maintain and expand riparian zone protection to reduce bank erosion potential and conflicts. (2)
3. Update flood hazard regulations to further limit floodplain development. (1)

# Appendix M:

# Map of Repetitive Damage in Enosburg

# Tyler Branch, Enosburg Town & Village, VT




| Disaster Number | Damage Category | Project Amount | Federal Share | Total Obligation | Location of Reoccuring Damage to Public Infrastructure |
|---|---|---|---|---|---|
| 4178 | C - Roads & Bridges | $9,975.75 | no data | no data | Hopkins Bridge Road |
| 4022 | C - Roads & Bridges | $2,085.47 | $1,876.92 | $1,876.92 | Hopkins Bridge Road |
| 1951 | F - Public Utilities | $11,505.34 | $8,629.01 | $8,629.01 | |
| 1995 | C - Roads & Bridges | $20,581.57 | $15,436.19 | $15,436.19 | Hopkins Bridge Road |
| | | $44,148.13 | $25,942.12 | $25,942.12 | |

Author: Map provided by the Department of Housing & Community Development (DHCD). FEMA Data.Gov & Project Work Sheets. Map created 1/22/2015.

# Vermont Economic Resiliency Initiative [VERI]

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Linking people to their landscape
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VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

# Vermont Economic Resiliency Initiative [VERI]

## Woodstock, VT

Community Report
July 2015

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

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- Fitzgerald Environmental Associates, LLC: Evan Fitzgerald
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Noelle MacKay, Commissioner of Housing and Community Development

# Table of Contents


Vermont Economic Resiliency Initiative (VERI): Woodstock Executive Summary ..... iii
List of Acronyms ..... vii
Glossary of Terms ..... viii
Project Overview ..... 1
  Why Was Woodstock Selected? ..... 2
  Study Area ..... 2
  Research and Outreach ..... 3
Flood History and Town Accomplishments ..... 6
  Flood History and Risk ..... 6
    Tropical Storm Irene ..... 6
  Town Accomplishments ..... 9
    Town-Wide Flood Policy ..... 9
  Site-Specific Projects ..... 10
Strategies and Projects to Protect Woodstock ..... 13
  Municipal Policy and Program Recommendations ..... 13
  Specific Project Recommendations ..... 15
    Building and Site Improvements ..... 16
    Channel and Floodplain Management ..... 17
    Infrastructure Improvements ..... 17
    Public Safety Improvements ..... 19
Conceptual Project Designs to Protect Woodstock ..... 20
  Create Floodplain at the Bridgewater Mill Mall ..... 20
    Project Overview and Objectives ..... 20
    Data Analysis and Results ..... 20
    Steps for Project Implementation ..... 21
    Projects Benefits ..... 21
  Upgrade Municipal Sewer ..... 22
    Project Overview and Objectives ..... 22
    Data Analysis and Results ..... 22
    Steps for Project Implementation ..... 23
    Project Benefits ..... 23
Next Steps ..... 24
  Education and Outreach ..... 25
  What Can Individuals Do to Reduce Their Risks? ..... 26
    Steps to Reduce Risks ..... 27
  What Can Businesses Do to Reduce Their Risks? ..... 28
    Steps to Reduce Risks ..... 29
References ..... 31

## Figures and Tables

Figure 1: Map of Study Area ..... 2
Figure 2: Study area location within the Ottauquechee River Watershed ..... 2
Figure 3: US Route 4 runs along the Ottauquechee River from Killington to Quechee ..... 3
Figure 4: Rock riprap placed at the Riverside Mobile Home Park following Tropical Storm Irene to reinforce the bank ..... 4
Figure 5: Woodstock Community Forum ..... 4
Figure 6: Photo of the White Cottage Snack Bar after the Flood of 1973 (Vermont Standard, 2013). 6
Figure 7: Flood damage costs in Woodstock (TRORC, 2014a) ..... 6
Figure 8: Tropical Storm Irene damage in West Woodstock, Vermont. (TRORC, 2011) ..... 7
Table 1: Businesses in Flood/Erosion Hazard Zones in VERI Study Area ..... 8
Table 2: How Woodstock Met Its ERAF Match ..... 10
Figure 9: Elevated mobile home at Riverside Mobile Home Park ..... 11
Figure 10: Dead River Propane offices have sealed walls and door dams to keep floodwaters out ... 11
Figure 11: The White Cottage Snack Bar was rebuilt farther away from the river ..... 12
Table 3: Categories of Municipal Policies and Programs ..... 14
Table 4: Mitigation Project Types ..... 15
Figure 12: Poor rock riprap placement that needs to be reinforced to improve the stability of US Route 4 ..... 18
Figure 13: Municipal sewer pump station in West Woodstock needs to be retrofitted to prevent inundation by floodwaters ..... 18
Table 5: Buyout Considerations for West Woodstock Businesses ..... 19
Figure 14: Field across the river from the Mill Mall ..... 20
Figure 15: Section showing possible floodplain creation project across the river from Mill Mall ..... 21

## Appendices

Appendix A: Floodplain Development Maps
Appendix B: Flood Hazard and Flood Damage Maps and Table
Appendix C: Results of EPA's Flood Resilience Checklist for Woodstock
Appendix D: Table of Municipal Policy and Program Recommendations
Appendix E: Maps and Tables of Projects to Protect Woodstock
Appendix F: Conceptual Project Designs to Protect Woodstock
Appendix G: Community Forum Meeting Notes

# Vermont Economic Resiliency Initiative (VERI): Woodstock Executive Summary

In communities around Vermont, rapidly melting snow and torrential downpours bring nightmares of washed out bridges, closed roads, flooded basements and shuttered businesses. To calm these fears, Vermonters have been working to better understand the flood risks they face and identify and implement projects that reduce, avoid or minimize these risks. The goal: to protect lives, help businesses remain open and reduce costs to taxpayers for repetitive repair to infrastructure.

After Tropical Storm Irene, Governor Shumlin challenged us to "build back stronger than Irene found us." The Vermont Economic Resiliency Initiative (VERI) is designed to help meet that challenge. It is modeled after successful project in Bennington, Vermont that minimized business interruption and saved taxpayers money by substantially reducing flood recovery costs (DHCD, 2015). With funding from the US Department of Commerce, Economic Development Administration (EDA), the Agency of Commerce and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched VERI to help ensure Vermont recovers quickly and remains open for business after disaster strikes.

In the first phase of the project, the VERI team evaluated and ranked areas where economic activity and associated infrastructure are at high risk of flooding. Based on this statewide assessment, input from the team's economic development steering committee and interest from local municipalities, five areas in seven communities (Barre City and Town, Brandon, Brattleboro, Enosburgh Town and Village, and Woodstock) were selected for a more detailed analysis of the local flood risks to the community and businesses.

Woodstock was selected as a pilot community because it has a densely developed downtown area with significant economic activity, critical transportation infrastructure and commercial buildings at risk of flooding and a history of community engagement including past efforts to identify flood risks throughout the town. For example, the Town of Woodstock has adopted strategies for protecting new development and substantially improved buildings from flood hazards through regulations that offer greater protection to the community than the minimum National Flood Insurance Program (NFIP) guidelines. With its completion of a town hazard mitigation plan in 2015, the town and village now qualify for the intermediate level of state reimbursement (12.5%) for costs related to federally declared disasters.

The team hosted two community meetings and worked directly with local leaders, municipal staff, local businesses and interested citizens to determine the locations of greatest risk and cost, identified potential projects and highlighted the work communities have accomplished to date to reduce the impact of floods. Based on this community insight, along with data collection and analysis, the team evaluated local flood risk to business and infrastructure and identified strategies and projects

Woodstock can implement to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining the local economy.

This report summarizes the team's work and identifies town-wide bylaw and plan updates and 16 site-specific projects in Woodstock, including the eight projects listed below deemed high priority by the team.

## Municipal Policy and Program Recommendations

Top recommendations include the following:

- **Monitor Rebuilding After a Disaster and Participate in the National Flood Insurance Program (NFIP):** People want to return their lives back to normal as quickly as possible after a disaster but local officials (zoning administrators and local boards) must monitor rebuilding to ensure that it does not violate town, state, or federal regulations. Allowing improper repairs after a flood may result in the loss of federal flood insurance and disaster recovery funding for the community. It is important to note that in many instances, buying out businesses and homes located in risky areas is the best way to safeguard against future losses of life and property.
- **Encourage Development Outside of the Floodway in the Village:** The floodway is the fastest moving part of the river during a flood. Buildings and other objects in a floodway can be washed downstream and cause culverts and bridges to clog with debris resulting in significant property damage. To protect the community and the economy, the village zoning bylaw should prohibit all new development in the mapped floodway.
- **Include the VERI Municipal Infrastructure Projects in the Local Hazard Mitigation Plan:** Woodstock can also add the projects listed in this report to the strategies portion of its hazard mitigation plan to improve eligibility for future grants.

## High Priority Specific Project Recommendations

**Building and Site Improvements:** This project would reduce flooding and/or erosion to specific property with improvements to the building and/or surroundings.

- **Floodproof Buildings at the West Woodstock Farmer's Market:** The building at the Woodstock Farmer's Market was flooded during Tropical Storm Irene, resulting in a complete loss of merchandise. Elevating the building or using dry floodproofing techniques could help reduce future losses. A site-specific assessment by an engineer and/or architect is recommended to determine the best method to protect this business with 40 employees.

**Channel and Floodplain Improvements:** This project lowers the risk of flooding and/or erosion to properties along the river through the improvement of natural river and floodplain functions.

- **Preserve Floodplain Along the Ottauquechee River:** The largest floodplain between the Bridgewater/Woodstock town line and downtown Woodstock is located between the Lincoln Inn and Riverside Mobile Home Park. Protecting this largely undeveloped floodplain through an easement will reduce the risk of future development in a high hazard area and will benefit downstream properties.

**Infrastructure Improvements:** These are projects that lower the risk of flooding and/or erosion to utilities, roadways and other municipal or state-owned infrastructure.

- **Replace Undersized Bridge on US Route 4 near Deerbrook Way:** During Tropical Storm Irene this bridge clogged with sediment and debris that choked traffic down to one lane and destroyed a home. Replacing the bridge with a larger opening would reduce future flood damage and help ensure this critical east-west transportation corridor remains open for trucks, emergency vehicles, employees, employers and visitors.
- **Improve River and Road Stability on US Route 4**: The road embankments along US Route 4 failed and washed out in multiple locations during Tropical Storm Irene. Since then, the Vermont Agency of Transportation has made improvements to protect this critical corridor from future floods; however, further reinforcement of the roadside embankments would help ensure this road remains open for business and the traveling public.
- **Relocate or Reinforce Drinking Water Line Owned by Woodstock Aqueduct Company**: Woodstock's main water supply line at the Elm Street Bridge ruptured during Tropical Storm Irene and left 1,600 residences and businesses without water for five days. While the water supply lines were upgraded following the flood, more work is needed to improve the system's reliability during major floods. Construction of a redundant water supply line from wells on Stimets Road and VT Route 12 to the reservoir on Cox District Road would help assure the availability of clean water to businesses and the public.
- **Relocate or Reinforce Town of Woodstock Sanitary Sewer Line**: The main sewer line at the Elm Street Bridge also failed and left 925 business and residential customers without sewer service for one week. A section of the replaced pipe downstream of the Elm Street Bridge was reinforced following the storm; however, a section lacks a concrete encasement and is vulnerable to future flood damage.
- **Upgrade West Woodstock Sewer Pump Station:** The sewer pump station across from the White Cottage Snack Bar was out of service for 28 days flowing Tropical Strom Irene requiring the town to pump and haul untreated sewage to the wastewater treatment facility. Since then, all the electrical wiring has been replaced and elevated, but additional measures are needed to protect the pump station from water and silt during future floods.

**Public Safety Improvements:** Projects that lower the risk of flooding and/or erosion to properties by avoiding future flood risks.

- **Buyout At-risk Properties in West Woodstock:** Several businesses in West Woodstock experienced severe losses from the 1973 flood and from Tropical Storm Irene. Buyouts would help reduce future losses to life and property in this area.

Two high priority projects (to relocate or reinforce the Town of Woodstock Sewer Line and upgrade West Woodstock Sewer Pump Station) were further detailed to help Woodstock take the next steps and to create model project designs to help other communities learn from the VERI project. An analysis was also performed to evaluate options to reduce repetitive flooding at the historic Bridgewater Mill Mall, home to a number of local businesses.

## Next Steps

As part of the ongoing community discussion regarding the VERI effort, we recommend the following steps to incorporate community input into the final prioritization and to advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization;
- Prioritize one to two projects to pursue each year with assistance from the Vermont Department of Environmental Conservation and Two Rivers-Ottauquechee Regional Commission staff to identify appropriate funding sources and partners;
- Apply for one to two grants each year to advance project development and/or designs;
- Implement projects as funding allows; and
- Monitor project success.

Tropical Storm Irene taught us many lessons -- a key one was that no one individual, business, organization, town or state agency can address and tackle large and complicated projects alone. Reducing the risk of future floods in Woodstock will require partnerships, funding and time to implement. The Agency of Commerce and Community Development, its sister agencies and the Two Rivers-Ottauquechee Regional Commission are committed to help Woodstock take the steps outlined in this report to save lives and protect jobs and its economy from future storms and floods. Flooding due to severe storms will happen again, the question is how can we best reduce the recovery costs to communities and ensure businesses remain open.

# List of Acronyms

**ACCD** – Vermont Agency of Commerce and Community Development

**ANR** – Vermont Agency of Natural Resources

**BFE** – Base Flood Elevation

**CDBG** - **DR** – Community Development Block Grant- Disaster Recovery

**CRS** – Community Rating System

**DEC** – Vermont Department of Environmental Conservation

**DHCD** – Vermont Department of Housing and Community Development

**EDA** – US Economic Development Administration

**EPA** – United States Environmental Protection Agency

**ERAF** – Emergency Relief Assistance Fund

**FEMA** – Federal Emergency Management Agency

**FWHA** – Federal Highway Administration

**HEC-RAS** – Hydrologic Engineering Centers Rivers Analysis System

**HGMP** – FEMA Hazard Mitigation Grant Program

**HMP** – Hazard Mitigation Plan

**LiDAR** – Light Detection and Ranging

**NFIP** – National Flood Insurance Program

**SFHA** – Special Flood Hazard Area

**TRORC** – Two Rivers-Ottauquechee Regional Commission

**USGS** – United States Geological Survey

**VERI** – Vermont Economic Resiliency Initiative

**VTrans** – Vermont Agency of Transportation

**WWTF** – Wastewater Treatment Facility

# Glossary of Terms

Terms are bolded the first time they appear in the text.

**100-Year Floodplain** – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Flood Zone or 100-Year Flood Hazard Area.

**500-Year Floodplain** – The area that will be inundated by the flood event having a 0.2% chance of being equaled or exceeded in any given year. Also called 500-Year Flood Zone or 500-Year Flood Hazard Area.

**Base Flood Elevation** – The computed elevation to which floodwater is anticipated to rise during a 100-year flood.

**Culvert** – A pipe or tunnel underground, usually under roads, that transports flowing water, sediment, debris and ice from one side to the other.

**Emergency Relief Assistance Fund** – This program allows towns in Vermont to increase the amount of state aid money they could receive as a match to federal aid for post-disaster recovery.

**Erosion** – The wearing away of rock or soil by flowing water.

**Fill** – A quantity of earth, stones, etc., for building up the level of an area of ground.

**Flash Flooding** – Rapid, short-term flooding often caused by severe rain and/or rapid snowmelt.

**Floodplain** – Area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge.

**Floodway** – The area immediately adjacent to the channel that must remain open to allow floodwaters to pass.

**Flood Resiliency** – The ability of individuals, communities, organizations and states to adapt to and recover from flooding hazards without compromising long-term prospects for development.

**Hazard Mitigation Plan** – A document and planning process that provides actions to reduce the long-term risk to human life, property, and the economy from natural disasters.

**Mitigation** – Any sustained action taken to reduce or eliminate the long-term risk to life and property from hazard events. It is an on-going process that occurs before, during, and after disasters and serves to break the cycle of repetitive damage and repair.

**No-rise Certification** – A certification by an engineer that a project will not increase flood heights.

**National Flood Insurance Program** – A federally funded and locally implemented program to reduce the impacts of flooding through individual insurance policies and incentives for floodplain regulations.

**Riparian Buffer** – Mixed composition, vegetated land adjacent to a stream separating it from other land uses.

**Riprap** – The application of rocks to reduce erosion and protect nearby infrastructure or private property. Also known as rock armoring.

**Special Flood Hazard Area** – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Flood Zone or 100-Year Flood Hazard Area.

**State River Corridor** – Area delineated by the Vermont Rivers Program adjacent to rivers and streams that provide functions that restore and maintain natural stability for a river. These areas are often at higher risk of erosion.

# Project Overview

In May 2013, the Vermont Agency of Commerce and Community Development (ACCD) and Two Rivers-Ottauquechee Regional Commission (TRORC) received disaster recovery funding from the US Economic Development Administration (EDA) for the Vermont Economic Resiliency Initiative (VERI). The goals of VERI are to:

1. Analyze threats to areas of economic activity and their associated infrastructure;
2. Develop plans to reduce impacts and avoid future losses and costs, and
3. Identify projects that communities and businesses can implement that maximize opportunities for businesses to stay open.

The overarching goal is to ensure that businesses and communities bounce back quickly when disaster strikes, and save time and money in recovery costs.

**The primary objective of the focus area assessments is to develop strategies and projects to make businesses and the communities more resilient to floods and other disasters.**

VERI is led by ACCD's Vermont Department of Housing and Community Development (DHCD) and TRORC, and is in partnership with the Agency of Natural Resources (ANR), Agency of Transportation (VTrans), and Vermont's Regional Planning Commissions. Early in the process, these agencies mapped where flood hazard risks intersect with areas of economic activity and infrastructure. Five priority communities were selected for a detailed assessment of those hazards. These five areas include Barre City and Town, Brandon, Brattleboro, Enosburgh Town and Village, and Woodstock. A river science and engineering team consisting of five consulting companies – Bear Creek Environmental, LLC, DuBois & King, Inc., Fitzgerald Environmental Associates, LLC, Landslide Natural Resource Planning, Inc., and Milone & MacBroom, Inc. – was hired to study these communities and assist developing recommended strategies and projects to reduce the vulnerability of infrastructure and businesses to flood damage.

A number of factors played a role in the selection of the five communities for detailed assessments. First, the project team ranked towns across the state by flood risk, economic activity and infrastructure at-risk. The team then looked at the 20 highest ranking communities and removed any that had undergone or had funding for similar analyses (e.g., Bennington and Waterbury). Next DHCD strived to select five pilot communities that represented different economic profiles (e.g., agriculture, tourism, downtowns) as well as different sizes. Other considerations included risk of future damage, economic factors, and level of community engagement and interest. Together, these factors helped determine the five pilot communities selected.

## Why Was Woodstock Selected?

Woodstock was selected as one of the pilot communities for the following reasons:

- The community has significant economic activity -- tourism in particular, with its close proximity to ski areas, tourist sites and a vibrant, state-designated village center;
- Past flood damage to infrastructure and business and close proximity to US Route 4, a critical east-west transportation corridor;
- An engaged community interested in reducing flood risk; and
- Local interest in floodplain protection.

## Study Area

Seven miles of the Ottauquechee River are included in the study area for this project. The area begins in Bridgewater, 0.9 miles upstream of the Bridgewater/Woodstock town line. It continues downstream for seven miles ending just east of the intersection of Prosper Road and US Route 4. Utilities outside of the study area were included in the flood hazard analysis if they impacted the study area. Figure 1 is a map of the study area, shown in red, in relation to the villages and several **hamlets** of the two towns.

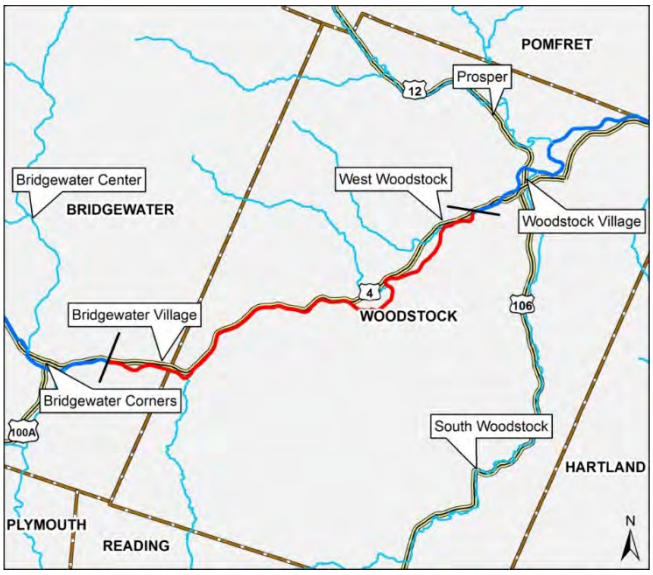


**Figure 1:** Map of Study Area

The Town of Woodstock is located in east central Vermont in Windsor County. As of 2010, just over 3,200 people lived within the town, which is approximately 45 square miles in size. The Village of Woodstock is a hub of commercial and residential development within the town, and is located along US Route 4 near the intersection with Vermont Routes 106 and 12. The town is divided into four hamlets, known as Prosper, South Woodstock, Taftsville, and West Woodstock (Town of Woodstock, 2014).

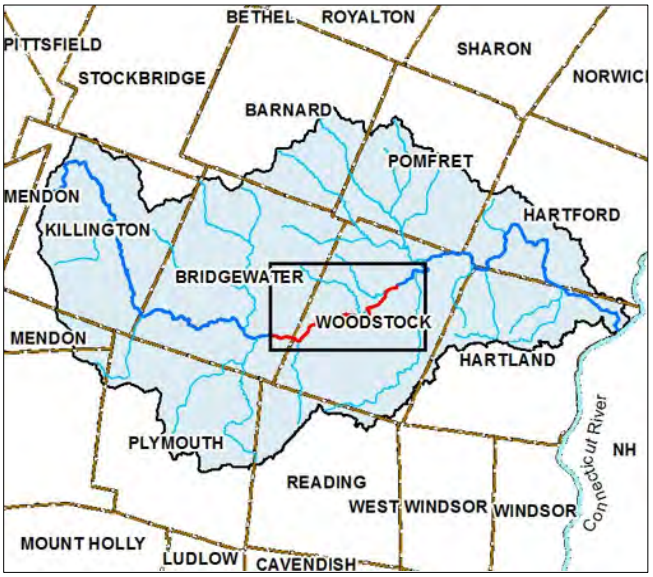


**Figure 2:** Study area location within the Ottauquechee River Watershed

As shown in Figure 2, the Ottauquechee River originates in the Green Mountains in the town of Killington and flows east for 41

miles before emptying into the Connecticut River in Hartland, Vermont. It drains approximately 185 square miles of land within both Rutland and Windsor counties (Bear Creek Environmental, 2013).

Historic settlement occurred along the Ottauquechee River as mills and residences were built in the 1800s. US Route 4 connects the communities and runs along Ottauquechee River from its headwaters in Killington to Quechee (Figure 3). This highway is a critical transportation corridor connecting the communities and central Vermont with both eastern New York and New Hampshire's seacoast. Goods and services, employees, businesses and tourists all rely on this highway.

**Figure 3:** US Route 4 runs along the Ottauquechee River from Killington to Quechee

Throughout most of Woodstock, the Ottauquechee River valley is fairly narrow, though it widens where Beaver Brook and Vondell Brook flow into the river, and in the vicinity of the Village of Woodstock. Land use along the river in Woodstock is a mix of residential, commercial, agricultural, and forest. The Ottauquechee River flows through the center of the more densely developed areas in Woodstock Village and in West Woodstock. Approximately 38 acres of 318 acres (12%) of the **100-year floodplain** in the Woodstock VERI study area is developed (Appendix A).

**Within the study area, 12% of the 100-year floodplain is developed. Development is concentrated within a few small areas.**

## Research and Outreach

The project commenced with a kick-off meeting in August 2014 at the Woodstock Town Offices to discuss the project and to identify flood risks within Woodstock. DHCD Commissioner Noelle MacKay and Mary Nealon of Bear Creek Environmental, LLC provided background on the project and then took questions from the group. Representatives from DHCD, TRORC, the Town of Woodstock, Sustainable Woodstock, the ANR Rivers Program, the Vermont House of Representatives, and the VERI team attended the meeting.

Following the kick-off meeting, the team reviewed existing information about the study area referenced in this report. The river scientists on the team walked the Ottauquechee River to observe the current conditions of the river and floodplain and to note the proximity of river features to economic assets.

Field observations included:

- Locations and dimensions of river bank **erosion** and rock reinforcement (Figure 4);
- Areas with significant accumulation of sediment in the channel;
- Potential areas of conflict where **tributaries** join the Ottauquechee River;
- Bridge and **culvert** dimensions and conditions;
- **Riparian buffer** conditions;
- Floodplain access; and
- Proximity of buildings to flood hazard areas.

**Figure 4:** Rock riprap placed at the Riverside Mobile Home Park following Tropical Storm Irene to reinforce the bank

The first community forum hosted by DHCD and TRORC was held on October 2, 2014 at the Billings Farm and Museum (Figure 5). Community members, business owners, homeowners, state representatives, town leaders and community organizations attended the forum.

DHCD Commissioner Noelle MacKay opened the meeting by discussing the importance of helping businesses bounce back rather than break after disasters. Then the floor was opened for ideas and questions from community members and discussion among the group.

Community members highlighted a number of areas in Woodstock that present possible risks:

- Water, sewer and power infrastructure;
- Storing propane tanks near the river are a hazard;
- Flooding, erosion, and ice jam problems related to Kedron Brook;
- Barnard Brook flooding;
- Bank stability issues on Cloudland Brook;
- Tributaries to the Ottauquechee are an erosion risk hazard;
- Concern over resale of previously flooded properties; and
- Emergency preparedness.

**Figure 5:** Woodstock Community Forum

Woodstock community members highlighted successfully completed as well as ongoing town projects following Tropical Storm Irene, including:

- Town of Woodstock has upgraded culverts;
- Billings Farm planted trees along the river to reduce farm flooding and improve the riparian buffer;
- A couple of projects have been undertaken at the bend in the Ottauquechee River at the foot of the Billings Farm field (an area known locally as "the Jungle" in East Woodstock).
    - Snow dump area was severely eroded during the flood. The Town received Community Development Block Grant - Disaster Recovery (CDBG-DR) funding to move the snow dump.
    - The Town of Woodstock has obtained grants to make the former snow dump into a park.
    - **Riprap** was replaced protecting the main sewer line to the Wastewater Treatment Facility (WWTF).

> **"How do disasters impact businesses, and how can we help them weather the storms?"**
>
> Commissioner Noelle MacKay, Vermont Department of Housing and Community Development

# Flood History and Town Accomplishments

## Flood History and Risk

According to the United States Geological Survey (USGS, 2014), the Ottauquechee River has had eight major floods since 1869. One of the most severe accounts was the Flood of 1927. More recent accounts of flood damage include the storm event of June 1973 and Tropical Storm Irene in August 2011.


**Figure 6:** Photo of the White Cottage Snack Bar after the Flood of 1973 (Vermont Standard, 2013)

In June of 1973, the historic Vermont Native Industries Mill, located near the Bridgewater/Woodstock town line, was forced to close due to building inundation (Vermont Mountain Cabin, 2015). Several businesses on the northern bank of the river in West Woodstock were total losses. Figure 6 shows the site of the White Cottage Snack Bar immediately after the 1973 flood, which was completely destroyed during the flood (Vermont Standard, 2013).

### *Tropical Storm Irene*

Tropical Storm Irene brought over seven inches of rain to the Woodstock area over the course of one day and exceeded a 100-year flood event. Maps documenting the damage that occurred (TRORC, 2014a) are included in Appendix B. Road and bridge damage was the most costly of all types of damage from the storm in Woodstock (Figure 7) with FEMA public assistance for Woodstock totaling over five million dollars. Numerous town roads were damaged as well -- the iconic Holt Iron Bridge was destroyed and the river washed out US Route 4 embankments leaving only one lane passible just west of Deerbrook Way.

**Tropical Storm Irene Damage Cost by FEMA Category**

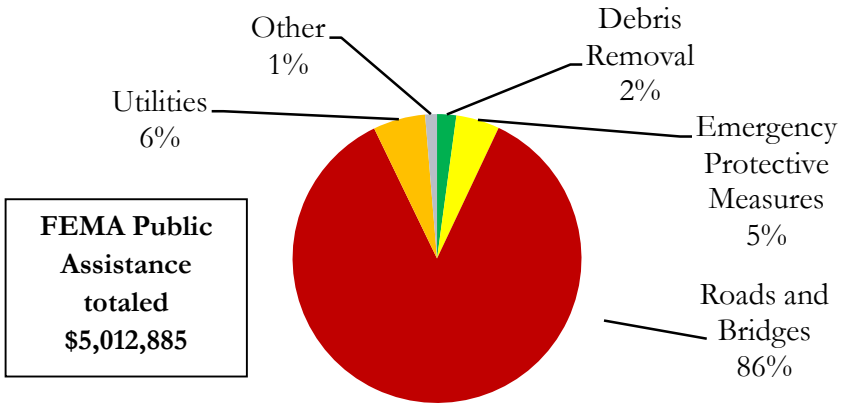


**Figure 7:** Flood damage costs in Woodstock (FEMA, 2012)

Flooding impacted numerous businesses as water filled the basement at the Bridgewater Mill Mall. A total of eight businesses are located in this historic woolen mill, which has been flooded repeatedly since its construction in 1825. Slightly farther east on US Route 4, flooding occurred in the basements of four other businesses, Thymeless Herb Farms, the Farmhouse Inn, the Woodbridge Café, and the Sleep Woodstock Motel.

Extensive damage also occurred at the Riverside Mobile Home Park, located on an especially vulnerable inside bend of the river just southwest of West Woodstock. Of the 40 mobile homes in the Park, 18 sustained damage from flooding (Town of Woodstock, 2011a). A map documenting the damaged mobile homes is included in Appendix B.

In the more developed area of West Woodstock, the storm caused severe damage to businesses and utilities. Flooding reached businesses on Mill Road in West Woodstock, including Dead River Propane, where floodwaters scattered and washed away numerous propane tanks. Major damage was sustained by three additional businesses on Route 4, as shown in Figure 8. The Woodstock Farmer's Market, which serves as one of the major local grocery stores, was flooded and lost all of

Inundation at the Woodstock Farmer's Market


Destroyed Vermont Standard building

Destroyed Dead River Propane Office building

Destroyed White Cottage Snack Bar building

**Figure 8:** Tropical Storm Irene damage in West Woodstock, Vermont. (TRORC, 2011)

its merchandise, causing $750,000 in damage, as well as lost income from recovery time (Irvine, 2012). Roaring floodwaters severely damaged the offices of Vermont Standard, Dead River Propane and the White Cottage Snack Bar.

After road and bridge damage, public utility damage accounted for the second highest cost due to Tropical Storm Irene. Woodstock's public sewer system was damaged in a number of locations along the Ottauquechee River leaving 925 customers without sewer service for one week.

In addition to sewer damage, a primary drinking water line ruptured during Tropical Storm Irene, where it crosses under the Ottauquechee River at the Elm Street Bridge. This left 1,600 customers without drinking water for five days.

While everyone remembers the big events, flood damage in Woodstock from rapid snowmelt and flash floods are common. In fact, Windsor County has seen floods of varying severity nearly every year between 1999 and 2014, many of which have required FEMA funds to aid in recovery (Town of Woodstock, 2015).

**What is the Floodway?**

The floodway is the area immediately adjacent to the channel that must remain open to allow floodwaters to pass.

**What is the 100-year Floodplain?**

The 100-year floodplain is also called the Special Flood Hazard Area, and is the base floodplain shown on FEMA maps.

**What is the State River Corridor?**

The River Corridor is the area delineated by the Vermont Rivers Program adjacent to rivers and streams that provide functions that restore and maintain natural channel stability. These areas are often at higher risk of erosion and/or flooding.

The team conducted a mapping analysis to identify at-risk businesses and facilities in the flood hazard zones using FEMA flood maps (FEMA, 2007) and the **State River Corridor** (Vermont Agency of Natural Resources, 2015). See Appendix B for complete details.

The businesses at highest risk have at least a portion of their building in the designated FEMA **floodway**. During a flood event, the floodway typically conveys the highest velocity waters and is one of the areas of greatest erosion risk. Also of importance is identifying businesses and important facilities and utilities in the 100-year floodplain (also known as the **Special Flood Hazard Area**) and the State River Corridor.

The table below provides a breakdown of the number of businesses and the number of employees that work in these buildings within these three flood/**fluvial erosion** hazard zones. These data only show if buildings are within the flood zone and do not show the elevation of the building relative to the flood zone elevation.

**Table 1: Businesses in Flood/Erosion Hazard Zones in VERI Study Area**

| | Floodway | 100-year Floodplain | State River Corridor |
|---|---|---|---|
| Number of businesses | 3 | 19 | 26 |
| Number of Employees | 61 | 169 | 366 |

The Dead River Propane Offices, the Woodstock Farmer's Market and Riverside Mobile Home Park are three businesses in West Woodstock that are located in the floodway. The White Cottage Snack Bar and the Vermont Standard building were in the mapped floodway prior to Tropical Storm Irene. All five of these businesses experienced severe damages during the 2011 flood. Nineteen businesses in the VERI study area in Woodstock are located in the 100-year floodplain.

## Town Accomplishments

The Woodstock community has been engaged over the past several years with planning and projects to reduce the risk of flooding to local businesses, infrastructure and residences. As described below, these efforts have addressed both town-wide policies and site-specific initiatives to reduce flood risks.

### *Town-Wide Flood Policy*

The town has worked closely with TRORC to study the Ottauquechee River and to prepare a town **Hazard Mitigation Plan** (Town of Woodstock, 2015). A study of the Ottauquechee River in Woodstock and Bridgewater (Bear Creek Environmental, 2013) was conducted under the direction of TRORC through funding by the State of Vermont Ecosystem Restoration Program. Town resiliency initiatives are also reflected in regulations that offer greater protection to the community than the minimum National Flood Insurance Program (NFIP) guidelines.

Zoning regulations for the Town of Woodstock provide ways to protect new development from hazards:

- Development within the FEMA floodway is prohibited within the town, and allowed in the Village if it does not cause an increase in flood heights.
- All new buildings to be built within the 100-year floodplain (outside of the floodway) must have lowest floor elevations (including the basement) that are greater than one foot above the **base flood** elevation (BFE).
- For a building undergoing significant improvements, the lowest floor must be at least one foot above BFE or be floodproofed so that it is water tight to at least one foot above BFE.
- If a new or substantially improved building within the 100-year floodplain has an enclosed area below its lowest floor, this area must be designed to equalize flood forces on the structure by allowing for the entry and exit of floodwaters (Town of Woodstock, 2010).

In 2014, the state of Vermont established an **Emergency Relief Assistance Fund** (ERAF) to provide matching funding for federal assistance after federally declared disasters. This program allows towns in Vermont to increase the amount of state aid money they can receive as a match to federal recovery aid. Towns that take certain steps to become more prepared are eligible for increased state money. Certain damage costs from federally declared disasters are reimbursed 75% by federal money. The state of Vermont contributes a minimum of 7.5% of the total cost, but if a town takes additional steps, the state aid can increase to 12.5% or 17.5% of the cost, leaving less for the town itself to pay (State of Vermont, 2015a).

In early 2015, the Town of Woodstock qualified for increased state aid for federally declared disasters. As seen in the table below, Woodstock and Woodstock Village have policies, plans and programs in place to receive the 12.5% state funding (State of Vermont, 2015; State of Vermont, 2015b). A key next step for the Village and Town is to protect State River Corridors or protect flood hazard areas from new encroachment and participate in FEMA's **Community Rating System** (FEMA, 2014a).

**Table 2: How Woodstock Met Its ERAF Match**

| ERAF Rating | Town 12.5% | Village 12.5% |
|---|---|---|
| Participate in the National Flood Insurance Program | Yes | Yes |
| Adopt 2013 Road & Bridge Standards | Yes | Yes |
| Adopt a Local Emergency Operations Plan | Yes | Yes |
| Adopt a Local Hazard Mitigation Plan | Yes | Yes |
| **Steps to increase State aid to 17.5% (need one to qualify)** | | |
| Adopt no new development in State River Corridor | No | No |
| Adopt no new development in Flood Hazard areas and participate in the Federal Community Rating System (CRS) | No | No |
| **ERAF Match** | **12.5%** | **12.5%** |

In January 2015, Woodstock drafted a town hazard mitigation plan that further outlines town goals pertaining to flooding and **flood resiliency**. Several of the actions the town identified to mitigate the risks of **flash flooding**, flooding, and fluvial erosion are included below.

- Maintain and update town bridge and culvert inventories.
- Regularly inspect and maintain town bridges and culverts.
- Upgrade/upsize, repair, or clean the culverts listed in the Village and Town's priority list as determined by Better Backroads culvert inventory.
- As part of the Town Plan updates, determine if revising and strengthening the Town's Flood Hazard Regulations is necessary to remain compliant with federal and state laws.
- Adopt fluvial erosion hazard/river corridor regulations.

## Site-Specific Projects

In addition to town-wide initiatives, site-specific projects in Woodstock reflect a greater awareness of flood protection measures and avoidance strategies. A number of projects have involved the acquisition and relocation of buildings in high hazard areas. This type of flood protection measure is the most effective, and Woodstock has a number of examples. Rather than rebuilding again in the same location, the Vermont Standard moved to a new location at Lincoln Corners. What remained of the building was demolished and the

> "It has been three-and-a-half years since Tropical Storm Irene hit and now that all the repairs are done and reimbursements made, local officials can see some positive effects from the storm…'We have a lot of improved infrastructure,' said [Woodstock] Town Manager Phil Swanson."
>
> (Fields, 2015.)

Woodstock Farmer's Market purchased the site for additional space. The former Lake Sunapee Bank on US Route 4 was also flooded and the building was moved farther back from the road and the Ottauquechee River. The bank moved its location to a nearby single family home, which was relocated and raised. The Town of Woodstock took similar measures when it chose not to replace the destroyed Holt Iron Bridge, removing a river-road conflict and making the community safer.

The town also developed a new building standard for the Riverside Mobile Home Park to help protect residents from future flooding. These buildings will be raised so that their first floor is two to three feet above the base flood elevation and secured onto a concrete slab (Figure 9). The elevation was selected because flooding during Tropical Storm Irene, in the location of the mobile home park, was two to three feet above base flood elevation (Town of Woodstock, 2011a). Even with these improvements, residents at this park remain vulnerable to being trapped in their homes during a flood event. Relocating the homes to higher ground would improve public safety.

**Figure 9:** Elevated mobile home at Riverside Mobile Home

Downstream of the mobile home park, two West Woodstock businesses took steps to reduce their flood risks. However, both businesses remain at-risk of fast floodwaters eroding the river bank in the vicinity of their buildings. One of three buildings at Dead River Propane was removed due to significant damage. Of the remaining buildings, one was renovated and used as office space, and one left as is and used as a garage. The office building was dry floodproofed because the elevation of its bottom floor is not greater than one foot above base flood elevation. The dry floodproofing at the Dead River Propane Offices included:

- Applying a concrete membrane "thoroseal" to seal the lower portion of the walls;
- Installing door dams at each exterior door (Figure 10);

**Figure 10:** Dead River Propane offices have sealed walls and door dams to keep floodwaters out

- Creating new office space with cement floor (not damaged by water and mud);
- Elevating electric services 42 inches above the floor;
- Raising the furnace on blocks to elevate it one foot above floor; and
- Building a roof to cover a four foot gap between the office building and garage to reduce snow loading (Town of Woodstock, 2012).

On the eastern side of the Dead River Propane Offices, the White Cottage Snack Bar, a local favorite restaurant, also faced major recovery after the storm. The building was destroyed by floodwaters and was torn down and rebuilt. The new structure (Figure 11) incorporates several features to increase its flood resiliency including the following:

- Relocating the building 25 feet closer to US Route 4 and 10 feet to the west to increase the distance between the building and the Ottauquechee River;
- Building a four-season structure with wood siding to replace the canvas siding;
- Elevating the concrete slab 1.5 feet above base flood elevation; and
- Installing refrigeration compressors and condensers on the second floor of the new building (Town of Woodstock, 2011b).

**Figure 11:** The White Cottage Snack Bar was rebuilt farther away from the river

Farther downstream, post flood sewer repairs were made to quickly restore service. The sewer main under the Elm Street Bridge was replaced and reburied within the streambed and the pipe sections exposed by floodwaters between the Elm Street Bridge and the Woodstock Wastewater Treatment Facility were armored with riprap.

# Strategies and Projects to Protect Woodstock

A combination of previous studies, field data collection, flood damage information and community input was used to develop projects to protect Woodstock businesses. Town zoning bylaws and permits were reviewed to provide recommendations for strategies that reduce flood losses. Based on community input and data gathering, the team developed a list of flood **mitigation** objectives for the Woodstock focus area to address important economic centers and vulnerable infrastructure and utilities. These objectives include:

1. Keep major roadways open (e.g., US Route 4);
2. Protect businesses and residences from flooding and erosion; and
3. Increase flood readiness of town water supply and sewer system.

Using the objectives outline above, the team developed a list of projects to protect businesses and infrastructure within the study area. Strategies and projects for the Town of Woodstock are summarized below, including municipal policy and program recommendations followed by site-specific project recommendations.

## Municipal Policy and Program Recommendations

Reducing the impacts of floods involves an ongoing process of evaluating and adjusting policies to minimize risks through protection, prevention and education. Accordingly, the VERI team first reviewed Woodstock's municipal plan, hazard mitigation plans and land use regulations to identify the policies they contain and those that are absent. The team also reviewed related plans for capital improvements, conservation, emergency and preparedness and continuity of operations. These documents were reviewed with the goal of identifying gaps and opportunities to improve the flood preparedness, safety and resilience of residents, visitors, businesses and local government.

The team then used the US Environmental Protection Agency's (EPA) flood resiliency checklist that was developed from a study in the Mad River Valley in Vermont (US EPA, 2014). This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

The checklist review found Woodstock currently employs 33 of 56 items on the checklist including promoting better management of stormwater runoff, utilizing steep slope development regulations, encouraging new development in safer areas and many more (TRORC, 2014b).

The results of both reviews identified 13 planning or policy opportunities that were then organized into four groups: Regulations, Community Planning, Emergency Planning, and Education and Outreach. The distribution of opportunities to improve policy and programs is shown in Table 3.

| Table 3: Categories of Municipal Policies and Programs | | |
|---|---|---|
| **Category** | **Description** | **Policies or Programs** |
| Land Use Regulations | Avoid and minimize land use conflicts around watershed resources that help lower the risk of flooding and/or erosion to properties. | 4 |
| Community Planning | Develop long term goals, recommendations and budgets to improve flood resilience. | 3 |
| Emergency Planning | Specific projects for supporting mitigation and recovery actions for flooding and other hazards. | 3 |
| Education and Outreach | Programs targeted at critical businesses and vulnerable populations to educate them about flood risk, mitigation and recovery. | 3 |

The results of the plan and policy reviews were then combined and scored with either a one (ineffective), three (limited) or five (effective) using the following three objectives:

1. Reduces flood risk (proposed project lowers the flood level);
2. Reduces erosion risk (proposed project lessens the vulnerability to erosion); and
3. Protects businesses, infrastructure and property.

The three scores were added to provide a total score. Cost and ease of implementation, political realities and limitations as well as input from the community were also considered. To assist the town with implementation, potential partners and funding sources were identified. Each recommendation was further explained and next steps were identified. This information was compiled into easy to read charts found in Appendix D.

The highest ranked regulatory changes included two to minimize river and land use conflicts and improve public safety. Recommended town plan updates included updating the capital and hazard mitigation plans to make these and other improvements were implemented to reduce threats to infrastructure over time.

The top priority policy and program recommendations were presented at the community forum and local feedback was incorporated into the final prioritization, below.

Top recommendations include the following:

- **Monitor Rebuilding after a Disaster and Participate in the National Flood Insurance Program (NFIP):** People want to return their lives to normal as quickly as possible after a disaster but local officials (zoning administrators and local boards) must monitor rebuilding to ensure that it does not violate town, state and federal regulations. Allowing improper repairs after a flood may result in the loss of federal flood insurance and disaster recovery funding for the community. It is important note that in many instances, buying out

businesses and homes located in risky areas is the best way to safeguard against future loses of life and property.

- **Encourage Development Outside of the Floodway in the Village:** The floodway is the fastest moving part of the river during a flood. Buildings and other objects in a floodway can be washed downstream and cause culverts and bridges to clog with debris resulting in significant property damage. To protect the community and the economy, the village zoning bylaw should prohibit all new development in the mapped floodway.
- **Include the VERI Municipal Infrastructure Projects in the Local Hazard Mitigation Plan:** Woodstock can also add the projects listed in this report to the strategies portion of its hazard mitigation plan to improve eligibility for future grants.

## Specific Project Recommendations

A variety of existing river data and stakeholder information was used to develop flood protection projects for the VERI study area in Woodstock. This information in conjunction with 2014 field work documenting economic assets and further discussions with stakeholders helped set the stage for these recommendations.

A table summarizing recommended projects to protect businesses and infrastructure from flooding is included in Appendix E. Maps showing the location of each project site in Woodstock, along with the relevant economic asset and flood hazard information are also included in Appendix E. The recommended projects fall into four primary categories as summarized below:

**Table 4: Mitigation Project Types**

| Category | Description | Number of Projects |
|---|---|---|
| Building and Site Improvements | Lowers the risk of flooding and/or erosion to specific properties through improvements to the building and/or surroundings, e.g., sealing off buildings to prevent water infiltration. | 5 |
| Channel and Floodplain Management | Lowers the risk of flooding and/or erosion to properties along the river through the improvement of natural river and floodplain functions, e.g., tree plantings along unstable river banks. | 3 |
| Infrastructure Improvements | Lowers the risk of flooding and/or erosion to roadways and other municipal or state-owned infrastructure, e.g., increasing the size of bridges and culverts to pass more flood waters. | 6 |
| Public Safety Improvements | Lowers the risk of flooding and/or erosion to properties through the avoidance of future flood risks, e.g., FEMA buyouts of improved properties highly vulnerable to flooding. | 2 |

To begin, the team screened and prioritized each project. Each project received a score of one (ineffective), three (limited) or five (effective) for the three objectives:

1. Reduces flood risk (proposed project lowers the flood level);
2. Reduces erosion risk (proposed project lessens the vulnerability to erosion); and
3. Protects businesses, infrastructure and property.

The three scores were added to provide a total score, which was then weighted based on the importance of the project in the region. Projects that would result in a regional economic boost were given the greatest weight, while projects that would offer minimal economic benefit to the business economy received a lesser weight.

Project partners and stakeholders, including representatives from DHCD, ANR, TRORC, and the Town of Woodstock, provided feedback on a draft list of mitigation strategies and their priorities in November 2014. The feedback was incorporated into the final prioritization of projects. Projects that received the highest priority rating are detailed below. Many of the high priority projects are from the *Infrastructure Improvement* category, as those at-risk areas potentially affect the greatest number of community members and businesses.

## *Building and Site Improvements*

**Floodproof Buildings at the West Woodstock Farmer's Market:** West Woodstock businesses were hit hard by floodwaters from Tropical Storm Irene. There are three primary options to floodproof commercial buildings.

1. **Elevate the building**: This could involve filling a basement and raising utilities (furnaces, electrical panels, etc.) to a higher floor above the base flood elevation – or – it could include jacking up the structure and extending the foundation.
2. **Dry floodproofing:** Under this scenario the building is not elevated, rather walls are made watertight. Impermeable layers are added to the walls and floors, and the foundation structurally must be able to withstand the forces of standing and moving water acting on the building.
3. **Wet floodproofing:** This option is used in situations where elevation and dry floodproofing are not viable. A combination of flood vents/openings, elevating utilities and special building materials is used with this technique. The building materials must be able to be covered in water, mud and other pollutants without difficult clean up or damage.

The method of floodproofing selected depends upon the structure, size, age and location of the building. Each building requires a site-specific assessment by a structural engineer. In all cases, outdoor fuel tanks servicing buildings in special flood hazard areas should be anchored and elevated.

The White Cottage, in West Woodstock, provides a good example of utilities being placed on the second floor above the base flood elevation. The Dead River Propane Offices provide an example of using dry floodproofing to reduce future flood losses by elevating electrical wiring, sealing the walls and utilizing flood logs to seal the doors.

The cost of floodproofing the Farmer's Market is estimated to be about $30,000, but would require a site-specific assessment by a structural engineer to determine the best methods and costs. A possible funding source for elevating a building is FEMA Hazard Mitigation Grant Program (HMGP).

### *Channel and Floodplain Management*

**Preserve Floodplain Along the Ottauquechee River Upstream of Riverside Mobile Home Park:** Generally, the floodplain of the Ottauquechee River is narrow within the VERI study area. Just upstream of the Riverside Mobile Home Park, the floodplain broadens, creating an important location for the storage of floodwaters and sediment. Preserving floodplain upstream of the Riverside Mobile Home Park is identified as a high priority project in the Ottauquechee River Corridor Plan (Bear Creek Environmental, 2013). The goal of this channel and floodplain management project would be to preserve as much of the 95 acres of undeveloped floodplain within the SFHA as possible between the Lincoln Inn and Riverside Mobile Home Park. This section of undeveloped floodplain constitutes approximately one-third of the total undeveloped floodplain within the study area and is important for allowing floodwaters to slow down, sediment to settle out, and for maintaining good water quality and wildlife habitat.

The project could involve a corridor easement to protect the floodplain from development and channel management activities or could involve the outright purchase of the land by the town, land trust or conservation group. A map showing the extent of a possible ANR River Corridor Easement and the estimated cost is provided in Appendix E. Not only does this project protect existing businesses within the watershed, but it reduces the chance of future development within the special flood hazard area and State River Corridor.

### *Infrastructure Improvements*

**Replace Undersized Bridge on US Route 4:** The opening of Bridge #47, located approximately 1,000 feet west of Deerbrook Way (near the Deerbrook Inn), completely clogged with sediment and debris during Tropical Storm Irene. This resulted in significant damage to US Route 4 and destruction of a single family home. As part of the design process, the structure should be evaluated to improve debris passage. Design and implementation of the project will likely take two to five years due to the environmental permitting, design required and the cost. The cost is expected to exceed $200,000.

**Improve River and Road Stability along US Route 4:** The road embankment adjacent to the Ottauquechee River failed in multiple locations during Tropical Storm Irene leading to the washing

out of roads. VTrans is actively working to improve river and road stability along US Route 4. The design of the US Route 4 corridor in the stretch between Westmont Way (about 2,000 feet east of the Bridgewater/Woodstock Town line) and Meadow Way (east of the Sleep Woodstock Motel) is currently in progress. There are areas where the embankment is eroding and the rock riprap is too small in size or was placed poorly (Figure 12).

**Figure 12:** Poor rock riprap placement that needs to be reinforced to improve the stability of US Route 4

According to Erik Akins, P.E., Senior Associate with Green International Affiliates, Inc. (Civil Engineering Consultant for VTrans), the project is advancing to the preliminary design stage. Unfortunately, after September 2015, the Federal Highway Administration (FHWA) will no longer provide funding for emergency repair work for damages incurred from Tropical Storm Irene. Due to these funding limitations, the project may be slowed.

**Relocate or Reinforce Drinking Water Line Owned by Woodstock Aqueduct Company:** The main water supply line at Elm Street Bridge ruptured leaving Woodstock Village and a portion of the VERI study area (West Woodstock) without drinking water following Tropical Storm Irene. The water line runs parallel to the downstream side of the Elm Street Bridge and is buried about six feet below the streambed. Due to the rupture, approximately 1,600 customers were without drinking water for about five days. The Woodstock Aqueduct Company is also considering plans to add a redundant line that would serve in an emergency if the line under the Elm Street Bridge should rupture. The cost is expected to exceed $200,000 for the redundant line and other improvements. These improvements may be eligible for the Drinking Water State Revolving Loan Fund money to augment Hazard Mitigation Grant Program funds. A summary of flood damages during the storm, items that were replaced post-flood and additional needs for the Woodstock Aqueduct Company is provided in Appendix E.

**Figure 13:** Municipal sewer pump station in West Woodstock needs to be retrofitted to prevent inundation by floodwaters

**Relocate or Reinforce Sewer Line under Elm Street Bridge:** The main sewer line crossing at the Elm Street Bride ruptured leaving Woodstock Village and a portion of the VERI study area (West Woodstock) without sewer service following Tropical Storm Irene. Approximately 925 customers in Woodstock and more than 25 businesses were left without sewer service for one week. The estimated cost of reinforcing the sewer line in the vicinity of the Elm Street Bridge is $100,000 to $200,000. A conceptual design for this project is included in the next section of this report.

**Upgrade West Woodstock Sewer Pump Station:** The West Woodstock Sewer Pump Station (Figure 13), located across from the White Cottage, was flooded and silted over during Tropical Storm Irene. While all the electrical wiring was replaced and elevated, the pump station still needs two foot to six foot tall sleeves with ladder rungs over the pump area and a wet well to protect it from the next event. The cost of the upgrades is estimated to be in the range of $50,000 to $100,000. A conceptual design for the sewer pump station is provided in the following section of the report.

## *Public Safety Improvements*

**Buyout At-risk Properties in West Woodstock:** In West Woodstock a number of commercial buildings were significantly damaged by Tropical Storm Irene, and our team recommends further study of the feasibility of property buyouts. The study would include identification of specific buildings and further evaluation of the pros and cons including direct and indirect flood damage reductions, impact on the economy, cost and funding sources. Robust public participation including meetings with individual property owners and affected businesses is a critical part of the evaluation because these buyouts represent peoples' lives, income and history.

> **"I highly endorse [the sewer and water line upgrades] as top priority, as I was able to get to Woodstock on the first Friday after Irene and saw the folks using porta-potties and potable water supplied on the town green."**
>
> Todd Menees, Vermont Department of Environmental Conservation

**Table 5: Buyout Considerations for West Woodstock Businesses**

| Pros | Cons |
|---|---|
| Removes business and people from harm's way | Some businesses have already invested money in rebuilding and/or floodproofing |
| Property can be used by community as a public park or wildlife area | The federal buyout process can take years |
| Fair compensation for property based on value prior to the disaster | Business is located in a well-traveled corridor and may not want to relocate |

# Conceptual Project Designs to Protect Woodstock

Using input from the community and our team's professional judgment, the team selected three flood protection projects to advance to a conceptual design stage. These projects include: floodplain reconnection by lowering the field across from the Mill Mall and two projects that improve flood resiliency of the municipal sewer system. The designs represent key components of the projects and are 20-30% complete. The town and other organizations can use this information to further prioritize projects, to evaluate potential project effectiveness and to secure funding for additional project design and implementation. Conceptual design drawings are provided in Appendix F.

## Create Floodplain at the Bridgewater Mill Mall

### *Project Overview and Objectives*

One way to reduce flooding to a group of businesses is to find ways to create upstream floodplain that slows and reduces the floodwaters reaching those businesses. Floodplain creation involves lowering an area adjacent to the river to provide storage of floodwaters and sediment. In an effort to evaluate the effectiveness of creating floodplain along the Ottauquechee River, the consultant team created a river model using a software program developed by the US Army Corps of Engineers called Hydrologic Engineering Centers Rivers Analysis System (HEC-RAS) (US Army Corps of Engineers, 2010).

**Figure 14:** Field across the river from the Mill Mall

The Mill Mall area was selected to evaluate the floodplain creation because of the potential benefits to businesses (the basement of which flooded during Tropical Storm Irene) and because the land on the opposite side of the river is currently too high to be accessed by flood flows. The land on the opposite bank (Figure 14) is a hay field of the Taylor Farm. The conceptual design entails lowering the elevation of approximately 2.5 acres of this land by four to six feet (Figure 15).

The floodplain creation project would provide local storage of floodwaters, sediment, woody debris and ice.

### *Data Analysis and Results*

Eleven cross sections were selected that describe the elevation of the river and the floodplain in the vicinity of the Mill Mall. The cross sections were defined using LiDAR (Light Detection and Ranging), a remote sensing technology. River discharges (amount of water in the river at a given time) used as input for the model were taken from the FEMA Flood Insurance Report for Windsor County (FEMA, 2007). Based on the results of the river modeling, the floodplain creation lowers the water level at the Mill Mall by about 0.7 feet during a 100-year flood event.

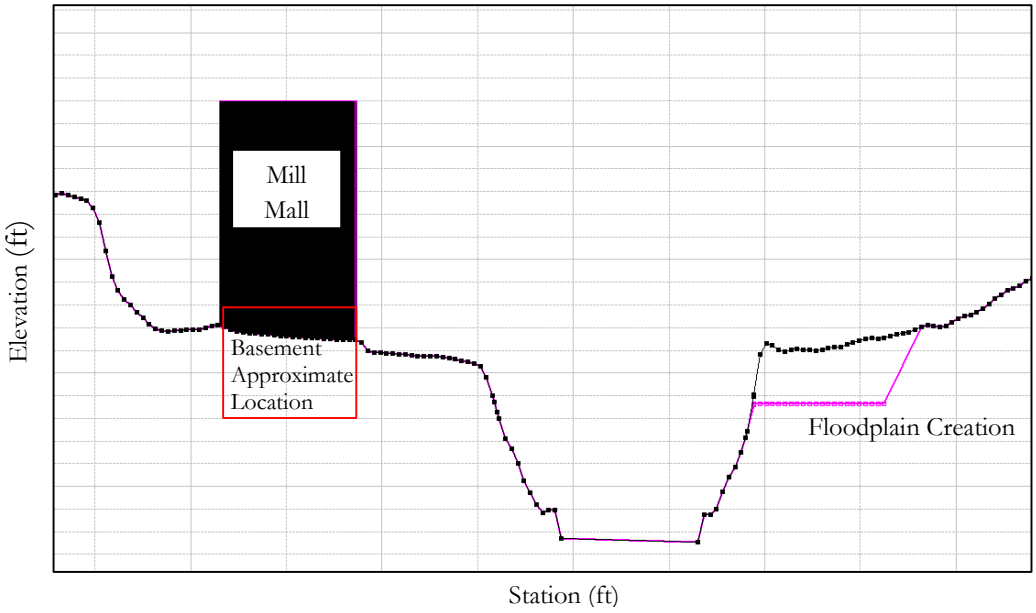


**Figure 15:** Section showing possible floodplain creation project across the river from Mill Mall

The floodplain creation as modeled requires 2.5 acres of land and involves the excavation of approximately 17,900 cubic yards of material. Lowering 2.5 acres of floodplain would be expensive due to excavation and land acquisition costs, and would likely exceed $200,000. The Vermont Ecosystem Restoration Program is one possible source of funding for the project.

## *Steps for Project Implementation*

The team recommends that the community further advance the conceptual project design and decide whether the relatively minor projected reduction in the 100-year flood level at the Mall justifies the scope and cost of the project. Advancement of the design would include borings or test pits to determine the quality of gravel at the site and initial discussions to assess the interest of the current owner. Assuming the community is interested in moving forward, next steps would include: topographic survey, detailed hydraulic modeling to confirm the benefits and state and federal permitting.

## *Projects Benefits*

Although the primary project benefit would be to reduce flood risk at the Bridgewater Mill Mall, there are other potential benefits including:

- Storage of floodwaters and sediment to benefit downstream properties;
- One-time supply of gravel for municipal use; and
- Improved channel and floodplain function.

## Upgrade Municipal Sewer

### *Project Overview and Objectives*

The team developed two conceptual designs to help the town prepare the sewer system for the next major flood. The first conceptual design provides details for encasing the sewer line under Elm Street in Woodstock Village. The second project is a redesign for the US Route 4 sewer pump station, which is located across from the White Cottage in West Woodstock.

### *Data Analysis and Results*

#### *Sewer Line Encasement near Elm Street*

The sewer lines under the Elm Street Bridge were destroyed during Tropical Storm Irene when erosion of the streambed and banks exposed the six inch and eight inch lines. Both lines were replaced at approximately the same position following the storm. Approximately 80 feet of the replacement lines at the downstream side of the Elm Street Bridge were encased in concrete. Using a crane on the bridge, large rocks were place around the remaining portion of the replacement pipes to help to protect them. The portion of the replacement lines without the concrete encasement remains vulnerable to damage during another major flood.

The conceptual design drawings provided in Appendix F include encasing an additional 185 feet of the existing six inch and eight inch sewer line with concrete. If anecdotal reports of shallow ledge under the pipes are confirmed during the design, then the concrete encasement can be doweled to the ledge to provide an extremely strong solution that is not vulnerable to undermining. The conceptual design also shows an optional third conduit encased in concrete. This conduit could be used in the future for other utilities, such as town water supply (currently owned and managed by the Woodstock Aqueduct Company) should those utilities be damaged in a future flood. This would allow utilities to bounce back quicker following a flood, thereby keeping businesses open.

#### *US Route 4 Sewer Pump Station Redesign*

The electrical supply, control system, and pumps of the US Route 4 sewer pump station were severely damaged during Tropical Storm Irene. When repaired, the electrical supply and pump controls were elevated approximately four feet above grade on a four-legged wooden platform, which considerably reduces the risk of damage due to inundation. The pumps were reportedly replaced with submersible models.

Access to the below ground pump chamber remains only a few inches above grade as it was prior to the storm and does not have a water-tight cover. It is therefore at risk of again being swamped during a flood. If the new submersible pumps continue to operate during a future flood, they would run continuously to purge floodwater rather than conveying incoming sewage.

As a minimum flood resiliency measure, a water-tight cover should be added to the pump chamber to prevent floodwaters from entering. However, since these covers can fail due to debris and

sediment impacts during a storm, it would be prudent to go a step further and elevate the access to the pump chamber in addition to installing a water-tight cover.

The conceptual design included in Appendix F shows a four-wall concrete collar around the existing access. It would be recessed into the ground and would extend vertically to above the 100-year flood elevation. Space constraints would appear to prevent placement of earth around the collar, so permanent ladders would be necessary to climb up the collar and down into the chamber. The collar itself would be equipped with a water-tight cover, removing the need for such a cover on the existing access. During a final design phase, modifications and additions to the conceptual design can be evaluated including such things as a metal collar as an alternative to the concrete collar shown, as well as the addition of an earthen or concrete barrier at the upstream side of the pump station that would serve to deflect floating debris during a major flood.

## *Steps for Project Implementation*

There are a number of recommended steps to upgrade the municipal sewer. First, a civil engineer should be hired to provide further project design. Both the sewer line encasement project and the pump station redesign would require a topographic survey, or at a minimum field measurements, to move the projects toward a final design. The evaluation of an additional conduit for future use would require coordination with the civil engineer and the sewer and water utilities. Based on a rough estimate, the sewer line encasement project would cost in the range of $100,000 - $200,000, while the sewer pump station retrofit may be more on the order of $50,000 - $100,000. A possible source of funding for the project is FEMA Hazard Mitigation Grant Program (HMGP).

## *Project Benefits*

Improving the resiliency of the sewer system in Woodstock would benefit 925 customers, including more than 25 Woodstock businesses that were without municipal sewer service for about one week following Tropical Storm Irene. The sewer line encasement project would have the added benefit of reducing the chance that raw sewage would be released in to the Ottauquechee River during the next flood. The third conduit would provide similar resiliency for the private water system and its customers. Retrofitting the sewer pump station would have the obvious benefit of reducing the need for the Town of Woodstock sewer department to have to pump and haul untreated sewage to the Woodstock Wastewater Treatment Facility.

# Next Steps

On April 23, 2015 the team hosted the second community forum to share the list of policy and project recommendations to decrease flood risk for Woodstock. At the forum, community members asked questions, provided input and helped rank the proposed list of priority recommendations.

The projects that the forum attendees most supported included relocating mobile homes located in hazardous areas, investing to improve the reliability of the water supply (Woodstock Aqueduct Company) and working to shore up the bank armoring on US Route 4. The top policy change was updating regulations to discourage development in flood-prone areas. One attendee expressed concern that this project focused on efforts to minimize floods, despite the fact that there are numerous other natural disasters that pose significant threats to Woodstock and other communities. It was noted that flood is the top risk in Vermont and strategies to address other risks are outlined more extensively in both the state and local Hazard Mitigation Plan documents. See Appendix G for the complete meeting notes from the first and second community forums.

The tables included in Appendices D and E provides a comprehensive list of recommended high priority projects for the Town of Woodstock to further discuss, explore, and advance as resources permit. The conceptual designs summarized above and in Appendix F are intended to provide examples for how to advance high priority projects to the next level and acquire funding for final design and implementation. As part of the ongoing community discussion regarding the VERI effort, the team recommends the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization;
- Prioritize one to two projects to pursue each year with assistance from DEC and TRORC staff to identify appropriate funding sources and partners;
- Apply for one to two grants each year to advance project development and/or designs;
- Implement projects as funding allows; and
- Monitor project success.

Implementing these projects and updating related flood policies will, over time, help Woodstock become safer and more resilient to future floods and there are a number of organizations and programs that can help. For example, the TRORC can help gather and review sample bylaws, capital plans and hazard mitigation plans and help draft town specific language for review and local adoption. DHCD's Municipal Planning Grants http://accd.vermont.gov/strong_communities/opportunities/funding/overview/municipal_planning_grants , the Vermont Rivers Program http://www.anr.state.vt.us/dec/waterq/rivers.htm and www.floodready.vermont.gov can help support these efforts. The Vermont Land Trust http://www.vlt.org/ can assist landowner's protection of critical floodplain with easements. The State's Hazard Mitigation Grant Program http://vem.vermont.gov/mitigation can help implement projects identified in Woodstock's Hazard Mitigation Plan. The Vermont Small Business

Development Center http://www.vtsbdc.org/ has offered extensive disaster assistance to businesses as well as compiling a great guide for owners to navigate these programs. And several federal and state programs can assist in funding the recommendations outlined in the report. Working together we can reduce the risk and financial burden of future flooding events.

## Education and Outreach

Vermont has a long tradition of managing its rivers to limit or prevent flood damage including armoring riverbanks with rocks, moving or straightening river channels and building dams and berms. Despite these efforts, flooding is the most common natural disaster in Vermont (ANR). Tropical Storm Irene showed Vermonters that rivers and streams are powerful and tend to make their own way during a flood. Because we cannot reliably control flooding, educating citizens, business and property owners about rivers and potential flood risks within their communities is critical.

> *"We all have short memories when it comes to flooding. It's just human nature to think it couldn't happen here again anytime soon."*
>
> Chris Campany, Executive Director Windham Regional Commission

Ongoing community education and outreach is an important part of any effort to promote flood safety and to protect local business and economies. Ultimately, the better informed everyone in the community is about the behavior of local rivers and streams, the more likely it is that they will make sound decisions.

**Make Information Readily Available:** Easy access to river and floodplain information is an essential way to help citizens and businesses incorporate flood risks into decisions they make. Most communities offer printed information at the town office or library as well as on town webpages.

**Common Handouts or Webpage Information Includes:**

- Maps of the local flood hazard areas and the permitting requirements in the floodplain.
- Information about flood insurance and floodproofing buildings.
- Information about how rivers, streams and watersheds work.
- Benefits of green infrastructure and conservation of existing floodplain.

**Actively Engage:** Many communities work to increase the understanding of rivers and risks via email or by posting information on their local Front Porch Forum. Communities often include flood maps and permitting information in their town meeting reports and other municipal mailings like sewer and water bills. Others promote awareness of flood history and risk by placing high water lines on prominent buildings in the community.

However, education and outreach efforts should not be the sole responsibility of local governments, and community groups like chambers of commerce, downtown business associations, neighborhood

groups, and watershed organizations are encouraged to partner with state, regional and local groups to offer local workshops and education sessions.

**Potential Workshop Topics and Partners or Presenters:**

- Flood Insurance and What You Need to Know (Department of Finance Regulation, Division of Emergency Management and Homeland Security, Vermont League of Cities and Towns )
- Developing a Continuity of Operations Plan (Small Business Development Centers, Regional Planning Commissions, Regional Development Corporations )
- Resilient Road Designs to Reduce Recurring Damage and Improve Water Quality (Agency of Natural Resources, Agency of Transportation)
- Planning for Resilience (Regional Planning Commissions)
- Flood Risk, Preparedness and Safety (Division of Emergency Management and Homeland Security, Regional Planning Commissions)
- Extreme Weather and Climate Change (Agency of Natural Resources, Vermont Natural Recourses Council )
- How Rivers, Streams and Watersheds Work (Agency of Natural Resources, Vermont Natural Resources Council, Vermont Land Trust )
- Low Cost Techniques to Reduce Flooding and Improve Water Quality (Agency of Natural Resources, Vermont Natural Resources Council, Regional Planning Commissions, Vermont League of Cities and Towns)

**Invest in Staff Training and Certification:** In many of Vermont's cities and towns, floodplain management is just one of many responsibilities of the local planning office or zoning administrator. Yet, administration of a floodplain ordinance is quite complex and the consequences of limited staff time and understanding of the regulations can easily allow inappropriate development in dangerous areas. The consequences of granting improper variances and not enforcing against violations may preclude the community from participating in the federal flood insurance program. Therefore, local government officials are strongly encouraged to support staff training and certification in floodplain management.

## What Can Individuals Do to Reduce Their Risks?

Most of us remember to annually change the batteries in our smoke alarms to reduce the risk of fire, but few of us prepare for floods or disasters. Since 2000, Vermont has had more than one federally-declared disaster per year and floods have occurred nearly everywhere in the state (ANR, 2015). Buildings located in a 100-year floodplain have 1% chance of being flooded every year. In other words, over a 30 year period (length of most home mortgages), there is a 26% chance of a 100-year flood (USGS, 2010).

The good news is that there are many steps that individuals can take to reduce the risks, loss, disruption and costs associated with flooding. Understanding what the risks of flooding are for your home and family will help you:

- Make sure that you have the right amount of insurance coverage;
- Protect your home and take steps to limit potential damage;
- Prepare plans detailing how your family will respond if flooding looks likely; and
- Practice so family members know what actions to take in the event of a flood or upon receiving a flood warning.

## *Steps to Reduce Risks*

- **Identify Flood Risk.** The first step is to identify your risk so you can plan appropriately. Floodplain maps are available at most town offices or click this link http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your home or apartment is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** Homeowners' or renters' insurance helps pay to repair or rebuild your home and replace personal property due to a covered loss, however it does not cover any damages caused by floods or your rent and living expenses while your home is rebuilt. All insurance policies have overall policy limits and specific limits for different types of coverage. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Fill Gaps in Your Insurance Coverage.** If your home is underinsured at the time of a loss, there is frequently a penalty or reduction in the amount the insurance company will pay for the loss. Property insurance also does not cover flood damages or your expenses if you cannot live in your home due to flood damages. All homeowners who live in flood-prone areas should carry flood insurance. Flood insurance is available for your home and personal property and can be obtained from your local agent.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

- **Plan Ahead.** Draft an emergency response and communications plan (family phone numbers) for your home and family. Use the process as an opportunity to bring family members together to discuss the roles needed during an emergency and how best to assign responsibilities. Make sure you have a designated place to meet other family members in the

event of an emergency. Also, don't forget to plan for individuals with special needs like prescription medication and for your pets as many public shelters or hotels do not allow animals.

  - Pack an emergency kit and make sure family members know where it is located.
  - Keep copies of your insurance policy, computer data and other important documents like tax returns and financial information safe from flooding on upper floors or stored offsite.
  - Document your home and possessions with photos or video to help simplify the insurance claims process. Generally, the more detailed documentation (receipts, serial numbers, etc.) you can supply during the claims process, the fewer problems you will experience.

- **Train and Practice.** Many of us participate in fire drills at work or school, but few of us practice at home for disasters. Training and practicing your emergency response and communications plan will help assure the plan is workable and family members understand their roles and responsibilities.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. If you know a storm is headed your way, fill up your gas tank in case you must evacuate. (If the power is out, it is not always easy to find an operating gas station.) If you must evacuate, try to contact your employer and let them know your plans. Having a plan and a few extra minutes to evacuate can make a difference.

FEMA http://www.ready.gov/make-a-plan and the Vermont Division of Emergency Management and Homeland Security http://vem.vermont.gov/preparedness/hazards/floods both provide more detailed information on how to prepare and protect your home and family from disasters and floods.

## What Can Businesses Do to Reduce Their Risks?

According to FEMA, nearly 40% of businesses do not reopen after a disaster and data from the US Small Business Administration indicates that over 90% of businesses fail within two years after being struck by a disaster.

It can take years to repair the damage to the building, furnishings, equipment and inventory. Disasters can also require businesses to relocate or cease operation temporarily, which may lead to canceled contracts and customers going elsewhere for goods or services. Even if the event does not impact the business directly, severe weather from snow or rain or even extended power outages can strand employees at home and complicate deliveries.

Identifying your risk can significantly reduce potential damages and business recovery costs. Understanding what the risks of flooding are for your business will help you:

- Make sure that you have the right insurance coverage for business interruption.

- Plan ahead and take steps like developing a continuity of operations plan to limit potential damage.
- Train employees so they know what actions to take in the event of a disaster or after receiving a flood warning.

## *Steps to Reduce Risks*

- **Identify Flood Risk.** Since 2000, Vermont has had more than one federally-declared disaster per year and floods have occurred nearly everywhere in the state (ANR). Identifying your risk is a good place to start. Floodplain maps are available at most town offices or click here http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your business is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** Many types of disasters are not covered under normal insurance policies and funding or loans from government agencies is often too little and too late. All insurance policies have overall policy limits and specific limits for different types of coverage and any business located in a flood-prone area should carry flood insurance. Also check to make sure your insurance includes business interruption coverage and that it reimburses other unexpected costs (like service interruptions from lost power or Internet access, law suits and unemployment compensation claims filed by employees). Business interruption insurance compensates a business for lost income, expenses and profits if a disaster, such as a flood, closes your doors. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf

- **Plan Ahead.** There are also a number of low-cost steps you can take to reduce the impacts of a flood. At a minimum, regularly back up computer data and store important tax and financial records and information such as your insurance policy details in a flood safe place. Documenting your building, furnishings, equipment and inventory with photos or video can speed the insurance claims process.

  All businesses should have a continuity of operations plan. A continuity of operations plan is a written document that outlines how your business will respond and recover from a flood or other disaster. At a minimum, your plan should include:

- A list of important contacts including your insurance company, key customers and vendors and evacuation contacts for staff.
- A map showing locations of important equipment to relocate (computers and servers) and where to shut off electricity, gas and other services.
- Procedures to protect your property and minimize business disruption – e.g. remote back up of computer files, a plan to relocate inventory or livestock.
- A back up location to conduct business while the building is being repaired.

Having a continuity of operations plan will help you identify and assign essential tasks that will help minimize the damage caused by flooding. Training and practice will help assure the plan is workable and employees are properly trained.

The Vermont Small Business Development Center http://www.vtsbdc.org and many of Vermont's Regional Development Corporations http://accd.vermont.gov/business/partners/rdc and Regional Planning Commissions http://www.vapda.org can also provide training and one-on-one assistance to help your business develop a continuity of operations plan.

CERF+ (Craft Emergency Relief Fund + Artists' Emergency Resources) offers tailored disaster guidance and recourses for artists (http://studioprotector.org/OnlineGuide/DisasterPlanning/DisasterSpecificPlanningResources.aspx ).

- **Train and Practice.** Employees need to understand flood warnings and what to do when they get one. This includes understanding the dangers of flooding and how to evacuate the building safely. Train all staff on procedures to shut down the business and how to deploy loss reduction measures like relocating equipment and inventory to upper floors and deploying door and window dams reduce flooding. Finally, remember that flooding can also affect employees' ability to work, as their priority may be to protect their home and family first.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. Having a continuity of operations plan and a few extra minutes to evacuate can save lives and your business.

The US Small Business Administration https://www.sba.gov/content/disaster-preparedness offers more detailed information on how to prepare and protect your employees and business and from disasters and floods.

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- USGS, 2014. Analysis of Floods, Including the Tropical Storm Irene Inundation, of the Ottauquechee River in Woodstock, Bridgewater, and Killington and of Reservoir Brook in Bridgewater and Plymouth, Vermont. http://pubs.usgs.gov/sir/2014/5214/pdf/sir2014-5214.pdf
- Vermont Agency of Natural Resources, 2015. Vermont Natural Resource Atlas. Available at: http://anrmaps.vermont.gov/websites/anra/default.html?LayerTheme=Floodplain%20Management
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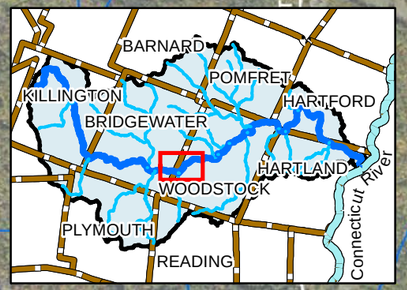
# Appendix A:

## Floodplain Development Maps

# Ottauquechee River Floodplain Development
# Bridgewater and Woodstock, Vermont - Map 1 of 2
# Vermont Economic Resiliency Initiative




BRIDGEWATER

WOODSTOCK

N BRIDGEWATER RD

MEDOW WY

BRIDGES RD

WOODSTOCK RD

Route 4

Ottauquechee River

Map 2 Match Line

BOURDON RD

HILLSIDE RD

Farmhouse Inn

Upstream End of VERI Study Area

Bridgewater Mill Mall

Bridgewater Village

ROUTE 4

RIVER RD

MILL RD

BLANCHARD RD

LARRY CURTIS RD

CURTIS HOLLOW RD

WESTMONT LN

QUINN RD

TH 12

TH 25

## Legend

- Surface Water
- ANR River Corridor
- USGS Irene Inundation Area
- Developed Floodplain
- Undeveloped Floodplain
- Town Boundary

**VERI Study Area Floodplain Development Summary**
**Percent of Floodplain Developed: 12% (37.6 acres)**
**Percent of Floodplain Undeveloped: 88% (280.5 acres)**

Floodplain development was determined based on an analysis conducted with the State's E-911 buildings layer as well as Bing aerial imagery. Development includes the following: buildings, parking lots, paved roads, gravel roads, and driveways. Floodplain, in this analysis, is defined as the FEMA 100 Year Flood Hazard Zone.

0 500 1,000 2,000 Feet

1 inch = 1,000 feet

N

Bear Creek Environmental



Map composed on January 6, 2015. Background is Bing Imagery.

# Ottauquechee River Floodplain Development
# Bridgewater and Woodstock, Vermont - Map 2 of 2
# Vermont Economic Resiliency Initiative


Downstream End of VERI Study Area

Woodstock Farmers Market, Dead River Propane, White Cottage Snack Bar

Riverside Mobile Home Park

Route 4

Map 1 Match Line

WOODSTOCK

Ottauquechee River

GRASSY LN
PROSPER RD
ROSE HILL
THOMAS HILL
CARLTON HILL
MILL RD
BARBERRY HILL
TH 91
COX DISTRICT RD
SENIOR LN
CHURCH HILL RD
RANDALL RD
WESTERDALE RD
WYMAN LN
WESTERDALE CUT-OFF
WOODSTOCK RD
BRIDGES RD
FLETCHER HILL
DOE HILL WY
BOURDON RD
RIVERSIDE PARK RD
GROVE HILL
PETERKIN HILL RD
TH 48

## Legend

- Surface Water
- ANR River Corridor
- USGS Irene Inundation Area
- Developed Floodplain
- Undeveloped Floodplain

**VERI Study Area Floodplain Development Summary**
**Percent of Floodplain Developed: 12% (37.6 acres)**
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Floodplain development was determined based on an analysis conducted with the State's E-911 buildings layer as well as Bing aerial imagery. Development includes the following: buildings, parking lots, paved roads, gravel roads, and driveways. Floodplain, in this analysis, is defined as the FEMA 100 Year Flood Hazard Zone.

0 500 1,000 2,000 Feet
1 inch = 1,000 feet

N

Bear Creek Environmental

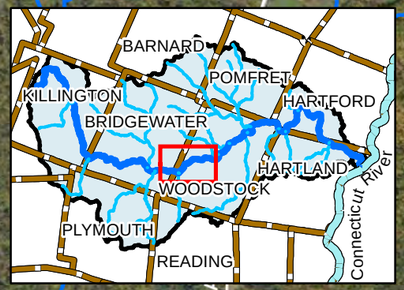


Map composed on January 6, 2015. Background is Bing Imagery.

# Appendix B:

## Flood Hazard and Flood Damage Maps and Table

# Ottauquechee River Tropical Storm Irene Damage
# Bridgewater and Woodstock, Vermont - Map 1 of 2
# Vermont Economic Resiliency Initiative




Upstream End of VERI Study Area

Map 2 Match Line

WOODSTOCK

BRIDGEWATER

N BRIDGEWATER RD

DEER BROOK WY

WESTERDALE RD

GABERT RD

WESTERDALE CUT-OFF

D4-US4-17

WOODSTOCK RB

BRIDGES RD

FLETCHER HILL

D4-US4-16

Sleep Woodstock Motel

Woodbridge Cafe

BOURBON RD

D4-US4-15

HILLSIDE RD

Farmhouse Inn

Bridgewater Village

Bridgewater Mill Mall

Thymeless Herbs Farm

D4-US4-14

ROUTE 4

BLANCHARD RD

LARRY CURTIS RD

QUINN RD

TH 12

## Legend

- Surface Water
- Local Economic Asset
- Irene Road Damage
- VTrans Road Repair Site

**Tropical Storm Irene Damage**

- Deposition
- Flooded, Propane Tanks Lost
- Sewer/Drinking Water Line Damaged or Broken
- Ice Jams/Deopsition (not Irene)
- Bridge Destroyed
- Building Flooded
- Basement Flooded
- Severe Bank Erosion
- Sewer Pump Flooded/Silted
- Destroyed Mobile Home
- Destroyed Mobile Home Replaced
- Destroyed Single Family Dwelling
- Destroyed Commercial Building
- Partially Rebuilt Commercial Building
- Rebuilt Commercial Building
- Damaged School
- Road Damage
- Tributary Damage
- Town Boundary

0 0.25 0.5 1 Mile

1 inch = 0.25 miles

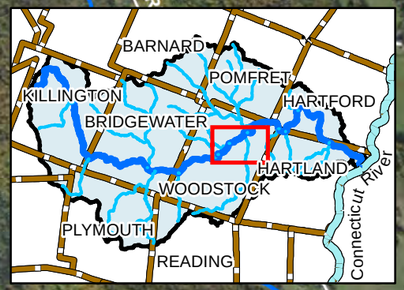
N

Bear Creek Environmental



Map composed on January 6, 2015. Background is Bing Imagery.

# Ottauquechee River Tropical Storm Irene Damage
## Bridgewater and Woodstock, Vermont - Map 2 of 2
## Vermont Economic Resiliency Initiative




Woodstock Water and Sewer Lines

Woodstock Sewer Lines

Woodstock Farmers Market

D4-US4-18

D4-22-IS

Little Theater Preschool

Downstream End of VERI Study Area

Dead River Propane Farm

White Cottage Snack Bar

Dead River Propane Offices

Vermont Standard

Riverside Mobile Home Park (extensively damaged)

Map 1 Match Line

Ottauquechee River

Kedron Brook

PROSPER RD
ROSE HILL EXT
ROSE HILL
EATON PL
RIVER ST
MOUNTAIN AV
ELM ST
BOND ST
HIGH ST
CROSS ST
SOUTH ST
MAPLE ST
GOLF AV
SOUTH RD
KELLY WY
SAWYER RD
PLEASANT ST
STANTON ST
LINCOLN ST
HIGHLAND AV EXT
MILL ST
BIRCH WY
HARTLAND HILL RD
LAUGHLIN RD
HAPPY VALLEY RD
GRASSY LN
TH 91
COX DISTRICT RD
CARLTON HILL
WYMAN LN
WOODSTOCK RD
RIVERSIDE PARK RD
FLETCHER HILL
GROVE HILL
GARDNER WY
CHURCH HILL RD
RANDALL RD

### Legend

- Surface Water
- Local Economic Asset
- Irene Road Damage
- VTrans Road Repair Site

**Tropical Storm Irene Damage**

- Deposition
- Flooded, Propane Tanks Lost
- Sewer/Drinking Water Line Damaged or Broken
- Ice Jams/Deopsition (not Irene)
- Bridge Destroyed
- Building Flooded
- Basement Flooded
- Severe Bank Erosion
- Sewer Pump Flooded/Silted
- Destroyed Single Family Dwelling
- Destroyed Commercial Building
- Rebuilt Commercial Building
- Damaged School

0 0.25 0.5 1 Mile

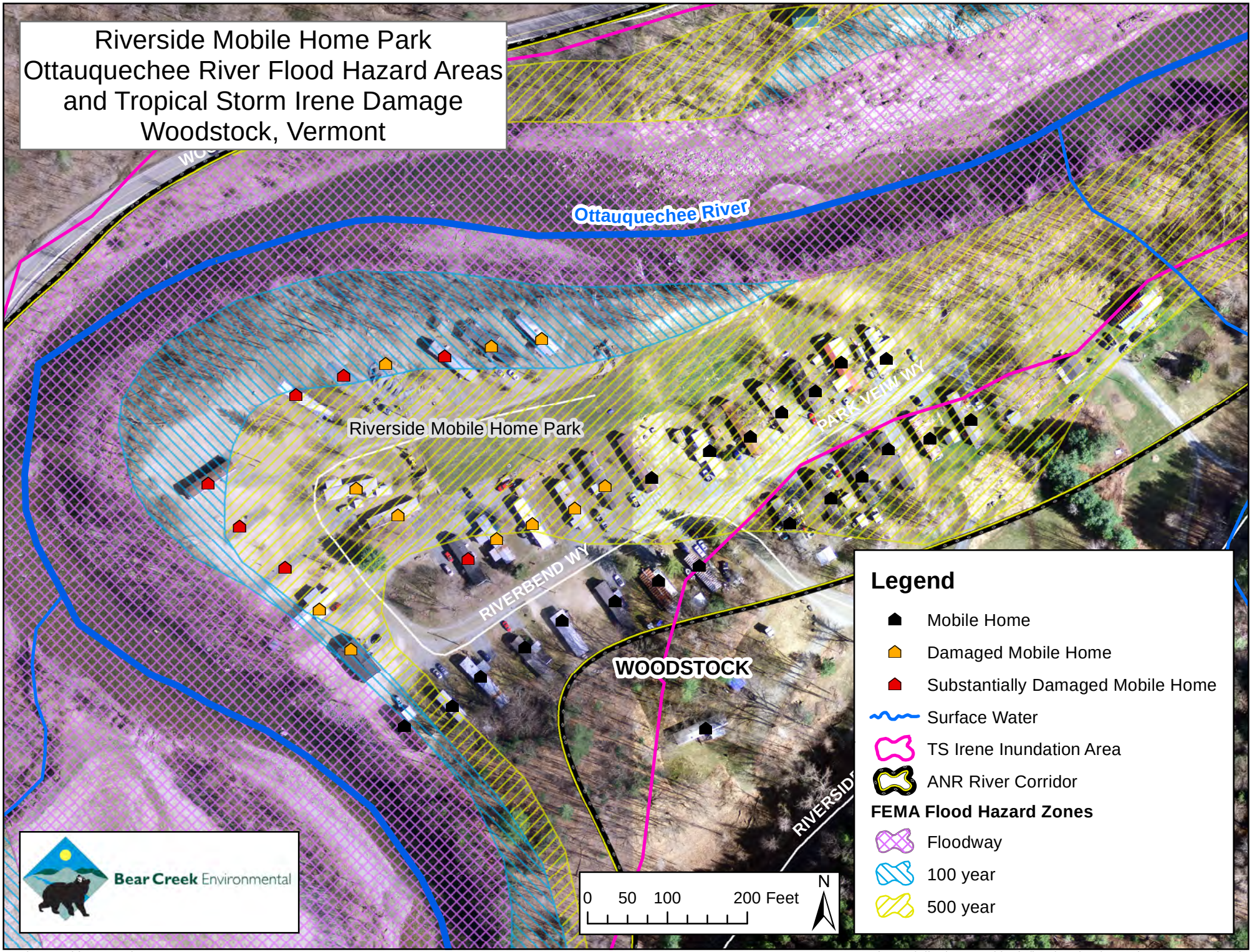
1 inch = 0.25 miles

N

Bear Creek Environmental



Map composed on January 6, 2015. Background is Bing Imagery. See Riverside Mobile Home Park Damage Map for further damage details.




Background imagery from VTrans.
Map composed on February 23, 2015.



Substantially damaged is defined as having a damage cost that is greater than 50% of the value of the home before it was damaged.

Businesses in Flood Hazard Zones in Study Area
Bridgewater and Woodstock, Vermont
Vermont Economic Resiliency Initiative (VERI)
February 25, 2015

| Business Name | E911 Business Address | Town | Number of Employees | FEMA Floodway | FEMA 100 Year Flood Zone | FEMA 500 Year Flood Zone | ANR River Corridor | TSI Inundation Area |
|---|---|---|---|---|---|---|---|---|
| Audsley Plumbing & Heating | 90 Mill Road | Woodstock | --- | | | X | X | X |
| Bridgewater Volunteer Fire Department | 7284 US Route 4 | Bridgewater | Municipal | | | | X | X |
| Bridgewater Wastewater Treatment Facility | 52 Woolen Mill Drive | Woodstock | Municipal | | X | X | X | X |
| BSEF Thrift Store | 102 Woolen Mill Drive | Bridgewater | 6 | | X | X | X | |
| Charles Shackleton Furniture | 102 Woolen Mill Drive | Bridgewater | 15 | | X | X | X | |
| David Crandall Jewelry | 102 Woolen Mill Drive | Bridgewater | 1 | | X | X | X | |
| Deerbrook Inn | 4548 West Woodstock Road | Woodstock | 2 | | X | X | | X |
| Donna's Hair Studio | 102 Woolen Mill Drive | Bridgewater | 2 | | X | X | X | |
| DR Propane Farm | 59 Mill Road | Woodstock | --- | | | X | X | X |
| DR Propane Offices | 909 West Woodstock Road | Woodstock | 21 | X | X | X | X | X |
| Ellaway Property Service | 738 West Woodstock Road | Woodstock | 10 | | | | | X |
| Farmhouse Inn | 5250 West Woodstock Road | Woodstock | 2 | | X | X | | X |
| Farmhouse Pottery | 1837 West Woodstock Road | Woodstock | 4 | | | X | X | X |
| Kedron Valley Veterinary Clinic | 1205 West Woodstock Road | Woodstock | 9 | | | X | X | |
| Lake Sunapee Bank Drive-Up | 906 West Woodstock Road | Woodstock | 1 | | X | X | | X |
| Lincoln Inn and Restaurant | 2709 West Woodstock Road | Woodstock | 4 | | | | X | |
| Mill Mall | 102 Woolen Mill Drive | Woodstock | 44 | | X | X | X | X |
| Miranda Thomas Pottery | 102 Woolen Mill Drive | Bridgewater | 3 | | X | X | X | |
| Old Mill Marketplace | 102 Woolen Mill Drive | Bridgewater | 2 | | X | X | X | |
| On the River Inn | 1653 West Woodstock Road | Woodstock | 4 | | | | X | |
| Ramuntos Pizza | 102 Woolen Mill Drive | Bridgewater | 12 | | X | X | X | |
| Riverside Mobile Home Park | Park View Way | Woodstock | Residential | X | X | X | X | X |
| Schultz Excavation | 2457 West Woodstock Road | Woodstock | 2 | | X | X | | |
| Sleep Woodstock Motel | 4324 West Woodstock Road | Woodstock | 2 | | | | | X |
| Thymeless Herbs Farm | 5394 West Woodstock Road | Woodstock | 2 | | | | | |
| Union Arena | 80 Amsden Way | Woodstock | 4 | | | X | | |
| USPO Bridgewater Village | 102 Woolen Mill Drive | Bridgewater | 3 | | X | X | X | |
| Vtrans Woodstock Garage | 3396 West Woodstock Road | Woodstock | State | | | | | X |
| Welch's Woodstock Hardware | 2517 West Woodstock Road | Woodstock | 11 | | | | X | |
| West Woodstock Sewer Pump Station | Between 447 & 449 West Woodstock Road | Woodstock | Utility | | | X | | X |
| White Cottage Restaurant | 863 West Woodstock Road | Woodstock | 10 | | X | X | X | X |
| Wild Apple Graphics | 2513 West Woodstock Road | Woodstock | 35 | | | X | X | |
| Woodbridge Café | 4374 West Woodstock Road | Woodstock | 4 | | | | | X |
| Woodbridge Inn | 5763 West Woodstock Road | Woodstock | 1 | | | | X | X |
| Woodstock Community Care Home | 1087 West Woodstock Road | Woodstock | 6 | | | | X | |
| Woodstock Farmer's Market | 979 West Woodstock Road | Woodstock | 40 | X | X | X | X | X |
| Woodstock Glassworks | 1007 West Woodstock Road | Woodstock | 3 | | X | X | X | X |
| Woodstock Union High School & Middle School | 100 Amsden Way | Woodstock | 130 | | | X | X | |
| | | **TOTAL NUMBER OF BUSINESSES** | **32** | **3** | **19** | **26** | **26** | **19** |
| | | **TOTAL NUMBER OF EMPLOYEES** | **395** | **61** | **169** | **351** | **366** | **144** |

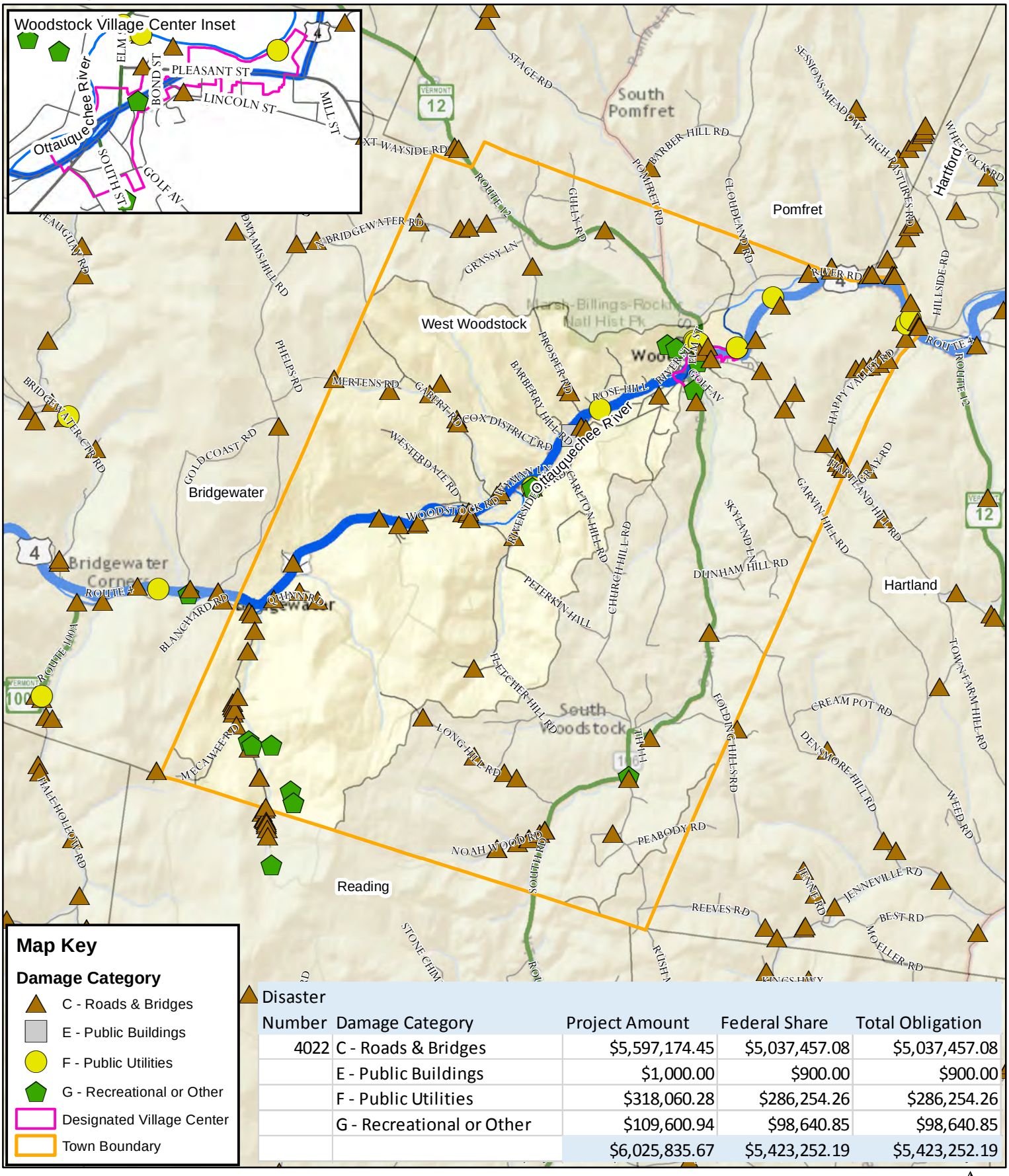
--- = Storage facility

Analysis involved the intersection of Vermont E-911 building points with flood hazard zones in ArcGIS. Results were further modified using Fall 2011 (post-Irene) aerial imagery.
If any portion of a building is within a flood hazard zone, as determined visually with aerial imagery, building is considered to be within the zone.

## Summary of Flood Damage and Economic Data Sources

| *Resource* | Reference |
|---|---|
| Ottauquechee River Stream Geomorphic Assessment | Bear Creek Environmental, LLC (2013) |
| Flood Damage Information | TRORC (2014a) |
| Town & Village of Woodstock Plan, Hazard Mitigation Plan | Woodstock (2014 & 2015) |
| FEMA Flood Maps | FEMA (2007) |
| State River Corridor | Vermont Agency of Natural Resources (2015) |
| Business Assets | TRORC (2014a) |
| USGS Tropical Storm Irene Inundation and Flood Analysis | USGS (2014) |

# Ottauquechee River - Woodstock, VT




## Map Key

**Damage Category**

- C - Roads & Bridges
- E - Public Buildings
- F - Public Utilities
- G - Recreational or Other
- Designated Village Center
- Town Boundary

| Disaster Number | Damage Category | Project Amount | Federal Share | Total Obligation |
|---|---|---|---|---|
| 4022 | C - Roads & Bridges | $5,597,174.45 | $5,037,457.08 | $5,037,457.08 |
| | E - Public Buildings | $1,000.00 | $900.00 | $900.00 |
| | F - Public Utilities | $318,060.28 | $286,254.26 | $286,254.26 |
| | G - Recreational or Other | $109,600.94 | $98,640.85 | $98,640.85 |
| | | $6,025,835.67 | $5,423,252.19 | $5,423,252.19 |



Author: Map provided by the Department of Housing & Community Development (DHCD).
FEMA Data.Gov Map created 1/22/2015.

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT

# Appendix C:

## Results of EPA's Flood Resilience Checklist for Woodstock

# Flood Resilience Checklist

Is your community prepared for a possible flood? Completing this flood resilience checklist can help you begin to answer that question. This checklist was developed as part of the U.S. Environmental Protection Agency's Smart Growth Implementation Assistance project in the state of Vermont. More information about the project can be found by reading the full report, *Planning for Flood Recovery and Long-Term Resilience in Vermont*, found online at www.epa.gov/smartgrowth/sgia_communities.htm#rec1.

## What is the Flood Resilience Checklist?

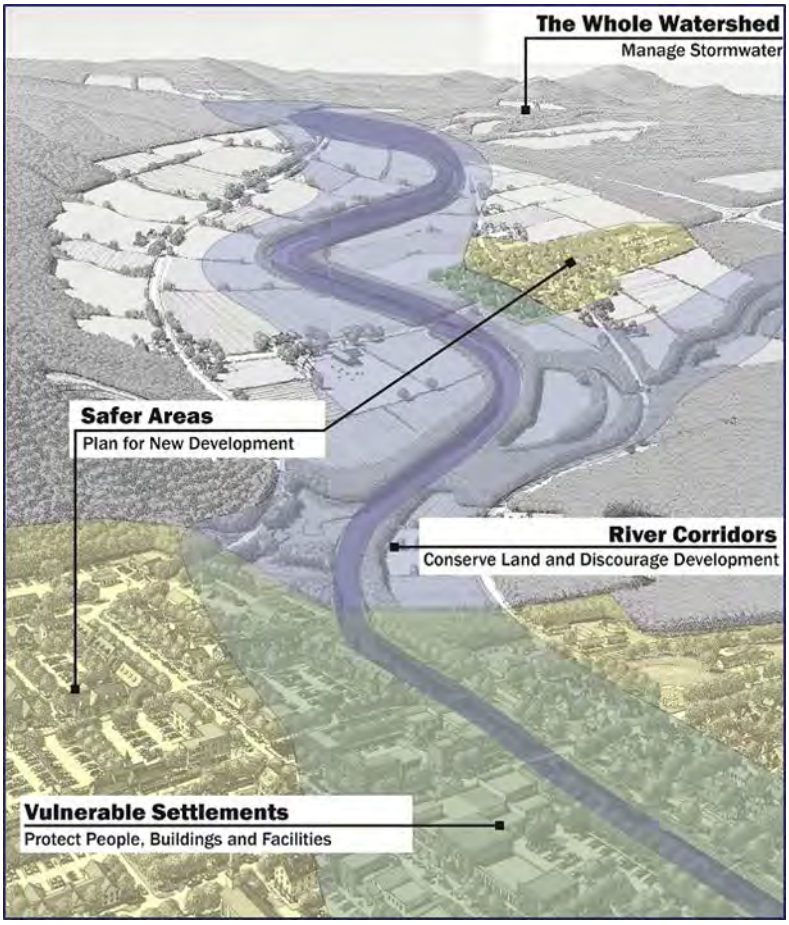
This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

## Who should use it?

This checklist can help communities identify opportunities to improve their resilience to future floods through policy and regulatory tools, including comprehensive plans, Hazard Mitigation Plans, local land use codes and regulations, and non-regulatory programs implemented at the local level. Local government departments such as community planning, public works, and emergency services; elected and appointed local officials; and other community organizations and nonprofits can use the checklist to assess their community's readiness to prepare for, deal with, and recover from floods.

## Why is it important?

Completing this checklist is the first step in assessing how well a community is positioned to avoid and/or reduce flood damage and to recover from floods. If a community is not yet using some of the strategies listed in the checklist and would like to, the policy options and resources listed in the *Planning for Flood Recovery and Long-Term Resilience in Vermont* report can provide ideas for how to begin implementing these approaches.




*This graphic illustrates the four categories of approaches to enhance resilience to future floods. Credit: Vermont Agency of Commerce and Community Development.*

# WOODSTOCK FLOOD RESILIENCE CHECKLIST

**Overall Strategies to Enhance Flood Resilience**
(Learn more in Section 2, pp. 9-11 of
*Planning for Flood Recovery and Long-Term Resilience in Vermont*)

Woodstock, Vermont

| | | |
|---|---|---|
| 1. Does the community's comprehensive plan have a hazard element or flood planning section? | ☐ Yes | ☐ No |
| a. Does the comprehensive plan cross-reference the local Hazard Mitigation Plan and any disaster recovery plans? | ☐ Yes | ☐ No |
| b. Does the comprehensive plan identify flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas, if applicable? | ☐ Yes | ☐ No |
| c. Did the local government emergency response personnel, flood plain manager, and department of public works participate in developing/updating the comprehensive plan? | ☐ Yes | ☐ No |
| 2. Does the community have a local Hazard Mitigation Plan approved by the Federal Emergency Management Agency (FEMA) and the state emergency management agency? | ☐ Yes | ☐ No |
| a. Does the Hazard Mitigation Plan cross-reference the local comprehensive plan? | ☐ Yes | ☐ No |
| b. Was the local government planner or zoning administrator involved in developing/updating the Hazard Mitigation Plan? | ☐ Yes | ☐ No |
| c. Were groups such as local businesses, schools, hospitals/medical facilities, agricultural landowners, and others who could be affected by floods involved in the Hazard Mitigation Plan drafting process? | ☐ Yes | ☐ No |
| d. Were other local governments in the watershed involved to coordinate responses and strategies? | ☐ Yes | ☐ No |
| e. Does the Hazard Mitigation Plan emphasize non-structural pre-disaster mitigation measures such as acquiring flood-prone lands and adopting No Adverse Impact flood plain regulations? | ☐ Yes | ☐ No |
| f. Does the Hazard Mitigation Plan encourage using green infrastructure techniques to help prevent flooding? | ☐ Yes | ☐ No |
| g. Does the Hazard Mitigation Plan identify projects that could be included in pre-disaster grant applications and does it expedite the application process for post-disaster Hazard Mitigation Grant Program acquisitions? | ☐ Yes | ☐ No |
| 3. Do other community plans (e.g., open space or parks plans) require or encourage green infrastructure techniques? | ☐ Yes | ☐ No |

| WOODSTOCK FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Do all community plans consider possible impacts of climate change on areas that are likely to be flooded? | ☐ Yes | ☐ No |
| 5. Are structural flood mitigation approaches (such as repairing bridges, culverts, and levees) and non-structural approaches (such as green infrastructure) that require significant investment of resources coordinated with local capital improvement plans and prioritized in the budget? | ☐ Yes | ☐ No |
| 6. Does the community participate in the National Flood Insurance Program Community Rating System? | ☐ Yes | ☐ No |
| **Conserve Land and Discourage Development in River Corridors**<br>(Learn more in Section 3.A, pp. 14-19 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Has the community implemented non-regulatory strategies to conserve land in river corridors, such as: | | |
| a. Acquisition of land (or conservation easements on land) to allow for stormwater absorption, river channel adjustment, or other flood resilience benefits? | ☐ Yes | ☐ No |
| b. Buyouts of properties that are frequently flooded? | ☐ Yes | ☐ No |
| c. Transfer of development rights program that targets flood-prone areas as sending areas and safer areas as receiving areas? | ☐ Yes | ☐ No |
| d. Tax incentives for conserving vulnerable land? | ☐ Yes | ☐ No |
| e. Incentives for restoring riparian and wetland vegetation in areas subject to erosion and flooding? | ☐ Yes | ☐ No |
| 2. Has the community encouraged agricultural and other landowners to implement pre-disaster mitigation measures, such as: | | |
| a. Storing hay bales and equipment in areas less likely to be flooded? | ☐ Yes | ☐ No |
| b. Installing ponds or swales to capture stormwater? | ☐ Yes | ☐ No |
| c. Planting vegetation that can tolerate inundation? | ☐ Yes | ☐ No |
| d. Using land management practices to improve the capability of the soil on their lands to retain water? | ☐ Yes | ☐ No |
| 3. Has the community adopted flood plain development limits that go beyond FEMA's minimum standards for Special Flood Hazard Areas and also prohibit or reduce any new encroachment and fill in river corridors and Fluvial Erosion Hazard areas? | ☐ Yes | ☐ No |

| WOODSTOCK FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 4. Has the community implemented development regulations that incorporate approaches and standards to protect land in vulnerable areas, including: | | |
| a. Fluvial erosion hazard zoning? | ☐ Yes | ☐ No |
| b. Agricultural or open space zoning? | ☐ Yes | ☐ No |
| c. Conservation or cluster subdivision ordinances, where appropriate? | ☐ Yes | ☐ No |
| d. Other zoning or regulatory tools that limit development in areas subject to flooding, including river corridors and Special Flood Hazard Areas? | ☐ Yes | ☐ No |
| **Protect People, Buildings, and Facilities in Vulnerable Settlements**<br>(Learn more in Section 3.B, pp. 19-26 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Do the local comprehensive plan and Hazard Mitigation Plan identify developed areas that have been or are likely to be flooded? | ☐ Yes | ☐ No |
| a. If so, does the comprehensive plan discourage development in those areas or require strategies to reduce damage to buildings during floods (such as elevating heating, ventilation, and air conditioning (HVAC) systems and flood-proofing basements)? | ☐ Yes | ☐ No |
| b. Does the Hazard Mitigation Plan identify critical facilities and infrastructure that are located in vulnerable areas and should be protected, repaired, or relocated (e.g., town facilities, bridges, roads, and wastewater facilities)? | ☐ Yes | ☐ No |
| 2. Do land development regulations and building codes promote safer building and rebuilding in flood-prone areas? Specifically: | | |
| a. Do zoning or flood plain regulations require elevation of two or more feet above base flood elevation? | ☐ Yes | ☐ No |
| b. Does the community have the ability to establish a temporary post-disaster building moratorium on all new development? | ☐ Yes | ☐ No |
| c. Have non-conforming use and structure standards been revised to encourage safer rebuilding in flood-prone areas? | ☐ Yes | ☐ No |
| d. Has the community adopted the International Building Code or American Society of Civil Engineers (ASCE) standards that promote flood-resistant building? | ☐ Yes | ☐ No |
| e. Does the community plan for costs associated with follow-up inspection and enforcement of land development regulations and building codes? | ☐ Yes | ☐ No |

| WOODSTOCK FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 3. Does the community require developers who are rebuilding in flood-prone locations to add additional flood storage capacity in any new redevelopment projects such as adding new parks and open space and allowing space along the river's edge for the river to move during high-water events? | ☐ Yes | ☐ No |
| 4. Is the community planning for development (e.g., parks, river-based recreation) along the river's edge that will help connect people to the river AND accommodate water during floods? | ☐ Yes | ☐ No |
| 5. Does the comprehensive plan or Hazard Mitigation Plan discuss strategies to determine whether to relocate structures that have been repeatedly flooded, including identifying an equitable approach for community involvement in relocation decisions and potential funding sources (e.g., funds from FEMA, stormwater utility, or special assessment district)? | ☐ Yes | ☐ No |
| **Plan for and Encourage New Development in Safer Areas**<br>(Learn more in Section 3.C, pp. 26-27 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Does the local comprehensive plan or Hazard Mitigation Plan clearly identify safer growth areas in the community? | ☐ Yes | ☐ No |
| 2. Has the community adopted policies to encourage development in these areas? | ☐ Yes | ☐ No |
| 3. Has the community planned for new development in safer areas to ensure that it is compact, walkable, and has a variety of uses? | ☐ Yes | ☐ No |
| 4. Has the community changed their land use codes and regulations to allow for this type of development? | ☐ Yes | ☐ No |
| 5. Have land development regulations been audited to ensure that development in safer areas meets the community's needs for off-street parking requirements, building height and density, front-yard setbacks and that these regulations do not unintentionally inhibit development in these areas? | ☐ Yes | ☐ No |
| 6. Do capital improvement plans and budgets support development in preferred safer growth areas (e.g., through investment in wastewater treatment facilities and roads)? | ☐ Yes | ☐ No |
| 7. Have building codes been upgraded to promote more flood-resistant building in safer locations? | ☐ Yes | ☐ No |

# WOODSTOCK FLOOD RESILIENCE CHECKLIST

**Implement Stormwater Management Techniques throughout the Whole Watershed**
(Learn more in Section 3.D, pp. 27-31 of *Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Has the community coordinated with neighboring jurisdictions to explore a watershed-wide approach to stormwater management? | ☐ Yes | ☐ No |
| 2. Has the community developed a stormwater utility to serve as a funding source for stormwater management activities? | ☐ Yes | ☐ No |
| 3. Has the community implemented strategies to reduce stormwater runoff from roads, driveways, and parking lots? | ☐ Yes | ☐ No |
| 4. Do stormwater management regulations apply to areas beyond those that are regulated by federal or state stormwater regulations? | ☐ Yes | ☐ No |
| 5. Do stormwater management regulations encourage the use of green infrastructure techniques? | ☐ Yes | ☐ No |
| 6. Has the community adopted tree protection measures? | ☐ Yes | ☐ No |
| 7. Has the community adopted steep slope development regulations? | ☐ Yes | ☐ No |
| 8. Has the community adopted riparian and wetland buffer requirements? | ☐ Yes | ☐ No |

# Appendix D:

## Table of Municipal Policy and Program Recommendations

# Woodstock

**Town-wide Policy and Program Options**

**Vermont Economic Resiliency Initiative (VERI)**

**Legend**

● Effective ◓ Limited ○ Ineffective



* Priority rating based on degree of community benefit

| | | OBJECTIVES | | | FEASIBILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Land Use Regulations** | | | | | | | | | | |
| Encourage development outside of the floodway. | **High** | ● | ● | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | The floodway is the fastest moving part of the river during a flood. Buildings and other objects in a floodway can be washed downstream, and cause culverts and bridges to clog with debris resulting in significant property damage. In the village zoning bylaw, consider prohibiting all new development from the mapped floodway. | Contact Town Planner and Planning Commission |
| Encourage development outside of the flood hazard and ANR mapped river corridor areas | **High** | ● | ● | ● | Moderate | < $10K | DEC River Management Program, RPC, VLCT, Consultant | MPG | New development in the flood area and river corridor puts owners at risk and reduces available floodplain. It also puts emergency responders, the public and downstream property owners at risk. In the flood hazard portion of the town and village zoning bylaw, consider prohibiting all new development. | Contact Town Planner and Planning Commission |
| Require repaired and rebuilt structures to be built higher. | **High** | ● | ○ | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | Owners rebuilding should raise the lowest floor 2 to 3 feet higher than the most recently recorded flood elevation in high-risk areas. These requirements can be added to the development standards portion of the flood hazard section of the town and village bylaw. | Contact Town Planner and Planning Commission |
| Monitor rebuilding after a disaster and keep participating in the NFIP. | **High** | ● | ● | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | People want to return to normal as quickly as possible after a disaster but local officials need to monitor rebuilding work to ensure that it does not violate town and federal regulations. Improper rebuilding may result in future federal disaster funding being unavailable for the town and its residences and businesses. | Work with Zoning Administrator. |
| **Town Plan** | | | | | | | | | | |
| Limit new development in village floodway, town and village floodplain and river corridor | **High** | ● | ● | ● | Moderate | < $10K | RPC, VLCT, Consultant | MPG | Language in the plan that restricts development in risky locations enables adoption of corresponding regulations and policies. Likewise, the plan should identify areas safe from floods and encourage development in those areas. This can be a component of the flood resiliency chapter. | Contact Town Planner and Planning Commission |
| Document road, sewer, and water infrastructure vulnerabilities in municipal and capital plans. | **High** | ○ | ○ | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | Areas that were damaged or have vulnerabilities should be documented so the community can plan for their replacement in their long-term budgets, easing the impact on taxpayers. Capital programs and budgets are not common in smaller towns but the Selectboard may start this process with a simple capital reserve fund. | Contact Town Planner and Planning Commission |
| Identify areas for conservation. | **Medium** | ● | ● | ● | Easy | < $10K | Town | DEC-ERP | The Ottauquechee River Corridor Plan identifies potential riparian easement sites. The Woodstock Conservation Commission can identify and work with willing landowners to establish conservation sites along the river to prevent future development in flood-prone locations. | Contact Conservation Commission |
| Document damages from flood events. | **Medium** | ○ | ○ | ● | Easy | < $10K | RPC, VLCT, Consultant | MPG | Disasters are easily forgotten over time and damages from the 2011 floods as well as recent rain and flood events should be documented. This will drive consideration of the implications of new investments in areas damaged by floods including .... Riverside Mobile Home Park, West Woodstock, and River/Elm Streets. | Contact Town Planner and Planning Commission |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

# Woodstock

**Town-wide Policy and Program Options**

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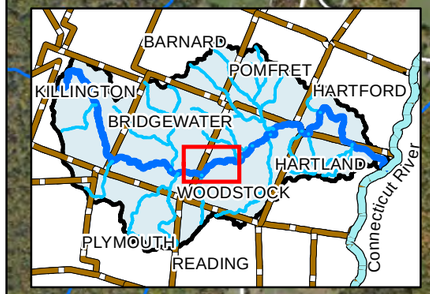
| **Recommendation** | **Priority*** | **Reduces Flood Risk** | **Reduces Erosion Risk** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Potential Partners** | **Potential Grants** | **Explanation** | **Next Steps** |
| **Emergency Planning** | | | | | | | | | | |
| Develop a local recovery and building retrofit fund. | **High** | ○ | ○ | ● | Difficult | ?? | Chamber, local churches, committees | VT Community Foundation | Towns will recover much more quickly after a disaster if they create a local fund to address urgent needs as federal and state money are slow to arrive. Establishing a local household and business small grant or loan fund is proven to speed recovery efforts. Towns could offer mini grants for backflow preventers and barriers for doors. | Work with local committee |
| Include the VERI municipal infrastructure projects in the local Hazard Mitigation Plan. | **High** | ● | ● | ● | Easy | < $10K | RPC, town | HMGP grants | Towns can also add the projects listed in this report to the strategies portion of the plan to improve eligibility for future grants. | Work with town Emergency Management Director. |
| Educate people about the causes, risks and warning signs of floods. | **Low** | ● | ● | ● | Easy<br>Moderate<br>Difficult | < $10K | Schools, RPC, Town | HMGP grants | Schools can include flood awareness and preparedness in spring and fall science and history programs. Schools and towns and other local groups such as the Rotary or the senior center can publicize flood risk areas, warning signs and evacuation plans. | Reach out to schools and community groups. |
| Develop evacuation plans. | **Medium** | ○ | ○ | ● | Moderate | < $10K | Homeowners Associations | HMGP grants | · Municipal facilities and schools as well as private facilities such as mobile home parks, senior centers, nursing homes and workplaces should all have evacuation plans. | Work with town Emergency Management Director. |
| **Education and Outreach** | | | | | | | | | | |
| Promote and educate property owners on the value of flood insurance. | **High** | ○ | ○ | ● | Easy | < $10K | Chamber, Homeowners Associations | HMGP grants | Homeowners' insurance does not pay for any flood related damage. Only flood insurance through the National Flood Insurance Program does. In Woodstock, only 35% of buildings in the flood hazard area have flood insurance. | Gather NFIP informational materials for distribution, and reach out to real estate agents. |
| Help businesses plan for disasters. | **Medium** | ○ | ○ | ● | Easy | < $10K | Chamber, Rotary | EDA grants | If a home is damaged or washed away, occupants can go stay in a hotel, with friend or family, or find a rental. When a business is flooded, it is much harder to relocate. Continuity of operations plans outlines the steps business can take during and after a disaster to reduce disruption and losses. | Offer continuity of operations planning training for businesses. |
| Educate landlords and contractors about local regulations. | **High** | ○ | ○ | ● | Moderate | < $10K | Realtors | HMGP grants | Many landlords and contractors may not understand the requirements for rebuilding after a flood. Specific standards must be met to maintain eligibility for flood insurance and other federal grants. | Reach out to landlords and contractors. |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

# Appendix E:

## Maps and Tables of Projects to Protect Woodstock

# Projects to Protect Businesses and Infrastructure
## Woodstock, Vermont - Map 1 of 2
## Vermont Economic Resiliency Initiative




**Legend**

- Local Economic Asset
- Project Site
- Surface Water
- US Route 4
- ANR River Corridor
- FEMA Floodway
- FEMA 100 Year Floodplain
- Town Boundary

0 0.125 0.25 0.5 Mile

1 inch = 0.25 miles

N

BRIDGEWATER

WOODSTOCK

N BRIDGEWATER RD

DEER BROOK WY

WESTERDALE RD

GABERT RD

WYMAN LN

WOODSTOCK RD

Lincoln Inn and Restaurant

Sleep Woodstock Motel

BRIDGES RD

FLETCHER HILL

BOURDON RD

Map 2 Match Line

Ottauquechee River

HILLSIDE RD

TH 25

BUSCUIT HILL WY

FLETCHER HILL

Bridgewater Village

Bridgewater Town Clerk

Bridgewater Mill Mall

ROUTE 4

BLANCHARD RD

QUINN RD

TH 12

Curtis Hollow Brook

Upstream End of VERI Study Area

| Site Number | Site Description | Notes |
|---|---|---|
| 1 | Bridgewater Mill Mall on Woolen Mill Dr | Floodproof |
| 2 | Taylor Farm at 7091 Curtis Hollow Rd | Create floodplain |
| 3 | Route 4 embankment near intersection of Westmont Way | Improve river and road stability |
| 4 | Thymeless Herbs Farm at 5394 W Woodstock Rd | Floodproof |
| 5 | Farmhouse Inn at 5250 W Woodstock Rd | Floodproof |
| 6 | Route 4 Bridge between Hillside Rd and Deerbrook Way | Replace / upgrade undersized bridge |
| 7 | Woodbridge Café at 4374 W Woodstock Rd | Floodproof |
| 8 | Sleep Woodstock Motel at 4324 W Woodstock Rd | Floodproof and improve onsite drainage |
| 9 | Bridges Rd east of Biscuit Hollow Rd | Improve river and road stability |



Bear Creek Environmental

Map composed on January 30, 2015. Background is Bing Imagery. Please see mitigation strategies table for more information about sites.

# Projects to Protect Businesses and Infrastructure
## Woodstock, Vermont - Map 2 of 2
## Vermont Economic Resiliency Initiative


**Legend**

- Local Economic Asset
- Project Site
- Surface Water
- US Route 4
- ANR River Corridor
- FEMA Floodway
- FEMA 100 Year Floodplain

0 0.125 0.25 0.5 Mile

1 inch = 0.25 miles

N

Woodstock Main Water and Sewer Lines

Woodstock Wastewater Treatment Facility

Downstream End of VERI Study Area

Woodstock Farmers Market

Woodstock Union High School and Middle School

Riverside Mobile Home Park

Lincoln Inn

Map 1 Match Line

Ottauquechee River

Kedron Brook

Woodstock Village

WOODSTOCK

| Site Number | Site Description | Notes |
|---|---|---|
| 10 | Floodplain on north bank between Lincoln Inn & Riverside MHP | Preserve floodplain |
| 11 | Riverside Mobile Home Park on Park View Way | Consider relocation; create floodplain |
| 12 | Audsley Plumbing & Heating at 90 Mill Rd | Floodproof |
| 13 | Dead River Propane Farm at 59 Mill Rd | Floodproof |
| 14 | Woodstock Farmers Market at 979 W Woodstock Rd | Floodproof / consider buyout |
| 15 | Dead River Company Offices at 909 W Woodstock Rd | Consider buyout |
| 16 | White Cottage Restaurant at 863 W Woodstock Rd | Consider buyout |
| 17 | West Woodstock Sewer Pump Station | Floodproof / upgrade |
| 18 | Main drinking water & sewer lines at Elm St Bridge | Relocate / reinforce |



Bear Creek Environmental

Map composed on March 11, 2015. Background is Bing Imagery. Please see mitigation strategies table for more information about sites.

# Woodstock

**Recommended Projects to Protect Businesses and Infrastructure**
**Vermont Economic Resiliency Initiative (VERI)**
**April 1, 2015**

**Legend**
● Effective ◒ Limited ○ Ineffective

* Priority rating based on objectives and potential business impact (refer to *Specific Project Recommendations* section of the report)



| | | | | OBJECTIVES | | | FEASIBILITY | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| **Building and Site Improvements** | | | | | | | | | | |
| Flood proof in West Woodstock in at Farmer's Market **(see site 14 on map 2)** | Businesses | 1 businesses with a total of 40 employees | **High** | ○ | ○ | ● | Moderate | $10K-$50K | 1-2 years | The building flooded (water 5 feet up) resulting in a complete loss of merchandise at Woodstock Farmer's Market. Floodproofing may be best accomplished by elevating the building or using dry floodproofing techniques. A site specific assessment by a engineer and/or architect to determine the best method is recommended. |
| Flood proof at the Bridgewater Mill Mall **(see site 1 on map 1)** | Commercial buildings | 8 businesses with a total of 44 employees | Medium | ○ | ○ | ● | Moderate | $10K-$50K | 1-2 years | Basements flooded at Bridgewater Mill Mall during Tropical Storm Irene. Wet floodproofing may be an option for this historic building. Elevating utilities is recommended. |
| Flood proof the businesses across Route 4 in vicinity of Thymeless Herbs Farm and Farmhouse Inn **(See sites 4 and 5 on map 1)** | Businesses and private homes | 2 businesses with a total of 4 employees | Medium | ○ | ○ | ● | Moderate | <$10K per building | 1-2 years | Thymeless Herbs Farm and Farmhouse Inn reported having flooding in basements across US Route 4. Animals died (chickens buried in the mud) and land contaminated with floodwaters at Thymeless Herbs Farm. |
| Flood proof and improve onsite drainage at businesses across from US Route 4 near Deerbrook Way **(see sites 7 and 8 on map 1)** | Businesses | 2 businesses with a total of 6 employees | Medium | ○ | ○ | ● | Moderate | <$10K per building | 1-2 years | Foundation wall collapsed at Woodbridge Café; Sleep Woodstock Motel owner reported issues with onsite drainage. |
| Flood proof businesses located along Mill Road **(see sites 12 and 13 on map 2)** | Businesses | 2 businesses (equipment storage only) | Medium | ○ | ○ | ● | Moderate | <$10K per building | 1-2 years | Audsley Plumbing and Heating was flooded, but was prepared. Dead River propane farm (Leonard's Gas & Elec.) was flooded; propane tanks washed into the Ottauquechee River and the fence was lost. A floodproofing best practice is to secure fuel tanks to avoid loose debris in the river. |
| | | | | | | | | | | |
| **Channel and Floodplain Management** | | | | | | | | | | |
| Preserve floodplain along the Ottauquechee River between the Lincoln Inn & Riverside Mobile Home Park **(see site 10 on map 2)** | Riverside Mobile Home Park and other downstream infrastructure | >25 businesses and 100 employees | **High** | ● | ● | ● | Moderate | $100-$200K | 1-2 years | Protect the largest undeveloped floodplain within the VERI study area through an easement. The floodplain is an important location for storage of floodwaters and sediment. |
| Create floodplain on the Taylor Farm, located across from the Mill Mall **(see site 2 on map 1)** | Commercial buildings | 8 businesses with a total of 44 employees | Medium | ◒ | ◒ | ◒ | Difficult | >$200K | >5 years | Flooding in basements at Mill Mall (Shackleton Thomas Furniture, BSEF Thrift Store, Donna's Hair Studio, Miranda Thomas Pottery, Old Mill Marketplace, Ramuntos Pizza, David Crandall Jewelry, and USPO Bridgewater Village). |
| Create floodplain on inside bend of Riverside Mobile Home Park **(see site 11 on map 2)** | Riverside Mobile Home Park | At least 18 units are at risk; the land is rented & there are 40 units within the mobile home park | Low | ◒ | ◒ | ◒ | Difficult | $50K-$100K | >5 years | Following relocation of several mobile homes, create floodplain on inside bend to reduce flood and erosion risk. |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.

# Woodstock

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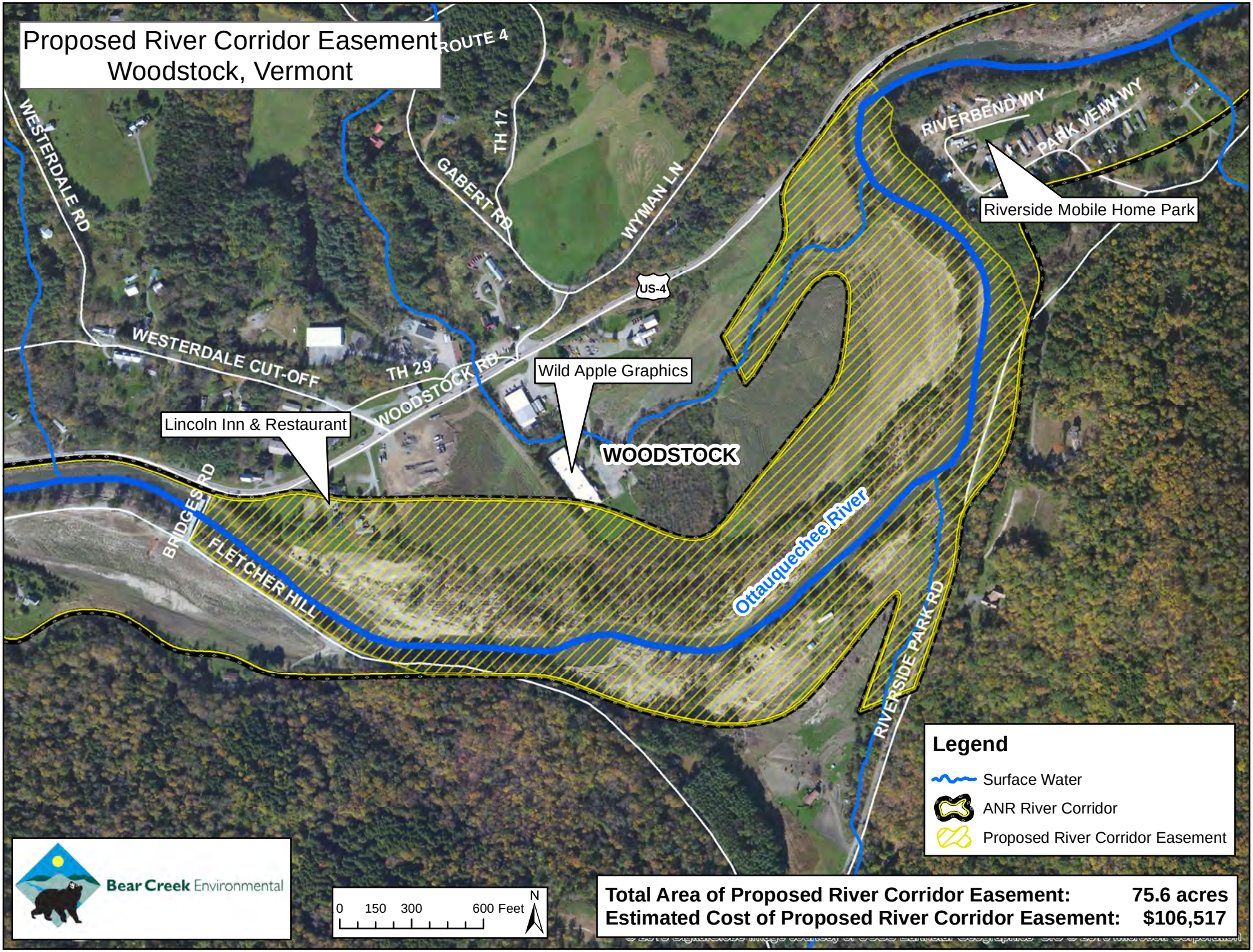
|---|---|---|---|---|---|---|---|---|---|---|
| **Project** | **What is At Risk?** | **Potential Business Impacts** | **Priority*** | **Reduces Flood Risk[1]** | **Reduces Erosion Risk[2]** | **Protects Businesses, Infrastructure, and Property** | **Ease of Implementation** | **Cost Range** | **Estimated Time for Implementation** | **Comments** |
| **Infrastructure Improvements** | | | | | | | | | | |
| Replace undersized bridge on US Route 4 **(see site 6 on map 1)** | Federal highway | >25 businesses and 100 employees | **High** | ● | ● | ● | Moderate | >$200K | 2-5 years | The bridge opening completely clogged with sediment and debris during Tropical Storm Irene, resulting in single lane damage and destruction of a single family home. Replacing the bridge with a larger opening (higher clearance) designed to better pass sediment and debris would reduce future flood damage. |
| Improve river and road stability along Route 4 **(see site 3 on map 1)** | Federal highway | >25 businesses and 100 employees | **High** | ○ | ◒ | ● | Moderate | >$200K | 1-2 years | The road embankments along US Route 4 blew out in multiple locations during Tropical Storm Irene, resulting in road wash outs. |
| Relocate or reinforce drinking water line owned by Woodstock Aqueduct Company under Elm St. Bridge **(see site 18 on map 2)** | Businesses and residents of Woodstock Village and West Woodstock | >25 businesses and 100 employees | **High** | ○ | ○ | ● | Moderate | >$200K | 1-2 years | Main water supply line at Elm Street Bridge ruptured leaving 1600 customers without drinking water following Tropical Storm Irene for 5 days. |
| Relocate or reinforce sanitary sewer line for Town of Woodstock under Elm St. Bridge and along the southern bank of the river in the Village **(see sites 18 and 19 on map 2)** | Businesses and residents of Woodstock Village and West Woodstock | >25 businesses and 100 employees | **High** | ○ | ○ | ● | Moderate | $100K-$200K | 2-5 years | Main sewer line crossing at Elm Street Bridge ruptured leaving 925 customers without sewer service following Tropical Storm Irene for one week. The sewer line was also damaged along the southern bank of the river between the bridge and Woodstock Wastewater Treatment Facility. |
| Upgrade West Woodstock Sewer Pump Station to keep water and silt out during future flood event **(see site 17 on map 2)** | Businesses and residents of Woodstock Village and West Woodstock | >25 businesses and 100 employees | **High** | ○ | ○ | ● | Easy | $50K-$100K | 1-2 years | Sewer pump station across from White's Cottage was flooded and silted over during Tropical Storm Irene. Subsequently, all the electrical wiring has been replaced and elevated. Additional work is needed to keep water and silt out during future flood events. |
| Improve river and road stability along Bridges Road **(see site 9 on map 1)** | Town Road | Residential | Medium | ○ | ◒ | ● | Moderate | $50K-$100K | 1-2 years | The ends of the roadway embankment were repaired following Tropical Storm Irene with FEMA funding. The middle section that was not repaired is at risk of failure. |
| **Public Safety Improvements** | | | | | | | | | | |
| Consider buyouts for at- risk properties in West Woodstock **(see sites 14, 15 and 16 on map 2)** | Businesses | 3 businesses with a total of 71 employees | **High** | ○ | ○ | ● | Difficult | >$200K | >5 years | Several businesses in West Woodstock experienced losses from flooding during the 1973 flood and Tropical Storm Irene. Buyouts would reduce future risk of losses, and would protect public safety. |
| Consider relocating mobile homes in flood and erosion hazard areas to higher ground **(see site 11 on map 2)** | Riverside Mobile Home Park | At least eighteen units are at risk; the land is rented and there are 40 units within the mobile home park | Medium | ○ | ○ | ● | Difficult | $100K-$200K | >5 years | Nine mobile homes were reported to be "uninhabitable" following Tropical Storm Irene. A total of 18 units were noted to be damaged, with 7 units having damage greater than 50 percent of the value of the building. The bank eroded at the bend in the river, and was stabilized following Tropical Storm Irene using rock. Four of the mobile homes were relocated following Tropical Storm Irene. The vacant lots could be conserved with easements to reduce future risk of losses. |

[1]**Reduces Flood Risk** - The proposed project/ strategy lowers the flood level. [2]**Reduces Erosion Risk** - The proposed project/ strategy lessens the vulnerability of a location to erosion.




Background is Bing Imagery. Map composed on March 30, 2015. Estimated cost information provided by Gretchen Alexander, River Scientist at the Vermont Agency of Natural Resources.

## Woodstock Aqueduct Company – Additional Needs

Pete Fellows of Two Rivers Ottauquechee Regional Commission provided an update on the Woodstock Aqueduct Company after speaking with Eric Wegner, Vice President.

Damages during Irene

The main water supply line at the Elm Street Bridge ruptured during Tropical Storm Irene in August 2011, leaving 1600 customers in Woodstock without water for about five days. A number of water supply lines were damaged during Irene including:

1. An 8 inch supply line under the Ottauquechee River in the vicinity of the Elm Street Bridge. Prior to Tropical Storm Irene the pipe was encased in concrete. The concrete snapped when undermined during high flows.
2. A 4 inch supply line under Barnard Brook to the Woodstock Foundation Building downstream of the access bridge.
3. Three 1 inch individual lines that carry water over to College Hill Road from US Route 4 near the Dead River Company.

Replacements following Tropical Storm Irene

The water supply lines were repaired as follows:

1. The 8 inch supply line at Elm Street was upgraded from schedule 40 to schedule 80 with a collar that allows segments to flex. The line was buried about 2 feet into clay and then covered with two to three feet of progressively larger material.
2. The 4 inch supply line to the Woodstock Foundation building was bored into clay substrate.
3. Customers that received potable water through the one inch supply line that ruptured during Irene went to wells for their potable water source.

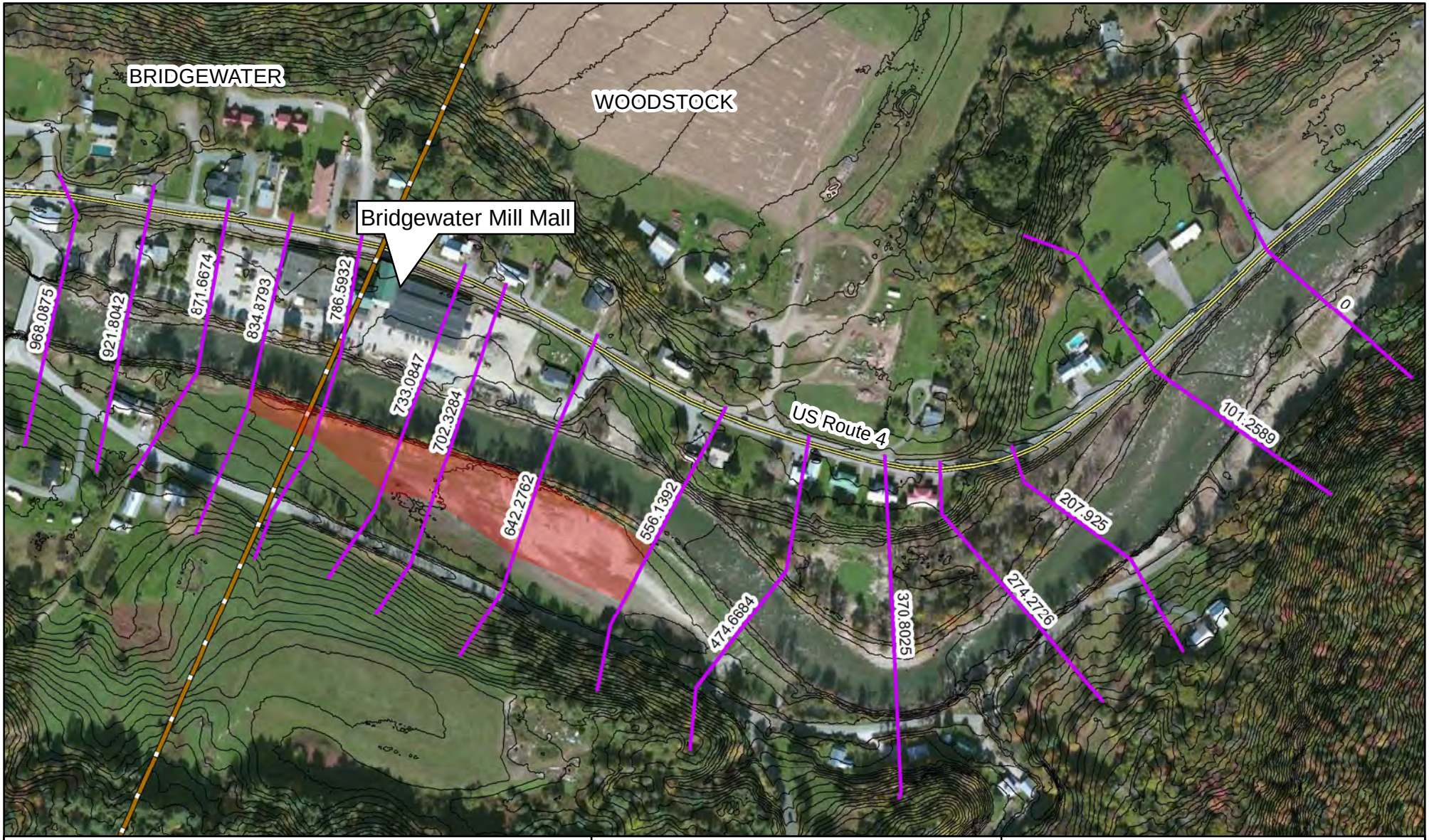
Needs

The Woodstock Aqueduct Company requires the following to be ready for an emergency:

1. Potable water temporary line package.
2. Redundant supply line from wells on Stimets Road and VT 12 to the reservoir on Cox District Road.
3. Solar backup for wells

# Appendix F:

## Conceptual Project Designs to Protect Woodstock




# Cross Section Locations for Conceptual Design of Floodplain Creation at the Bridgewater Mill Mall
## Bridgewater & Woodstock, Vermont
## Vermont Economic Resiliency Initiative

Legend

- Cross Section
- Proposed Floodplain Creation Area
- Town Boundary
- Major Road
- 1 Meter Contour

0 125 250 500 Feet

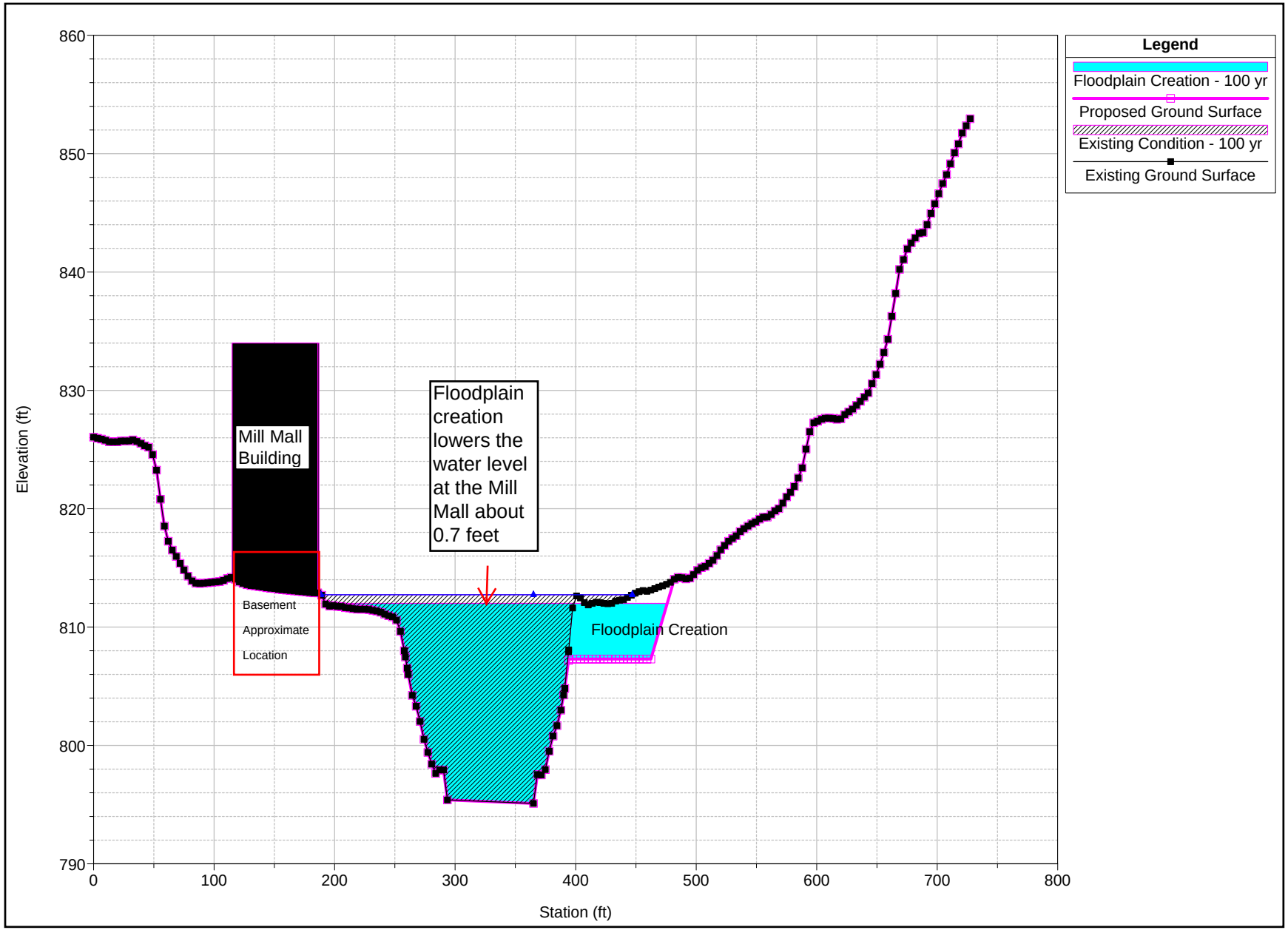
N

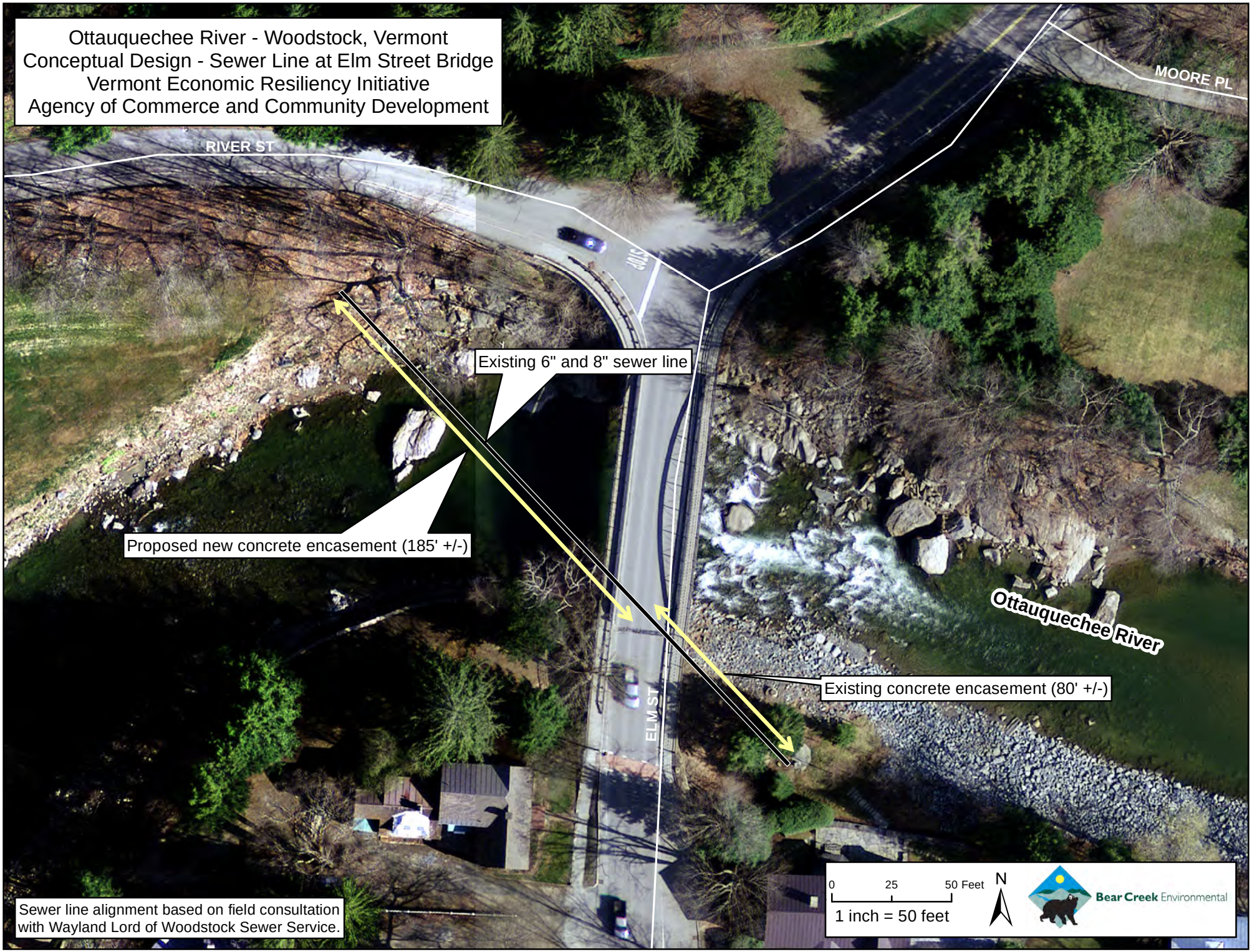
Floodplain creation surface area is approximately 2.5 acres. About 17,900 cubic yards of material would need to be excavated.

Background is Bing Imagery. Map composed on February 27, 2015.

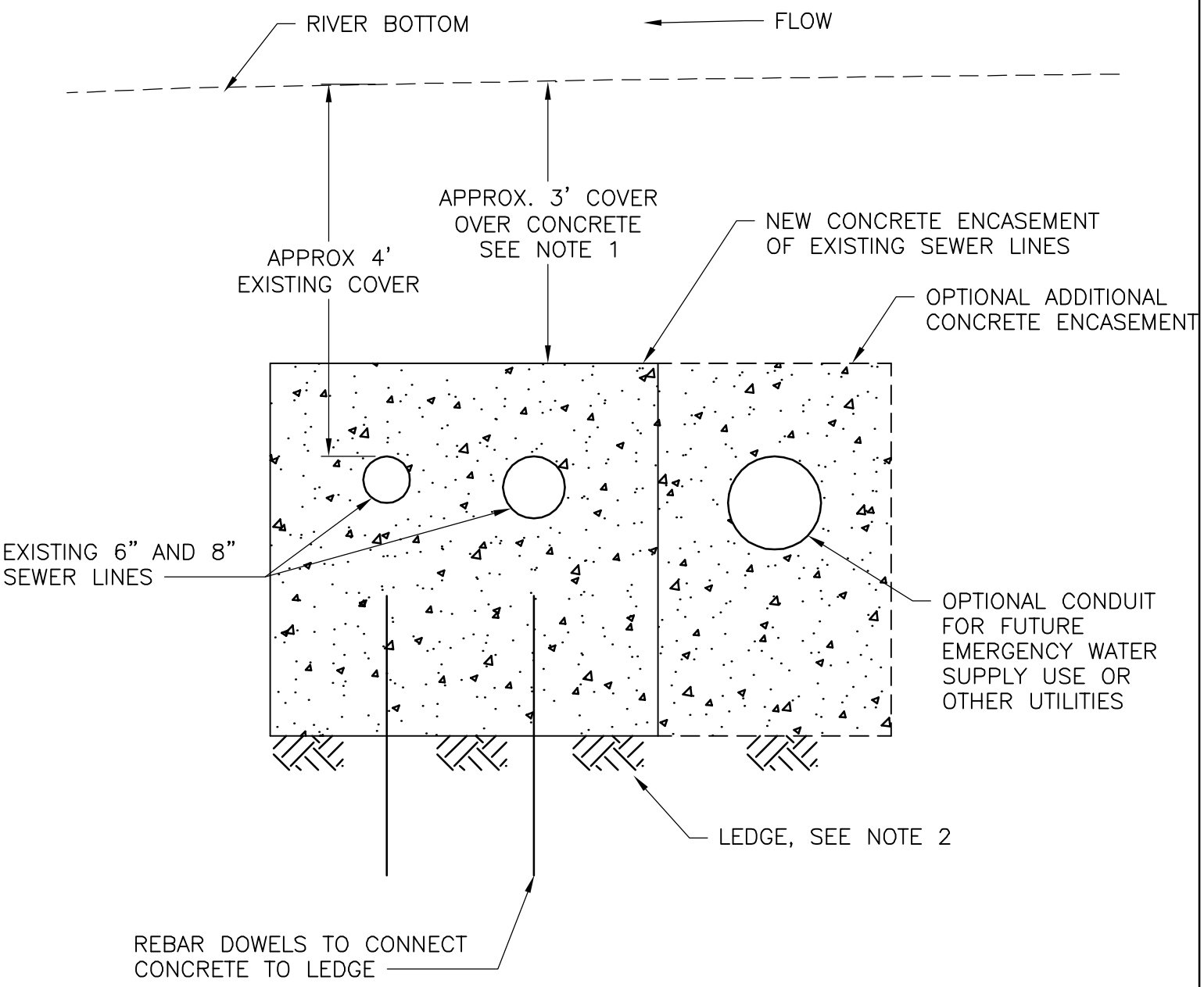
Bear Creek Environmental

100 Year Flood Event - Section 786
HEC-RAS Model Output






Imagery from VTrans. Map composed on January 2, 2015.




NOTES:

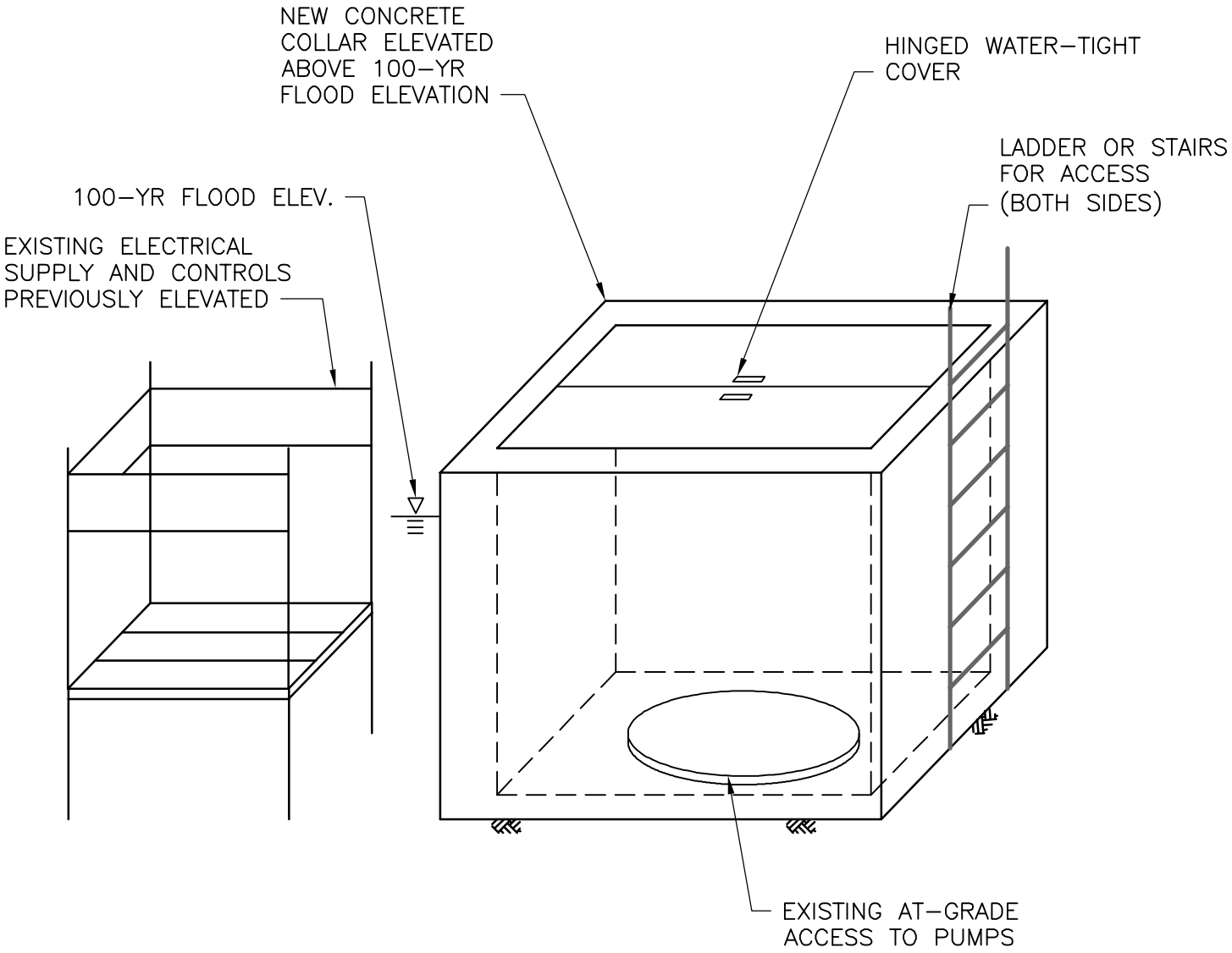
1. AS PART OF DESIGN PHASE, EVALUATE VERTICAL RIVER STABILITY. IF NECESSARY, REPLACE SEWER LINES AT DEEPER DEPTH TO PREVENT EXPOSURE OF CONCRETE DUE TO SCOUR.

2. TOWN SEWER SERVICE STAFF REPORT LEDGE. CONFIRM PRESENCE AND EXTENT DURING DESIGN PHASE.

# ELM ST. SEWER LINE ENCASEMENT – CROSS SECTION

| | | | | |
|---|---|---|---|---|
| DuBois & King inc. ENGINEERING • PLANNING • MANAGEMENT • DEVELOPMENT | VERI-WOODSTOCK<br>OTTAUQUECHEE RIVER<br>ELM STREET SEWER LINE<br>CONCRETE ENCASEMENT | DRAWN BY: ZDC | DATE: FEB. 2015 | FIGURE |
| | | CHECKED BY: MTM | D&K PROJECT #: 122618L | |
| | | PROJ. ENG.: MTM | SCALE: N.T.S. | |

I:\122618_VERI_Flood_Resiliency\Woodstock-Ottaquechee\CAD\122618L Woodstock-DT01.dwg 2/27/2015 12:08 PM




# FLOOD COLLAR RETROFIT

| | | | | |
|---|---|---|---|---|
| DuBois & King inc. ENGINEERING • PLANNING • MANAGEMENT • DEVELOPMENT | VERI-WOODSTOCK<br>OTTAUQUECHEE RIVER<br>ROUTE 4 SEWAGE LIFT STATION<br>FLOOD COLLAR RETROFIT | DRAWN BY: ZDC | DATE: FEB. 2015 | FIGURE |
| | | CHECKED BY: MTM | D&K PROJECT #: 122618L | |
| | | PROJ. ENG.: MTM | SCALE: N.T.S. | |

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# Appendix G:

## Community Forum Meeting Notes

# Vermont Economic Resiliency Initiative (VERI)

# Community Forum - Village of Woodstock

## MEETING NOTES

October 2, 2014 – 6:30 - 8:30 PM

### Project Overview

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.

VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy.

### For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI

### Meeting Summary

19 community members, business owners, and homeowners from the Ottauquechee River catchment area in Woodstock attended the Vermont Economic Resiliency Community Forum. The community identified two major flood hazard risks in Woodstock – repeat flooding of Morgan Hill Road businesses due to the elevation of the road and perceived flooding risk along Kedron Brook. Successful mitigation projects in the Woodstock have included restoring riparian buffers, maintaining undeveloped parcels of land in the flood plain, and upgrading aged or insufficient infrastructure, such as culverts. Further analysis and technical assistance needs of the community emphasized changes to flood insurance policies, hardening or retrofitting waste water treatment and electrical utility services, improving access to capital soon after a disaster, and augmenting the capacity of the State of Vermont river engineers to analyze and mitigate risk.

### Present

- Residents and Business Owners: Bill Emmons (Cloudland Farm), Laura Spittle, Barry Milstone (Farmhouse Inn), Molly Hutchins (Green Mountain Horse Association), Patrick Crowl (Woodstock Farmer's Market), Ray Bates, Beth Finalyson (Woodstock Chamber of Commerce), Sally Miller

(Sustainable Woodstock)

- Technical Assistance: Mary Nealon (Bear Creek Environmental)
- Town of Woodstock: Mary Riley, Michael Brands, Phil Swanson, Nick Scheu, Don Bourdon, Chris Miller
- Regional Planning Commission: Pete Fellows (TRORC), Ellie Ray (TRORC)
- Woodstock Foundation: David Donath, Marian Koetsier, Susan Plump
- State of Vermont: Noelle MacKay (DHCD), Chris Cochran (DHCD), Marie Caduto (ANR), Todd Menees (ANR), Allison Clarkson (VT House of Representatives)
- Media and Press: Phil Camp and Curt Peterson (The VT Standard)

## Introduction

David Donath, President of the Woodstock Foundation, convened the Vermont Economic Resiliency Initiative (VERI) Community Forum in Woodstock and he introduced Commissioner Mackay from the Vermont Department of Housing and Community Development. Commissioner MacKay welcomed everyone and thanked people for participating in a second round of community meetings presently being held in five Vermont communities state-wide. The Commissioner explained that the community forums are examining ways to improve economic resiliency for natural disaster impacted communities in the aftermath of Tropical Storm Irene. Through the Vermont Economic Resiliency Initiative, the State will analyze risks to public infrastructure, alongside economic activity, river corridor and flood data, to better mitigate future flood hazards and to improve overall resiliency. The Commissioner provided the audience with a VERI project overview and the findings of the first two phases of the project. After her introductory remarks, the Commissioner explained that the purpose of the meeting was to collect information about risks to infrastructure and economic activity observed during Irene, subsequent risk reduction, and suggested improvements for long-term resiliency.

## Overview of the Riverine Study Area

The Vermont Agency of Natural Resources has designated a river scientist to review the geomorphology, flood hazard risks, sediment deposition potential, and impacts to the built environment of select rivers and tributaries within each targeted VERI community. The scientists presented their initial findings of the river corridors at each of the community forums and provided technical assistance to the respective community throughout the meeting.

Notes

- Bear Creek Environmental has completed a baseline study of the Ottauquechee River and its tributaries. Initial studies analyzed the river geomorphology and flow dynamics. Current evaluations are identifying flood resiliency opportunities and conflicts between businesses, infrastructure and the river.
- VTrans is working with river engineers and scientists to analyze river instability which may impact the integrity of public infrastructure, including roads. There is a Roads and Rivers Training for transportation officials and contractors to address flood resiliency in road design and construction.
- The community is invited to share their priorities and concerns with the extended VERI team.

### Public Input

The DHCD Commissioner solicited input from forum participants with regard to flood risk and mitigation opportunities in Woodstock. The questions posed were:

1) What are the hazards and risk areas in the town?
2) What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?
3) What still needs to be addressed in the interests of long-term security and sustainability?
4) What information should the final report include and how should this information be presented?

Identified hazards and risks will be further analyzed in Phases 3 and 4 of VERI.

### Identified Natural Disaster Hazards and Business Risks

What are the hazards and risk areas in the town?

Notes

- The Green Mountain Horse Association (GMHA) and an adjacent business flood repeatedly, although the road is reasonably unaffected. The repeated flooding results from the raising of the Morgan Hill Road bed, which created a dam on the flood plain. The increased elevation of the road caused the flooding to go above the floodproofing on the Vermont Horse Country Store building, which did not occur in the 1973 flood. Additionally, the bridge at the foot of Morgan Hill is a debris catcher, which increases back-flooding risk. Flooding from Tropical Storm Irene caused $60,000 in physical losses and $130,000 business loss (mixed direct and

indirect TS Irene) to GMHA. This risk may be mitigated by reducing the elevation of Morgan Hill Rd. bed by half a foot.

- Roy Bates, Irene v. Ice Jams - Compared '27 flood, to '38 flood, '73 flood and Irene
- Kedron Brook has not been adequately studied for future flood risk particularly if the waterway becomes jammed with ice or if the large trees on the bank are uprooted. If Kedron floods, it could flood Woodstock Village. The risk may be mitigated by analyzing the effects of the riparian buffer on water flow and velocity and being vigilant when the ground is saturated, as flooding could be imminent.
- Like observations for Kedron Brook, the river along Bill Emmon's Farm on Cloudland Road is lined with large trees. The property owner asked, "Can we start to log the larger trees in riparian zones so we do not have a slide?"
- Water, sewer and power Infrastructure still at risk.
- If Barnard Brook along Rte. 12 floods, it will affect more that Woodstock so there should be cooperative agreements between the affected towns to minimize risk.
- The number of propane tanks near the river is a floating debris hazard. These hazards should be moved away from river.
- Woodstock residents expressed concern over the resale of previously flooded properties.
- The flood destroyed the Elm Street water line and existing businesses couldn't operate in the village for a short period.

### Effective Hazard Mitigation and Risk Reduction

What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?

<u>Notes</u>

- The storms effectively inundated a series of fields above and below Woodstock including Billings Farm and the Woodstock Inn and Resort Golf Club.
- Emergency Plans were effective during Irene for those town who had them in place, practiced them in advance of a disaster, and when the emergency plan shared responsibility for implementation.
- The Town of Woodstock has upgraded culverts since Irene. Two Rivers Ottauquechee Regional Commission (TRORC) will produce a map of where culverts have been replaced.
- Many improvements have been made to the bend in the Ottauquechee River at foot of Billings Farm field, colloquially known as "The Jungle" in East Woodstock. Before Irene, the Town discussed re-developing "the Jungle." In Irene, the snow dump area here was lost due to

erosion, but a Community Development Block Grant Disaster Recovery (CDBG-DR) grant enabled the snow dump to be moved. The Village of Woodstock has obtained grants to make it a park, providing an economic benefit to the Town. The Town also replaced the riprap at the bend, guarding the sewer mainline to the waste water treatment facility.

- Billings Farm has planted trees along the river to reduce farm flooding, riparian buffer.
- Woodstock has a high number of senior support complexes which were hit hard because of no water and sewer. Homestead facility had a water cooled generator, now they have an air cooled generator.
- The banks gave great micro-loans and the Vermont Economic Development Authority (VEDA) was great during Tropical Storm Irene.
- Stream Alteration Engineers worked very hard.

### Resiliency and Sustainability Planning

What still needs to be addressed in the interests of long-term security and sustainability?

Notes

- Electrical Systems Infrastructure:
  - Burying the power lines will decrease electrical outages, improving local resiliency.
  - Generators are critical to relief efforts, particularly to vulnerable populations, such as the elderly.
- Water Systems Infrastructure:
  - The Woodstock Aqueduct Company manages the town water system and it is in need of many upgrades. The Woodstock water system is old and a risk to the village.
- Unemployment insurance for businesses:
  - Businesses do not have special exception for laid off employees from a disaster.
  - Adjustments the state made to reduce the cost of unemployment insurance were not enough.
- Access to capital:
  - There were too few grants for businesses for recovery.
  - Funding needed for debris clean up, none existed.
  - Must make it easier for actively recovering businesses to access existing support.
  - Communities need local foundations or funds. 'We care for our community' fund because states and federal funding will come with more strings and paperwork, which is time consuming for businesses trying to resume operations.

- Flood Insurance:
    - Homeowners and businesses need flood insurance which help to cover business loss. These policies should be reviewed by a lawyer.
    - Response would be better, in terms of damage, some communities have improved.
    - The cost of insurance has increased too much and small businesses can't afford it. And without flood insurance, businesses cannot receive Hazard Mitigation Grants.
    - Everyone needs to get elevation information for accurate insurance quotes.
- Acquisition "Buy-outs" of Risk Properties: Develop a state buyout program using conservation funds.
- River Management:
    - The State needs more River Management Engineers to assess present risk and reserve staff for disasters/flood response.
    - Remember tributaries of the Ottauquechee- tributary areas are risky.
- Roads: What is the town doing about Morgan Road? Reducing the road grade could have downstream affects that should be considered.
- Flood plain protection: Need to keep flooding the golf course.
- Emergency Planning:
    - Ask businesses, even households, to have emergency plans and to do practice exercises using the plans.
    - Better emergency management now than prior to Irene.
    - State now has a system to track business damage.
- Continuity of Operations for Businesses:
    - Continuity planning for businesses, now done by small business development centers

### Information Sharing and Dissemination

What information should the final report include and how should this information be presented?

Notes

- Show maps of what happened, what has been done, and where we are today. Provide a geographic context.
- Who is the audience: For the town reports, the broad community within those towns, also other towns so they can replicate it.
- Need to contact other large businesses to get their input (school, inn, utilities etc.)

## Next Steps and VERI Implementation

Notes

- Flood insurance reform bill
    - VT doesn't have updated flood maps.
    - Elevation data must be obtained privately in order to get a realistic insurance estimate.
    - State could consider takeover of flood insurance as done in North Carolina.
- Need better mapping of Fluvial Hazard Areas, river corridor maps being released next year.
- Look more at how we can retrofit for flood resiliency.
- Additional data
    - Water and sewer line in-stream crossings
    - Morgan Hill Road flooding history
    - Ray Bates study of village flood history
- Completed culvert replacements and future needs

# Vermont Economic Resiliency Initiative (VERI)

# Community Forum - Woodstock

## MEETING NOTES

April 23, 2015 – 7:00 – 9:00 PM

## VERI Project Overview

With funding from the US Economic Development Administration (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.
VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining our economy.

## For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI/Woodstock/

## Summary

Twenty-two people attended -- 10 project team members and 11 from the from the Woodstock area representing the town, local boards, landowners, community members and business owners. The forum showcased three overarching municipal policy and program recommendations made by Two Rivers-Ottauquechee Regional Commission (TRORC), accompanied by eight project recommendations made by Mary Nealon of Bear Creek Environmental and project-specific flood-proofing/mitigation opportunities for nine project-specific sites. Community members were given the opportunity to ask questions, provide input, and rank the proposed projects. The four projects that proved to be most popular by community and other representatives were to relocate mobile homes in flood hazard areas to higher ground, work toward Woodstock Aqueduct line improvements, improve river and road stability along Route 4, and work toward sewer pump station improvements.

## Welcome and Overview

[Noelle MacKay, Commissioner of the Department of Housing and Community Development]

Commissioner MacKay began by going over the agenda for the evening and emphasized the importance of community input on the proposed flood reduction projects. Starting off with the "big picture," Noelle said the Vermont Agency of Commerce and Community Development's role after

Irene was post-disaster recovery and noted that while Irene impacted buildings and infrastructure, it was also a tremendous impact on the State's economy. The state applied for and received a grant from the US Economic Development Authority to help five Vermont communities build back stronger and to take steps to protect their economy from future floods.

Noelle introduced the project team members and provided background information on a successful project in Bennington that created the model for this project. She also explained the process for selecting the five towns – each with high flood risk to economic activity and infrastructure.

Woodstock was selected as a VERI pilot community for a range of reasons, including the fact that the community has a significant amount of economic activity (particularly in the tourism sector). Woodstock has been prone to commercial and infrastructural flood damage along US Route 4 and it has an engaged community with a sincere interest in floodplain protection. It was also a good fit for the project because the community has made great progress on flood resiliency planning, as evidenced by the adoption of a Local Hazard Mitigation Plan, the Ottauquechee River Corridor Management Plan and active participation in the National Flood Insurance Program.

As part of this project, a team of river scientists and engineers were hired to further assess the Ottauquechee River watershed in Woodstock and identify local threats to infrastructure and business. On the basis on this research, they made recommendations to reduce the impacts of future floods throughout the town.

The first Woodstock Community Forum was held in early October 2014 (meeting notes here), where Noelle sought input from attendees on three topics: what did they see happen during Irene, what have they done to prepare for the next flood, and what would they like state government, the Town, and other agencies and organizations to do to help the community prepare for the next flood?

The VERI team combined this information and its analysis into a draft report that contains recommended projects and town-wide policy and program options to reduce flood risks. The projects were ranked by the consultants on whether they are effective, limited, or ineffective at reducing erosion risk, flood risk, and damage to businesses, infrastructure, and property. The ease of implementation, cost, and potential partners are also factors.

Noelle stressed that this is a draft report, and that the team is eager to get comments from the public. The report will be up on the project web site until May 7th [now extended until May 12]. She believes the report can serve as a road map for the community and provide a menu of options for what can be done to help protect the community. She noted that putting these projects into the next

iteration of Woodstock's Hazard Mitigation Plan is a good way to help fund them, if they're not already addressed in the current plan. The Agency of Commerce and Community Development will work with partners to help identify funding sources once priority projects are identified.

## Overview of Municipal Policies and Programs to Reduce Future Floods

[Pete Fellows, Two Rivers-Ottauquechee Regional Commission]

Before presenting policy and program recommendations for the community, Pete first noted some of the Town's accomplishments regarding flood resiliency. Woodstock has one full-time planner on staff (who was in attendance at the forum), and he worked with him and others on a number of issues post-Irene. The town plan identifies a number of important flood and erosion hazard goals.

Both the Town and Village Woodstock have taken many steps to be eligible for 12.5% state reimbursement through the Emergency Relief and Assistance Fund (ERAF) in the event of federally declared disasters, including NFIP participation, adoption of 2013 State Road & Bridge Standards, Local Emergency Operations Plan, and a Local Hazard Mitigation Plan. As of yet, the Town has not adopted a policy that states no new development in the River Corridor or no new development in Flood Hazard areas and participation in the Federal Community Rating system (which only a few Vermont communities currently participate). Implementation of these two programs would qualify the Town for an additional 5% match through the ERAF program.

Pete then discussed specific policy and program recommendations developed by the team. Some of these recommendations are not easy, and not without controversy, and are presented to promote discussion. Three recommendations were considered high-priority by the team: prohibition of future development from Village floodway areas, making municipal infrastructure a top priority, and monitoring rebuilding/encourage floodproofing and relocation after a disaster.

## Overview of Project Recommendations and Conceptual Designs

[Mary Nealon, Bear Creek Environmental, LLC]

Mary started her discussion with background on the Ottauquechee watershed, both within and beyond Woodstock. She explained the terms floodway, floodplain, fluvial erosion hazard area and river corridor. She explained that the team identified eight specific project recommendations (with the municipal sewer upgrade projects being twofold, covering two distinct site needs). After discussing these projects, she encouraged the participants to share information on specific sites worthy of being bought out in the West Woodstock area.

Proposed projects were broken into the four categories:

- Building & Site Improvements
- Channel and Floodplain Management
- Infrastructure Improvements
- Public Safety Improvements

The following are the four top-ranked projects, as determined by voting following the forum:

Consider relocating mobile homes in hazard areas (Public Safety Improvement):

A large swath of the land upstream from the mobile home park, including the land surrounding the Lincoln Inn & Restaurant and a large portion of the Riverside Park Road, and the access road to the mobile home park, falls within the bounds of the ANR River Corridor area. Additional development in this area will be at risk of future flooding and may also worsen damage to downstream development, including the Riverside Mobile Home Park. All told, eighteen of the forty mobile homes in the park were damaged during Irene, seven of which were classed as substantially damaged properties. While one means of mitigating flood impacts to the mobile homes is to conserve a total of 75.6 acres of land along the Ottauquechee just upstream of the mobile home park through a River Corridor Easement (at a projected cost of $106,517), a further option is to relocate the existing homes to areas outside of hazard zones. Moving them will substantially improve odds of decreased damaged in future flood events.

Improve US Route 4 river and road stability (Infrastructure Improvement):

The area along US Route 4 at the Deer Brook was damaged during Irene, leading to a loss of a travel lane along a heavily traveled corridor that residents, tourists and commercial trucks are reliant on for travel between US Route 7 and Interstate 89. Work in this area will vastly improve transportation safety and infrastructure resilience at a key confluence area along the river.

Upgrade Woodstock Aqueduct (Infrastructure Improvement):

The privately-held Woodstock Aqueduct Company sustained extensive damage to its existing water line during Irene. Following that flood disaster, the system was left with three unmet needs: a potable water temporary line package; a redundant supply line from wells on Stimets Road and VT Route 12 to the Cox District Road; and solar power back-up for wells. The projected cost for all three

projects would be an amount equal to or less than $200,000, and could be at least partially off-set by Drinking Water Revolving Fund grant money.

**Sewer pump improvements** (Infrastructure Improvement):

In order to improve waste system resilience, there are two proposed projects in different areas of Woodstock: upgrading the pump station along US Route 4 and sewer line encasement work instream near Elm Street. These infrastructural enhancements will protect against environmental concerns and public health and safety, among other issues. The estimated cost for sewer line encasement upgrades is projected to be between $100,000 and $200,000, and may be offset with funding from FEMA's Hazard Mitigation Grant Program (HMGP). The pump station upgrades, meanwhile, are projected to cost between $50,000 and $100,000, and may also be funded, in part, with HMGP grant money.

## Where to Get Help

[Noelle MacKay, Commissioner of the Department of Housing and Community Development]

The program and policy changes, along with the site-specific projects, are directed at the community as a whole, including town government. Following Mary's presentation, Noelle shifted the discussion to what individuals can do to address flooding.

She noted a number of case studies (available at the table beside the building entrance and online) that highlight mitigation measures on existing buildings, including historic buildings. The perception is that not much can be done to floodproof old buildings, but this isn't true. Grants for these types of projects don't commonly go to individuals, but Noelle said they will be looking into some creative funding sources for projects that involve businesses and individuals.

Noelle talked about the Woodstock VERI web page, ACCD's Flood Resiliency web page, and the Flood Ready Vermont website. Vermont's Small Business Development Center was also mentioned, especially their disaster recovery guide for businesses. FEMA is also planning to present training on small business recovery in September, and the upcoming Vermont downtown conference will feature a session on floodproofing by engineer Bob Stevens.

Notes and Responses from the Public:

- One attendee expressed concern over the State solely concentrating mitigation efforts on flood events, despite the fact that there are numerous other natural disasters that pose significant threats to Woodstock and other communities. In response, Noelle noted that these other risks are outlined more extensively in both the state and local Hazard Mitigation Plan documents. Outlining the risks that Woodstock is most vulnerable to will ensure that the Town and Village receive prioritized funding for projects that address particular hazard issues/mitigation efforts.
- A second attendee asked if there is funding to relocate business out of flood areas. A discussion ensued regarding FEMA buy-out funding, which provides 75% of a property's value to landowners. This process requires a 25% match, which has come from the State to make property owners whole following Irene. Additional HMGP funding exists that bases relocation of commercial sites on thresholds (ex: employee-base size, location, etc.).

## Project, and Policy and Program Prioritization

Sticky dots were handed out for people (six each) to place on the charts to prioritize project recommendations, and policy and program recommendations, in Woodstock. The Town's ranking of the high priority projects can help the Town advance projects. Before ending the presentation, Noelle thanked everyone for coming, especially those who participated in the VERI forum for the second time.

The results of the project prioritization and the policy and program prioritization are below, in order of popularity -

| Dots | Site Number | Description |
|---|---|---|
| 9 | 11 | Consider relocating mobile homes in hazard areas |
| 8 | 18 | Upgrade Woodstock Aqueduct |
| 5 | 6 | Improve US Route 4 river and road stability |
| 5 | 17 | Upgrade Municipal Sewer (Sewer Line encasement/Pump Station) |
| 4 | 11 | Preserve floodplain on inside bend of Riverside Mobile Home Park |
| 3 | 10 | River Corridor Conservation Easement (Lincoln Inn to mobile home park) |
| 2 | 2 | Create floodplain across from the Bridgewater Mill Mall |
| 2 | 3 | US 4 general improvements |
| 2 | Municipal Policies & Programs | Floodway Village Protections in Plan/Bylaws |
| 1 | 14 | Floodproof Woodstock Farmers Market |
| 1 | Municipal Policies & Programs | Evacuation Plans |
| 1 | Municipal Policies & Programs | River Corridor Protections |

# Vermont Economic Resiliency Initiative [VERI]

## Consultant Team

DuBois & King inc.

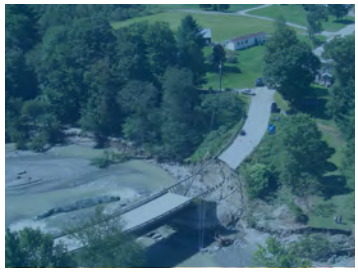
Landslide
Linking people to their landscape
Natural Resource Planning
Community Involvement
Watershed Assessment
Project Coordination
GIS Mapping
Facilitation

Bear Creek Environmental

Fitzgerald Environmental Associates, LLC.
Applied Watershed Science & Ecology

Engineering, Planning, Landscape Architecture and Environmental Science
MILONE & MACBROOM

VERMONT
AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT



# Chapter 5

## VERI: Part of the Quilt to Rebuild a Stronger Vermont

## Chapter 5


Overview ..... 5.1

Listening and Documenting Lessons Learned ..... 5.2

Filling the Data Gap ..... 5.4

- River Corridor Protocols and Maps ..... 5.4
- Identifying Vulnerable Roads Segments ..... 5.5
- Identifying Undersized Bridges and Culverts ..... 5.5
- Digital Parcel Data ..... 5.6

Provide Tools and Training to Municipalities ..... 5.6

- VERI Framework for Targeting Investment to Protect Business and the Economy ..... 5.7
- Flood Resilience Checklist ..... 5.8
- State Planning Manual Update ..... 5.9
- Stormwater and Green Infrastructure Guidelines ..... 5.9
- Technical Guidance: Standard River Management Principles and Practices ..... 5.10

Update Standards and Policies ..... 5.10

- Town Plan Updates: New Flood Resilience Element Required ..... 5.11
- ERAF Updates ..... 5.11
- New Rivers, Road and Bridge Standards ..... 5.13
- Flood Hazard Area and River Corridor Rule ..... 5.15
- Shoreland Protection and Water Quality Protection Acts ..... 5.15

Strengthen Communication and Coordination ..... 5.16

- Information Easy to Access: Flood Ready Vermont ..... 5.16
- Roads and Rivers Training ..... 5.17
- Targeting Rebuilding and Mitigation Investments Together ..... 5.18

Improve Response and Preparedness ..... 5.19

- Assisting Businesses Planning ..... 5.20
- Updating and Testing Emergency Preparedness Plans ..... 5.20
- Integrating Data Gathering with Emergency Management ..... 5.21
- Improving Response Time ..... 5.22

Next Steps: Implementing VERI through Partnerships ..... 5.22

Resources ..... 5.24

Appendix 5.1: ..... 5.25

## Overview

Vermont's hard-won experience from flooding taught us many lessons – a key one was that no one individual, business, organization, town or state agency can reduce flood vulnerabilities alone. Fortunately, projects like VERI and other studies and related initiatives deepened partnerships and identified new opportunities that have helped communities, the state, and its regional and non-profit partners develop and advance an integrated, long-term strategy of policies, programs and investments to:

- protect people and property;
- strengthen Vermont's preparedness at a business, community and state level;
- ensure a coordinated, fast and efficient response after a disaster;
- reduce the repetitive repair costs to infrastructure that impact community, state and federal budgets; and
- ensure businesses stay open and Vermont's economy remains strong after an event.

The VERI project and partnership has played a key role in the rebuilding 'quilt'. It helped fill data gaps and created a step-by-step process to help the state, RPCs, and cities and towns examine where flood and fluvial erosion hazard areas pose a risk to critical infrastructure and key economic assets. It identified five areas where flood risks intersect with key economic activity and laid out policy and project-specific strategies to reduce these risks. At the same time, it developed a comprehensive method to identify, prioritize and implement local policy changes and projects to minimize flooding for communities across Vermont and it focused mitigation efforts and funding needs for the state moving forward.

VERI created a new standard for future planning efforts which will help local municipal leaders - with limited time, staff and expertise - make informed choices on upgrading infrastructure, how to protect current businesses and where to site future developments to reduce costs and decrease risk. More significant is that the VERI process and framework is replicable and can help other Vermont

communities and states plan and take steps to minimize the costs and struggle to rebuild local infrastructure and economies.

Over time, VERI's process, along with new and improved flood data, laws, planning and education, as well as funding for projects that reduce identified vulnerabilities will not only improve the quality of Vermont's streams and rivers, but also reduce the cost of flooding to our businesses and economy. For these reasons, Vermont state agencies and their partners are committed to building on the foundation started with VERI to help other communities and businesses better analyze, understand and manage their risks.

The next section provides a snapshot of the lessons Vermont and its partners learned from its recovery. It describes how the state addressed data gaps that in turn informed the development and implementation of new policies and programs to help the state, business and communities reduce their risks and costs through improved comprehensive planning and preparedness and mitigation efforts.

## Listening and Documenting Lessons Learned

After Tropical Storm Irene, as the state transitioned from response toward longer-term recovery work, several extensive outreach efforts were undertaken to better understand what worked, what didn't and what was needed to rebuild stronger and safer. Several of these efforts were led by the State of Vermont, such as the Community Recovery Partnership, which hosted 13 meetings in the hardest hit communities across the state in the months following Tropical Storm Irene to learn more about local recovery and rebuilding needs directly from those impacted (DHCD, 2012). Other efforts were led by non-profits such as the Institute for Sustainable Communities (ISC), which engaged hundreds of stakeholders in their Resilient Vermont Project that developed a report containing recommendations to help make Vermont a model of community, economic and environmental resilience (ISC, 2014). Another was a more targeted review of state policy and programs with state agency staff (Smith, 2013)

While occurring at different times in the recovery process, the findings of these and other efforts were fairly consistent and summarized on the following page.

- ***Fill the Data Gaps.*** Stakeholders were clear that consistent, easy-to-use information was needed to identify risks from flooding. FEMA's flood maps are often out of date and incomplete as they only include inundation risk and do not identify locations at risk from fluvial erosion. Filling this data gap is critical if communities and the state are to better plan and prioritize investments.

- ***Provide Tools and Training to Municipalities.*** Many of Vermont's municipalities have limited capacity to plan, identify and manage their risks. A better aligned and integrated support system of tools, incentives, guidance and funding would help spur the changes needed to help municipalities take action.

- ***Update Standards and Policies.*** There is a need to align Vermont's rules and investments to ensure that they align with the information we have regarding mitigating hazards before damage occurs and reducing risk to homes, businesses and infrastructure. There was an understanding that many of our past practices – building in floodplains, paving areas that provide storage for stormwater or building to outdated standards – need to change if we are to withstand future events.

- ***Strengthen Communication and Coordination.*** Pre-planning and establishing working relations prior to an event increases efficient and effective recovery outcomes. Strengthening cross-agency partnerships in state government as well as with RPCs and among municipalities was an outcome highlighted by stakeholders.

- ***Improve Response and Preparedness.*** Planning and responding to floods and disasters crosses town and state lines and requires cooperation among individuals and many partners. It is impossible to anticipate and reduce all risks, but more opportunities to share information and resources to develop and practice emergency plans would help accelerate recovery from a variety of disasters.

Vermont has made progress in each of these five areas and the VERI project has played a role filling data gaps, providing tools and outreach to communities and strengthening partner communication and coordination needed to implement change.

## Filling the Data Gap

System-wide changes take time and must be informed by accurate and timely information to be successful. A lesson learned from Tropical Storm Irene was that consistent and easy to access information was needed to identify, prioritize and act on opportunities to reduce risks at the local level. Because Vermont's cities and towns regulate land use and own and manage much of their infrastructure, work by the VERI team to create statewide maps identifying infrastructure and buildings prone to flooding was critical to its long-term flood mitigation strategy. The following are some projects that have filled the data gaps since Tropical Storm Irene:

### River Corridor Protocols and Maps

VERI funding partially helped the state refine and finalize its stream geomorphic assessment protocols and river corridor procedures. By 2014, the state released an initial statewide river corridor map that is considered a national model. The river corridor maps combined with FEMA FIRM maps, created the first statewide inundation and fluvial erosion hazard map. This filled large holes in Vermont's flood maps and identified areas of greatest vulnerability. The state river corridor maps are now in a user-friendly format, accessible to everyone and illustrate where floods are likely to occur, helping individuals, businesses and municipalities better understand their risks and take steps to improve their safety and reduce or eliminate the risk (http://floodready.vermont.gov/assessment/vt_floodready_atlas).

The initial river corridor map layers hatched a number of subsequent projects to create more powerful tools to improve the decision making processes during and after a disaster, including the following:

- ***Hazard Mitigation Prioritization Tool***: Work is currently underway to enhance the functionality of the statewide River Corridor Map Layer by creating a statewide Risk Analysis and Hazard Mitigation Prioritization Tool. When complete, local planners will have a science-based GIS river sensitivity layer to identify high priority local hazard mitigation activities. The state is also working on complementary efforts to integrate river corridor data into the transportation planning and project prioritization process.

- ***State Buildings At-Risk***: Another project was launched to conduct a vulnerability assessment of all state buildings to determine which are subject to the greatest risk of flood and fluvial erosion damage. Buildings identified at-risk that play a critical role in government operations will be prioritized for further assessment including scopes of work and cost estimates to mitigate risks.

## Identifying Vulnerable Roads Segments

The river corridor maps were the critical missing piece that allowed the VERI team as well as VTrans to identify vulnerable culverts, roads and bridges and analyze the risk to transportation network. The river corridor and sensitivity data identified over 400 locations on state roads and more than 2,200 locations on town highways that are vulnerable to damage from floods (see Table 5.1).

**Table 5.1: Vermont Roadways with Unstable River Corridors (URC)**

| Description | State Highways | Town Highways |
|---|---|---|
| Total Miles | 2,707 | 11,482 |
| Miles within URC | 207 | 349 |
| Percent of Miles within URC | 8% | 3% |
| Number of Road Segment Locations within URC | 428 | 2,239 |

## Identifying Undersized Bridges and Culverts

The state has worked over several years with the RPCs to create and populate The Vermont On-Line Bridge and Culvert Inventory Tool. The inventory now includes details and locations on approximately 90,000 structures, and is continually updated and accessible online to cities, towns and the general public (www.vtvulverts.org). Applying VERI's GIS screening tool to this data set preliminarily identified over 700 undersized bridges and culverts at risk of failure from flooding. As seen in Figure 5.1, the risks to the transportation network are statewide, but knowing their locations and understanding the extent of the challenge gives the state and municipalities critical information needed to take steps to strengthen the weak links in the transportation network.

### Digital Parcel Data

Parcel data in Vermont is currently collected and managed by municipalities to support a variety of functions from property valuation and taxation to permitting and land use. However, in many communities parcel maps are outdated and/or on paper and the methodology is not consistent from town to town.

State agency partners are currently advancing a 3-year, $1.5 million project to build a consistent statewide digital parcel data set that is online and easy to access and use. Overlying parcel data with the river corridor maps would enhance emergency response activities and identify owners of properties for buy-outs or that are in need of floodproofing. Aggregating this data into larger regional and watershed areas will provide conservation organizations (e.g. land trusts, VHCB) with a tool to identify key parcels where the protection of a river corridor and floodplains would reduce downstream hazards and risks. The data will also support regional or watershed-based land use regulations that help protect floodplains and reduce stormwater flows.

With support from the Hazard Mitigation Grant awarded through the VT DEMHS to VT ANR, access to these and other mapping tools and information about each community's current flood preparedness is now publicly available through the Flood Ready website (http://floodready.vermont.gov/). An expanding array of flood and other map-based data to help communities plan and prepare for flooding is available on the Natural Resource Atlas (http://anrmaps.vermont.gov/websites/anra/).

## Provide Tools and Training to Municipalities

While filling data gaps and giving home and business owners, local governments and state policymakers the information they need to understand risks and vulnerabilities and make informed decisions is important, this information must be integrated into local plans, policies, and regulations.

Where development and infrastructure is located, which land is prioritized for conservation and how rivers are managed directly impacts the vulnerability of Vermont's businesses and economy. In Vermont many of these decisions occur at a local level, by volunteers with little or no full-time municipal staff support. According to the Vermont League of Cities and Towns, a member organization whose mission is to serve and strengthen Vermont local governments, there are 5,000 elected and appointed volunteers making land use decisions in Vermont. Tools, training, outreach and support was a need highlighted in many of the post-Tropical Storm Irene reports and listening sessions. State agencies responded and below are highlights of some of the initiatives developed:

## VERI Framework for Targeting Investment to Protect Business and the Economy

Vermont's villages and downtowns are unique historic, economic and cultural assets. Vermont's long-term economic development strategy is to support reinvestment and growth in and around Vermont's historic centers – many of which are near rivers or lakes and vulnerable to damage from floods. In most Vermont communities, it's not practical or possible to relocate buildings and infrastructure to locations outside of river corridors.

Exactly how to improve public safety and reduce damage from flooding in these areas is a challenge for many communities, as there are many competing and conflicting interests. For this reason, VERI provides municipalities with a methodology (see Chapter 3 in this report) for integrating flood information, economic and business data and on-the-ground river analyses to help prioritize updates to local plans, policies, and regulation. VERI helps communities to support growth, reduce risks from flooding and ensure local businesses stay open and the economy strong after a disaster. The five regional assessments provide a roadmap for those communities, but also pinpoints where other communities should target their limited resources to ensure existing businesses are protected and new development is not located in undeveloped floodplains and river corridors.

VERI's work also helped the five targeted areas knit together a patchwork of existing flood reduction plans, programs, projects and laws into a more integrated mitigation framework. Over time, this framework will be refined and tailored to help more Vermont communities understand and anticipate flooding and take actions to reduce the risks and costs to their economy.

## Flood Resilience Checklist

To help municipalities evaluate local programs and regulations, target limited resources and determine next steps, the Vermont Department of Housing and Community Development (VT DHCD) applied for and received a grant from U.S. EPA's Smart Growth Implementation Assistance (SGIA) program. Using the communities in the Mad River Valley as the test case, this project developed a checklist to help communities identify changes to regulatory and non-regulatory programs that reduce the cost and impact of future floods. This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed (see Appendix 5.1 for checklist).

The VERI team utilized this checklist as the basis for the policy and program review for the municipalities in the five study areas. In these study communities, the checklist highlighted the importance of including priority projects in their hazard mitigation plans and capital improvement plans for successful implementation. This more comprehensive approach to effect lasting change will help other communities take steps to better withstand and more quickly recover from flood-related disasters.

VT DHCD has also requested that the RPCs utilize the checklist when communities are developing municipal plan updates to ensure that flood resilience is front and center in the minds of local decision makers and that plans, policies and program updates are identified and prioritized.

## State Planning Manual Update

State statute defines how local and regional planning occurs in Vermont and creates a framework for regulatory and non-regulatory implementation. The local planning process and the zoning regulations that implement the plans are described in a VT DHCD published manual to assist communities in complying with the rules. The manual explains how to develop, prepare or amend a municipal plan and outlines implementation tools. The guide, published in 1987 and republished in 2000, is sorely out of date and missing key planning elements, like economic development and the newly required flood resilience element. VT DHCD, state agencies and a diverse group of stakeholders are currently working on a comprehensive update of the guide that will provide current regulations and examples of best practices to assist communities, including information to help communities learn from VERI and take steps to integrate and align local plans with implementation programs. Upcoming modules of the planning manual will also include model bylaws and a range of options to protect river corridors and floodplains and manage stormwater. The manual will be released in November 2015.

## Stormwater and Green Infrastructure Guidelines

By using multiple strategies to keep stormwater runoff close to where it falls and letting it infiltrate into the ground rather than rushing it off the land and into streams and rivers, the state, communities and business can reduce flooding and at the same time improve the quality of water.

The state's new Stormwater Master Planning Guidelines are designed to help municipalities manage stormwater with guidance, case studies, funding sources and sample stormwater regulations (http://www.vtwaterquality.org/erp/docs/erp_SWMPFinal5-30-13.pdf). This guidance, along with new clean water requirements, has resulted in more municipalities incorporating stormwater management into capital improvement projects and creating regulatory provisions to reduce the amount of storm and floodwaters flowing into our rivers and streams.

**Green stormwater infrastructure** (also called Low Impact Development or LID), are systems and practices that help address the problem of flooding and runoff by using vegetation and soil to slow, sink and spread stormwater.

At the state level, the Interagency Green Infrastructure Council, compromising the Secretaries of VT ACCD, VT ANR, Vermont Department of Buildings and General Services and VTrans have developed plans and guidance to incorporate green stormwater infrastructure into existing and planned development at the state and local level (http://www.watershedmanagement.vt.gov/stormwater/htm/sw_green_infrastructure.htm). Refer to Chapter 6 for details on green infrastructure practices and tools.

### Technical Guidance: Standard River Management Principles and Practices

Completed in 2013, Vermont's new Standard River Management Principles and Practices helps municipalities, contractors and property owners manage rivers to reduce future flood and erosion risks (http://www.watershedmanagement.vt.gov/rivers/docs/SRMPP_Edition_1.2_lowres.pdf). This guidance explains how to manage rivers toward their least erosive, equilibrium (or naturally stable) condition – which helps break the cycle of flood recovery activities that can make property near post-flood river channels more vulnerable to damages from future flooding.

With the adoption of Flood Hazard Area and River Corridor Protection Procedures in 2014, the state re-organized and compiled this best practices guidance for managing streams and rivers toward the creation of functioning floodplains and least erosive stream channels into the following categories:

- Slowing, Spreading, and Infiltrating Runoff
- Avoiding and Removing Encroachments
- Improving River and Riparian Management

## Update Standards and Policies

Prior to Tropical Storm Irene, flooding on a statewide scale had not been seen since the 1970s, and before that, 1927. However, local and regional flooding occurs almost every year and costs individuals, businesses, municipalities and the state millions of dollars. Experience has shown that tools, training and outreach is not enough to create the change that is needed to reduce Vermont's risk.

Vermont has made progress in aligning statute, rules and programs in support of more resilient communities. Vermont has also taken a number of steps to reduce or eliminate long-term risk to people and property from hazards and their effects. Specific progress includes:

## Town Plan Updates: New Flood Resilience Element Required

State laws were updated in 2012 requiring all Vermont community and regional plans after July 1, 2014 to have a flood resilience element that identifies their vulnerabilities and risks and outlines strategies and projects to reduce those risks. The plans must identify flood hazard and fluvial erosion hazard areas, based on the new state river corridor maps. To reduce the risk of flood damage to infrastructure and property, the plans must designate areas for protection, including floodplains, river corridors, and land adjacent to streams, wetlands, and upland forests. Communities and regions must also recommend policies and strategies to protect the areas identified to decrease risks to public safety, critical infrastructure, existing buildings and municipal investments. These plans and maps create the foundation for future development regulations that exceed NFIP minimums.

Municipalities were also encouraged to ensure that the flood resilience elements in town plans were also consistent with Hazard Mitigation Plans to confirm that recommendations did not conflict, and instead worked in harmony. In 2015, over 60% of Vermont's 290 municipalities include flood resilience plans and 57 percent have submitted Local Hazard Mitigation Plans (34% of these are approved by FEMA).

## ERAF Updates

Vermont also restructured its ERAF through the rule-making process to further incentivize local flood planning activities and the adoption of local land use regulations that go beyond the NFIP minimum regulations (http://floodready.vermont.gov/find_funding/emergency_relief_assistance). ERAF provides state funding to match Federal Public Assistance grants provided through FEMA after a federally-declared disaster. FEMA covers 75 % of eligible project costs for cities and towns to repair damaged infrastructure after a presidentially-declared disaster, leaving 25% of the cost to be covered by the municipality. To assist communities in dealing with this cost, the State of Vermont established ERAF. Before Tropical

Storm Irene, ERAF split the 25% cost and paid 12.5% and 15 % if the community had adopted road and bridge and NFIP standards. With the new rules, starting in October 2014, the ERAF rule established three different levels of state contribution towards the 25% non-federal share, creating financial incentives for municipalities to take steps to plan and reduce their risk. Depending upon the level of adoption of recommended mitigation actions (see Table 5.2), the ERAF match requirement will vary from 7.5 percent to 17.5 percent of the total project costs.

**Table 5.2: ERAF Matching Requirements**

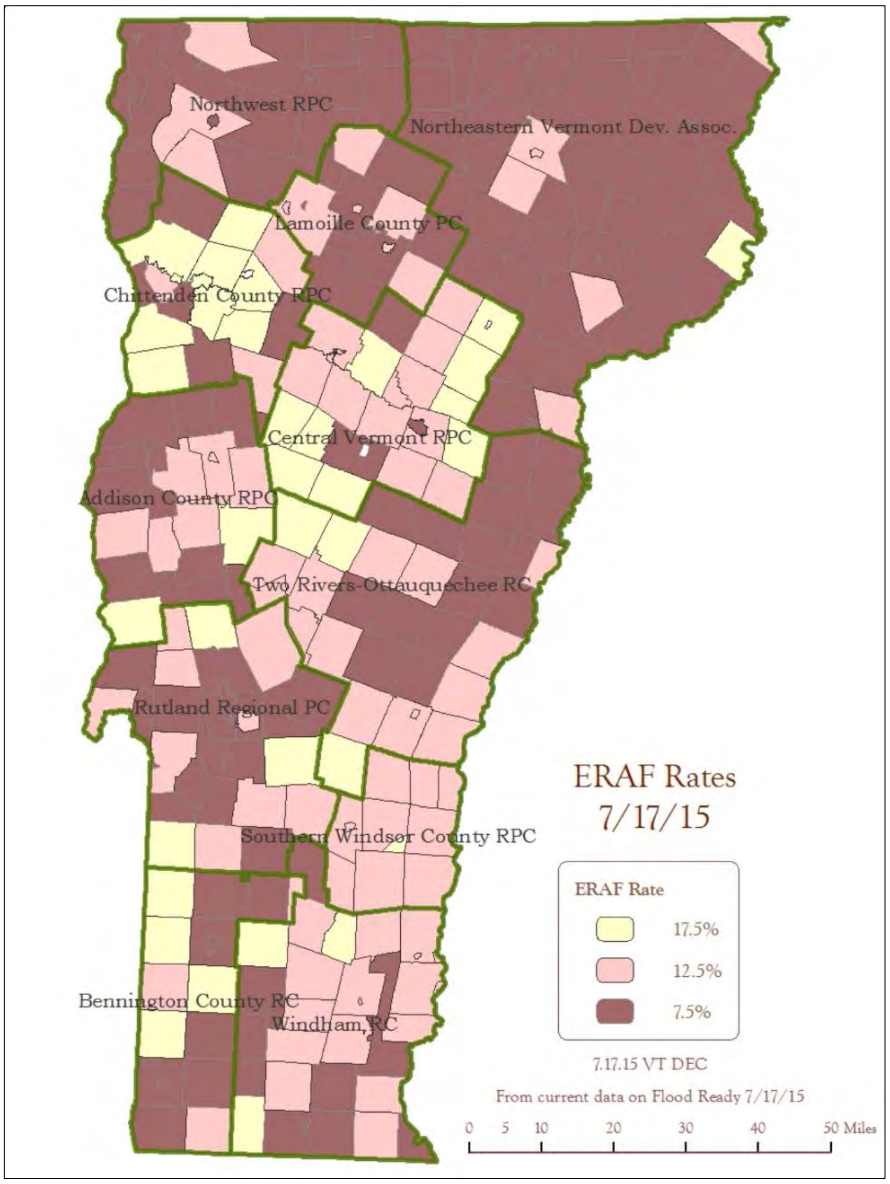
| State aid to towns for federally-declared disasters is 7.5 % |
|---|
| Base level, no mitigation actions required |
| **Steps to increase State aid to 12.5% (all four required to qualify)** |
| Participate in the National Flood Insurance Program |
| Adopt 2013 State Road & Bridge Standards |
| Annually Adopt Local Emergency Operations Plan |
| Adopt Local Hazard Mitigation Plan |
| **Step to increase State aid to 17.5% (one required to qualify)** |
| Adopt no new development in a River Corridor |
| *–or–* |
| Adopt no new development in Flood Hazard areas **and** participate in the Federal Community Rating System |

In two short years, the changes to the ERAF program has delivered meaningful results, detailed in Table 5.3 and Figure 5.2.

**Table 5.3: Municipalities and ERAF Requirements – 2014 Compared with 2015**

| 2014 | 2015 | ERAF Mitigation Actions |
|---|---|---|
| 87% | 89% | Participate in the National Flood Insurance Program |
| 70% | 87% | Adopt 2013 State Road & Bridge Standards |
| 36% | 82% | Adopt Local Emergency Operations Plan |
| 35% | 57% | Adopt Local Hazard Mitigation Plan |
| 0% | 24% | Adopt Interim River Corridor Protection: no new encroachment in a Special Flood Hazard Area or FEH, or no new encroachment in a River Corridor |
| 0% | 3% | Adopt River Corridor Protection (explicit based on river corridor maps posted 1/2/2015 on the Natural Resources Atlas tinyurl.com/floodreadyatlas) |
| 0% | 0% | Adopt no new development in Flood Hazard areas and participate in the Federal Community Rating System |

**Figure 5.1: Map of ERAF participation (July 2015)**

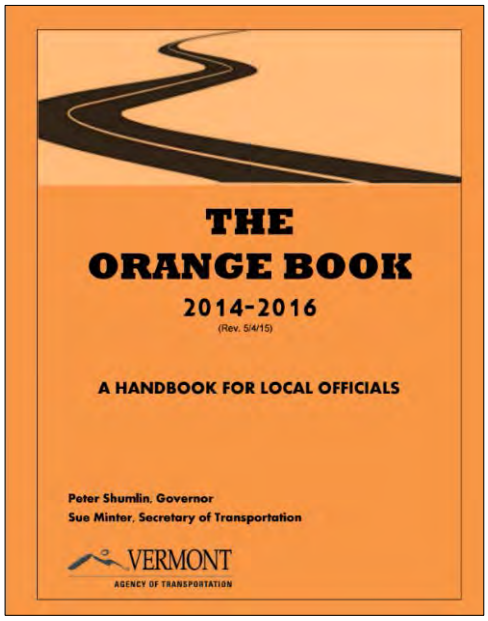



## New Rivers, Road and Bridge Standards

In response to Tropical Storm Irene, Vermont pushed to make sure bridges and culverts were rebuilt to more flood-resistant standards. However, without consistent statewide "codes and standards" FEMA reimbursement is limited to the cost to rebuild or restore the restructure to its pre-disaster conditions. To assure Vermont builds stronger and avoids future confusion related to FEMA reimbursement policies, a number of rules, performance measures and design standards were updated to assure consistency.

In 2013, VTrans updated the 'Orange Book' of road and bridge standards to improve safety, reduce life cycle costs and reduce environmental impacts (see Figure 5.3). As seen in Table 5.3, 87% of municipalities have adopted local transportation standards that meet or exceed the Agency of Transportation 2013 recommended template for town road and bridge standards. Training and education to support the statewide flood mitigation framework is ongoing and it now incorporates a variety of environmental protection measures and new engineering requirements. The state continues to assist municipalities in interpreting and adopting the 2013 Town Road and Bridge Standards. These standards include practices aimed at reducing erosion and allowing drainage structures to pass debris during flood conditions, reducing damage and repair expense. Other related updates include changes to the hydraulic manual to ensure upgrades to the transportation network are designed to withstand increased water flows as well as new stream alteration rules that consistently regulates river management practices like streambank stabilization and road improvements.

**Figure 5.2: VTrans Updated the Orange Book in 2013**



## Flood Hazard Area and River Corridor Rule

Vermont closed regulatory loopholes with the new Flood Hazard Area and River Corridor Rule that took effect March 1, 2015. The rule assures full state compliance with NFIP by regulating development exempt from municipal regulation like state buildings and transportation projects, public utilities and agricultural and silvicultural activities. The rule creates "No adverse impact" procedures and standards that prohibits development (e.g., roads, buildings, berms) that would change the height or velocity of floodwaters. The general permit is now finalized, as are Memoranda of Understanding with the VT AAFM and VTrans.

## Shoreland Protection and Water Quality Protection Acts

Activities that protect and improve water quality often go hand-in-hand with sinking, slowing and spreading stormwater which reduces the impact of flooding. Communities, RPCs, the Vermont Legislature and state agencies have been working together to develop and implement legislation that reduces velocity of flood waters and improves water quality.

The Shoreland Protection Act went into effect July 1, 2014. It regulates development along lakeshores and limits clearing of vegetation and the creation of new impervious areas near lakes, ponds and reservoirs with a surface area of greater than 10 acres. This law is intended to protect water quality, preserve habitat and natural shoreline stability and protect the economic and recreation benefits of lakes and their shores.

**Figure 5.3: Governor Shumlin Signing the Shoreland Protection Act into Law**

In June 2015, the Governor signed the Water Quality Protection Act into law that is designed to curb stormwater runoff into Vermont's waterways and create a new municipal roads permit and program to fund local stormwater and erosion controls. The law also establishes the State Clean Water Fund that raises $5.3M to improve river, river corridor, floodplain, and stormwater management practices that reduce flood hazards. A broad array of groups are working closely to ensure flood protection and water quality goals are aligned and achieved with this new statute.

## Strengthen Communication and Coordination

Tools, guides, manuals, projects are for naught if there is duplication of effort, organizations are working in silos and decision makers do not know where to find information and support. Response and recovery efforts after Tropical Storm Irene clarified the need for cross-collaboration, understanding partner needs, goals and language and coordinated strategies that met multiple objectives. Those lessons after Tropical Storm Irene were not forgotten and state agencies have been working to effectively communicate and collaborate. Results include the following:

### Information Easy to Access: Flood Ready Vermont

Led by VT ANR, other state agencies, communities, RPCs and others worked on develop the 'Flood Ready Vermont' website to provide a site where communities could find the information, tools and guidance to help them develop in safer places, protect the functions of watersheds that provide protection, adapt critical infrastructure and prepare for emergencies (www.floodready.vermont.gov). The site includes information on the cost of flooding, how to conduct a community risk assessment or update your plan, funding availability and tools to update infrastructure or project floodplains.

## Roads and Rivers Training

After Tropical Storm Irene, roads were being repaired by VTrans and rivers stability evaluated by VT ANR. Often this work was not done in partnership with an understanding of each other's goals and needs. In an effort to improve this understanding, the state launched the 'Roads and Rivers' Training Program which incorporates education on design and construction techniques that reduce flood risks and vulnerabilities into road projects. The curriculum offers three levels of training - introductory, intermediate, and advanced - for state and municipal staff, RPCs, private engineers and equipment operators. Level One is a desktop version that introduces river health and fluvial erosion concepts and is available on-line (http://wsmd.vt.gov/rivers/roadstraining/). Level Two combines classroom and fieldwork and demonstrates how model designs and maintenance practices can reduce river impacts, future flooding and erosion. Level Three trains VTrans designers in river science so they too can understand how to interpret and apply best practices when VT ANR are understaffed after a disaster. The program is now in its third year and to date has trained over 423 municipal and state staff and private engineers and operators.

**Figure 5.4: Road and Rivers Training Program**

## Targeting Rebuilding and Mitigation Investments Together

The scale and devastation of Tropical Storm Irene to Vermont's business, infrastructure and individuals was massive for a small rural state. State agencies along with our local, regional and statewide partners realized the imperative of working together to integrate and target funding that helped rebuild the state quickly, but also reduced the risk of future flooding. Thus, the state partnered with local, regional, state and federal organizations to help communities rebuild infrastructure, restore services and assist residents and businesses rebuild.

Two major sources of rebuilding and mitigation funding were the $23 million in Hazard Mitigation Grants from FEMA and the $40 million of US Housing and Urban Development's Community Development Block Grant- Disaster Recovery allocation. VT DEMHS and VT DHCD oversaw these funding sources and worked together along with VHCB, the Vermont Community Foundation, local philanthropic organizations and others to ensure funds were maximized and state recovery goals met.

Together they provided business grants and loans to help them recover from flood damages and keep their doors open. Municipalities received funding or planning grants to:

- Move municipal buildings and services out of the floodplain.
- Buyout of 136 homes and commercial properties, restoring floodplain access and creating more than a dozen new river access points and recreation areas.
- Build replacement affordable housing for 82 households in Brattleboro and Waterbury.
- Assist nearly two dozen communities with infrastructure improvements for increased resilience- including up-sizing culverts and bridges and protecting roads from further erosion, installing storm-water management systems, repairing and floodproofing buildings, relocating roads away from rivers, repairing a flood control dam and installing municipal sewer/ water to replace onsite services that washed away.

- Prepare for the future, by obtaining detailed elevation data and studying key transportation infrastructure and treatment options for vulnerable sites along the Mad and Winooski Rivers.

- Analyze risk of natural disaster to every mobile home park in the state and funding the development of emergency plans for park residents.

Funding supported a wide range of projects and plans to reduce the cost and impact of future disasters and efforts to work together to target funding and project to increase our resilience. Other initiatives, led by diverse organizations and stakeholders, built upon this collaborative approach (see Figure 5.6).

**Figure 5.5: Stafford Hill Solar Farm Increases Vermont's Safety and Resilience**


An innovative public-private partnership between the U.S. Department of Energy, the State of Vermont, GMP and Dynapower recently installed the first microgrid powered solely by solar and battery back-up. The project's 4 megawatts of battery storage maintains critical services to a nearby high school that serves as an emergency shelter when the grid goes down. Recently, GMP announced a partnership to create clusters of self-sustaining microgrids that are more resilient than the existing power distribution system that depends on a vulnerable network of poles and wires.

## Improve Response and Preparedness

Vermont has experienced flooding in every year since 2007, and has had at least one federally-declared disaster in 21 of the past 25 years. Vermont does not have resources to mitigate and anticipate every risk, therefore a strong emergency management network of local, regional and state partners are key part of the state's ongoing work to plan, prepare, respond and quickly recover from disasters and other and other disruptions.

## Assisting Businesses Planning

In the wake of Tropical Strom Irene is was clear that many of Vermont's small businesses lacked plans and resources to help them withstand serious weather-related disasters and extended power or other service outages. Vermont learned that the most effective way for towns and businesses to recover and rebound from disasters is to plan ahead. As 96.5% of Vermont's employers are small businesses, Vermont's Small Business Development Centers, RPCs and RDCs provide regional trainings and one-on-one services to support business disaster planning, preparedness and recovery planning. In September 2015, local, state and federal partners, including FEMA, are sponsoring a statewide training to help more of Vermont's small businesses write continuity of operations plans (COOP). Participants will leave the training with a business continuity plan and training on how to use it before and during disruptions as well as a list of local, state and federal resources to help them re-open and get back to business faster the next time a crisis occurs.

## Updating and Testing Emergency Preparedness Plans

Training and preparation is key to successfully navigating any natural disaster. After Tropical Storm Irene, state agencies, led by VT DEMHS, worked to strengthen our preparedness and response. Vermont participates in Emergency Management Assistance Compact (EMAC) to promote intergovernmental coordination, training and the sharing of resources during natural and man-made disasters. Since Tropical Storm Irene, state agencies have been more active and involved in EMAC.

In 2013, state agencies and regional and local partners collaborated to update the State Emergency Operations Plan (SEOP) that describes Vermont's plans and capacity to respond to emergencies resulting from all identified hazards. VT ACCD is responsible for recovery in the areas of economic development, community development and historic and cultural resources. Lessons learned and updates were included in the SEOP update to ensure that experience and updated procedures were captured and not lost.

Planning is underway for July 2016 Vigilant Guard – a simulated disaster to help the National Guard, states, state agencies, regional planning commissions, cities, towns, utilities, first responders and others practice, test and refine their emergency plans, procedures and operations.

## Integrating Data Gathering with Emergency Management

In 2014, Vermont implemented and provided statewide training on emergency operations and updated DisasterLAN (DLAN), a web-based tool that gathers and shares information to help the emergency operations center teams work as quickly and efficiently as possible. The state continues to develop, train, and implement the incident command process model to manage emergencies and trained the State Rapid Assessment and Assistance Teams (S-RAAT) to assess disaster damages and report immediate impacts to health and safety, homes, and critical infrastructure.

All VTrans, VT AAFM and RPC staff have now received basic training on the Incident Command System and senior managers and operation staff have received more advance training. Town staff are also receiving training. The state also launched the "Local Liaison" program, allowing towns to work directly with their RPC and VTrans district staff following a disaster to report initial damage information.

During Tropical Storm Irene, there was no centralized source of information on businesses and land owners that were impacted and thus, could not aggregate recovery need and track progress. VT DHCD working with VT AAFM, VT DEMHS, local and regional partners collaborated to develop and train field staff on the Business, Agricultural, Cultural and Historic Resources Damage Assessment (BACH-DA) tool. This is a web-based assessment forum that gathers information on damage from businesses, farms and historic and cultural resources in one centralized database. The training and tool is designed to improve communication and coordination of support after an event and ensure those impacted have information on recovery resources.

### Improving Response Time

Examples of the state's ongoing commitment to deliver better results through collaboration and information sharing, include:

- A rapid response joint field task force of river engineers, scientists, and restoration specialists to deploy along with transportation engineers and RPC staff in the immediate aftermath of a flood disaster to provide regulatory, technical and administrative assistance for in-stream reconstruction projects to ensure they are incorporating design measures that increase flood resilience.

- The VT-Alert system, an all hazards alert and notification system to assure people accurate and up-to-date information when disasters strike. The system shares information about severe weather warnings, significant highway closures, hazardous materials spills, the response actions of local and state agencies, and if needed, recommends protective actions to protect life and property. Information is shared via web, email, and cell phones for those who sign up.

## Next Steps: Implementing VERI through Partnerships

While this first phase of the VERI projects has helped identify and focus funding needs to ensure a strong economy, resilient to flooding, to be truly successful project recommendations need to be prioritized and funded. During the response and recovery phase, the Irene Recovery Office supported an interagency effort to coordinate recovery work across state agencies, RPCs and non-profit partners that clearly demonstrated the benefits of collaboration. This same strategy of partnership is being employed with the funding and implementation phase of VERI.

Currently the agencies are collaborating on developing the next iteration of the State Hazard Mitigation Plan, due to be completed by November 2018, which will support integration of VERI's methodology and recommendations including:

- Prioritizing state funding for local infrastructure projects and maintenance practices that strengthen the transportation network.

- Creating a strategic plan that identifies and targets high risk properties to buyout and critical floodplain to conserve.
- Establishing a dedicated fund to support the purchase of hazard-prone properties that are at high risk but are not eligible for funding through FEMA or other programs.
- Creating grant and loan funding criteria to ensure that all new construction takes place outside the designated floodplain, river corridor and repetitive loss areas.
- Integrating the "no adverse impact" development standard across state policies and programs, and encouraging municipalities to adopt the same standards through regulation, education and financial incentives.
- Designating pilot "adaptation areas" and directing public investments into those areas.
- Developing private and public funding sources to floodproof and elevate commercial and residential properties.
- Assessing state and non-state programs and economic development investment decisions to determine the degree to which they support long-term recovery goals to reduce vulnerabilities.

The state is committed collaborating to support the VERI communities' implementation of local programs as part of a comprehensive strategy to reduce the state's flood risks.

- The Resilient Vermont Project, a joint effort between the State of Vermont and the Institute for Sustainable Communities (ISC), developed a number of priority recommendations to reduce the state's flood vulnerabilities – one was to create "Vermont Strong Network" a cross-sector collaboration that includes nonprofit, public and private organizations involved in resilience work to align efforts, share best practices, and leverage resources to advance resilience efforts statewide. The network is currently working to support VERI's recommendations and identify an expanded partnership network for implementing and supporting community priorities.

- High Meadows and the Vermont Community Foundation have launched a new statewide pilot program called Community Resilience Organizations, that aims to create local teams and help them identify actions that would benefit from broader community engagement, such as developing emergency and continuity of operations plans for business, completing stream bank plantings, or training local officials and volunteers on their emergency operations plans.

VERI built upon the relationships developed and strengthened during the recovery – and brought together state, regional and local partners to create a new model to help towns identify changes and investments needed to break the cycle of repetitive loss, speed post-disaster economic recovery and reduce the long-term financial burden of disasters on impacted communities, businesses, and individuals. VERI showed businesses and communities that the state is concerned with their welfare and it expanded the capacity of public officials to make policy changes and take steps to implement identified critical infrastructure improvement to ensure their economic viability in the years to come.

## Resources

- Department of Housing and Community Development, State of Vermont (October 2012). Community Recovery Partnership Report. The Report can be found at: http://accd.vermont.gov/sites/accd/files/Documents/strongcommunities/cpr/CRP_Report10_2012_F.pdf

- Smith, Gavin. Coastal Hazards Center, University of North Carolina at Chapel Hill (2014). Vermont State Agency Policy Options. Smart Growth Implementation Assistance Program: Disaster Recovery and Long-Term Resilience Planning in Vermont. Funded by US EPA and FEMA. The Report can be found at: http://accd.vermont.gov/sites/accd/files/Documents/strongcommunities/cpr/VT-StateAgencyPolicyOptionsFINAL_web.pdf

- Institute for Sustainable Communities (2014). Vermont's Roadmap to Resilience: Preparing for Natural Disasters and the Effects of Climate Change in the Green Mountain State. Link to the report can be found at: http://www.iscvt.org/wp-content/uploads/2014/06/vermonts-roadmap-to-resilience-web.pdf

EPA United States Environmental Protection Agency

Smart Growth IMPLEMENTATION ASSISTANCE

# Flood Resilience Checklist

Is your community prepared for a possible flood? Completing this flood resilience checklist can help you begin to answer that question. This checklist was developed as part of the U.S. Environmental Protection Agency's Smart Growth Implementation Assistance project in the state of Vermont. More information about the project can be found by reading the full report, *Planning for Flood Recovery and Long-Term Resilience in Vermont*, found online at www.epa.gov/smartgrowth/sgia_communities.htm#rec1.

## What is the Flood Resilience Checklist?

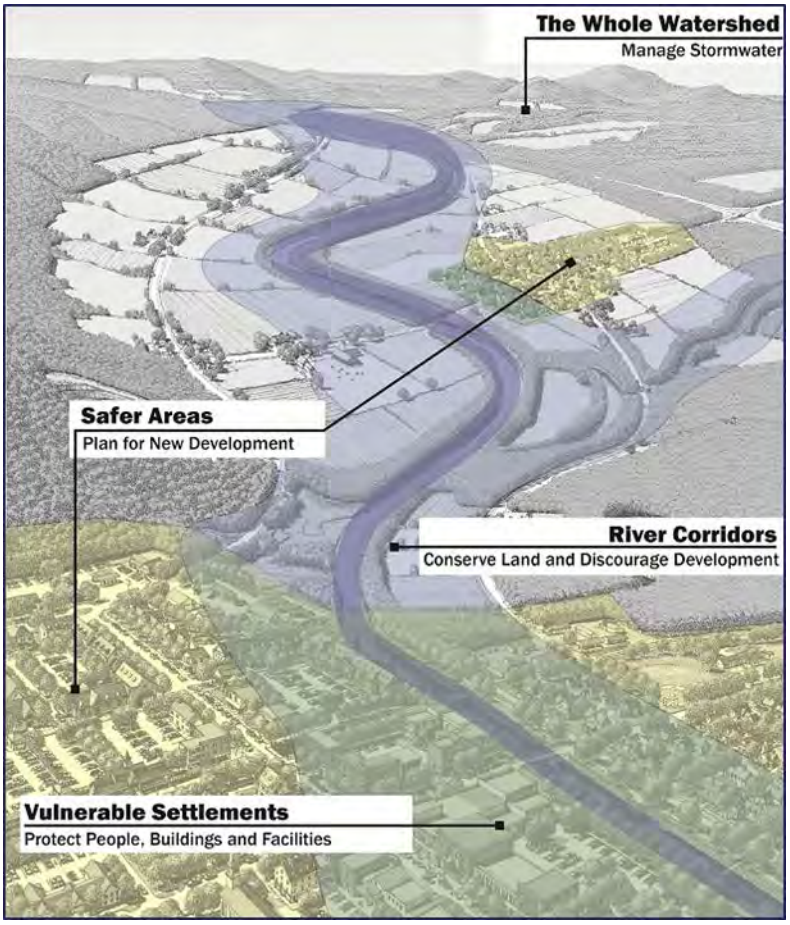
This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

## Who should use it?

This checklist can help communities identify opportunities to improve their resilience to future floods through policy and regulatory tools, including comprehensive plans, Hazard Mitigation Plans, local land use codes and regulations, and non-regulatory programs implemented at the local level. Local government departments such as community planning, public works, and emergency services; elected and appointed local officials; and other community organizations and nonprofits can use the checklist to assess their community's readiness to prepare for, deal with, and recover from floods.

## Why is it important?

Completing this checklist is the first step in assessing how well a community is positioned to avoid and/or reduce flood damage and to recover from floods. If a community is not yet using some of the strategies listed in the checklist and would like to, the policy options and resources listed in the *Planning for Flood Recovery and Long-Term Resilience in Vermont* report can provide ideas for how to begin implementing these approaches.



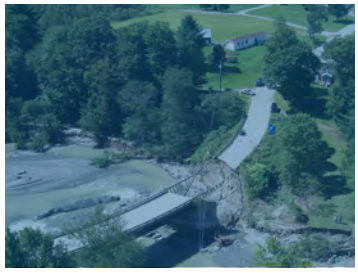

*This graphic illustrates the four categories of approaches to enhance resilience to future floods. Credit: Vermont Agency of Commerce and Community Development.*

| FLOOD RESILIENCE CHECKLIST | | |
|---|---|---|
| 3. Does the community require developers who are rebuilding in flood-prone locations to add additional flood storage capacity in any new redevelopment projects such as adding new parks and open space and allowing space along the river's edge for the river to move during high-water events? | ☐ Yes | ☐ No |
| 4. Is the community planning for development (e.g., parks, river-based recreation) along the river's edge that will help connect people to the river AND accommodate water during floods? | ☐ Yes | ☐ No |
| 5. Does the comprehensive plan or Hazard Mitigation Plan discuss strategies to determine whether to relocate structures that have been repeatedly flooded, including identifying an equitable approach for community involvement in relocation decisions and potential funding sources (e.g., funds from FEMA, stormwater utility, or special assessment district)? | ☐ Yes | ☐ No |
| **Plan for and Encourage New Development in Safer Areas**<br>(Learn more in Section 3.C, pp. 26-27 of<br>*Planning for Flood Recovery and Long-Term Resilience in Vermont*) | | |
| 1. Does the local comprehensive plan or Hazard Mitigation Plan clearly identify safer growth areas in the community? | ☐ Yes | ☐ No |
| 2. Has the community adopted policies to encourage development in these areas? | ☐ Yes | ☐ No |
| 3. Has the community planned for new development in safer areas to ensure that it is compact, walkable, and has a variety of uses? | ☐ Yes | ☐ No |
| 4. Has the community changed their land use codes and regulations to allow for this type of development? | ☐ Yes | ☐ No |
| 5. Have land development regulations been audited to ensure that development in safer areas meets the community's needs for off-street parking requirements, building height and density, front-yard setbacks and that these regulations do not unintentionally inhibit development in these areas? | ☐ Yes | ☐ No |
| 6. Do capital improvement plans and budgets support development in preferred safer growth areas (e.g., through investment in wastewater treatment facilities and roads)? | ☐ Yes | ☐ No |
| 7. Have building codes been upgraded to promote more flood-resistant building in safer locations? | ☐ Yes | ☐ No |

# FLOOD RESILIENCE CHECKLIST

**Implement Stormwater Management Techniques throughout the Whole Watershed**
(Learn more in Section 3.D, pp. 27-31 of *Planning for Flood Recovery and Long-Term Resilience in Vermont*)

| | | |
|---|---|---|
| 1. Has the community coordinated with neighboring jurisdictions to explore a watershed-wide approach to stormwater management? | ☐ Yes | ☐ No |
| 2. Has the community developed a stormwater utility to serve as a funding source for stormwater management activities? | ☐ Yes | ☐ No |
| 3. Has the community implemented strategies to reduce stormwater runoff from roads, driveways, and parking lots? | ☐ Yes | ☐ No |
| 4. Do stormwater management regulations apply to areas beyond those that are regulated by federal or state stormwater regulations? | ☐ Yes | ☐ No |
| 5. Do stormwater management regulations encourage the use of green infrastructure techniques? | ☐ Yes | ☐ No |
| 6. Has the community adopted tree protection measures? | ☐ Yes | ☐ No |
| 7. Has the community adopted steep slope development regulations? | ☐ Yes | ☐ No |
| 8. Has the community adopted riparian and wetland buffer requirements? | ☐ Yes | ☐ No |



# Chapter 6

## Tools for Weathering the Storm

## Overview

This chapter provides an 'à la carte' mix of 101 overviews, guidance and more advanced tools that communities and businesses can use to weather the next storm. Documents are grouped into the following categories: floodproofing, managing debris, reducing stormwater with green infrastructure, protecting floodplain river corridors, planning and preparing for disasters and were developed based on the needs identified in the five VERI communities.

## Tools You Can Use

| Topic | Tools for Businesses | Tools for Municipalities | Tools for Individuals |
|---|---|---|---|
| **Floodproofing** | | | |
| • Floodproofing for Business | ✓ | | ✓ |
| • Floodproofing Regulations for Municipalities | | ✓ | |
| • Case Studies | ✓ | ✓ | ✓ |
| **Managing Debris** | | | |
| • Dealing with Debris 101 | ✓ | ✓ | ✓ |
| • Reducing Disaster Debris | ✓ | | ✓ |
| • Debris Management Plans | | ✓ | |
| **Reducing Stormwater with Green Infrastructure** | | | |
| • Green Infrastructure 101 | ✓ | ✓ | |
| • Green Landscaping | ✓ | ✓ | ✓ |
| • Policies to Promote Green Infrastructure | | ✓ | |
| **Protecting Floodplain River Corridors** | | | |
| • River Corridor Protection 101 | ✓ | ✓ | ✓ |
| • River Corridor Protection – Regulatory | | ✓ | |
| • River Corridor Protection – Non Regulatory | | ✓ | |
| **Planning and Preparing for Disasters** | | | |
| • Preparation Matters for Municipalities | | ✓ | |
| • Preparation Matters for Businesses | ✓ | | |

# Wet and Dry Floodproofing for Business

While it is a "best practice" to locate your business outside flood-prone areas, in most Vermont communities it's not practical or possible to locate or move a business to a flood safe location. In these cases, there are a range of floodproofing options to consider. Floodproofing typically involves a combination of building modifications and site improvements to reduce flood damage. While floodproofing does not eliminate all flood risks, it can help reduce the risk to a manageable level and may reduce insurance premiums.

## Why it Matters

Flooding can occur anywhere with little or no warning and with devastating effects. In fact, every Vermont town has experienced flooding and the state has had least one federally-declared disaster in 21 of the past 25 years. Given these odds, business should take a proactive role in understanding the risks and exploring floodproofing options as a way to reduce the odds and severity of future flood damages and to enable flooded businesses to recover and resume operations sooner.

## Floodproofing Options to Protect Buildings

There are a number of ways to protect your property from flood damage, reduce losses and bounce back more quickly.

- **Elevate Your Building**
  In some cases, the most effective way to reduce or avoid flood damage is elevate the habitable part of the building. Elevation involves raising a building in place so that the habitable space is located above the anticipated height of flood waters. Buildings are lifted off their foundations with hydraulic jacks and then replaced on top of a new or extended foundation. Obviously, lighter wood-frame buildings are easier and often cheaper to raise than masonry buildings. To account for flash flooding or higher than expected flooding levels, experts recommend increasing the safety margin against flood damage by raising the building elevations more than one foot above FEMA's Base Flood Elevation (BFE) the location.

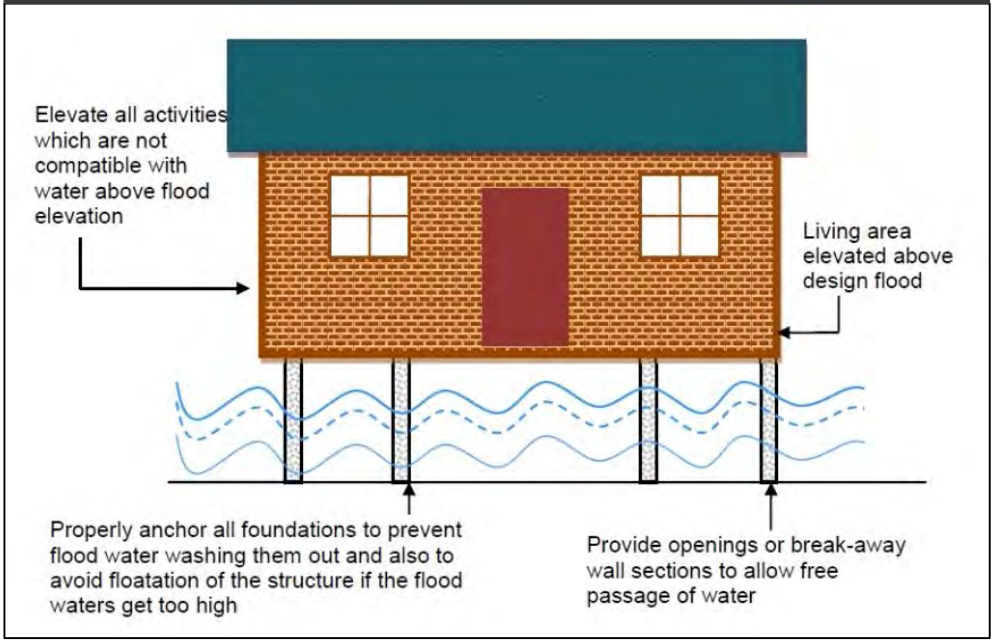
**DEFINITION**

Base Flood Elevation (BFE) is the calculated elevation to which floodwater is anticipated to rise during the base flood. BFEs are shown on Flood Insurance Rate Maps (FIRMs) and on the flood profiles. The BFE is the regulatory requirement for the elevation or floodproofing of building. The relationship between the BFE and a building's elevation determines the flood insurance premium.

## Wet Floodproof Your Building

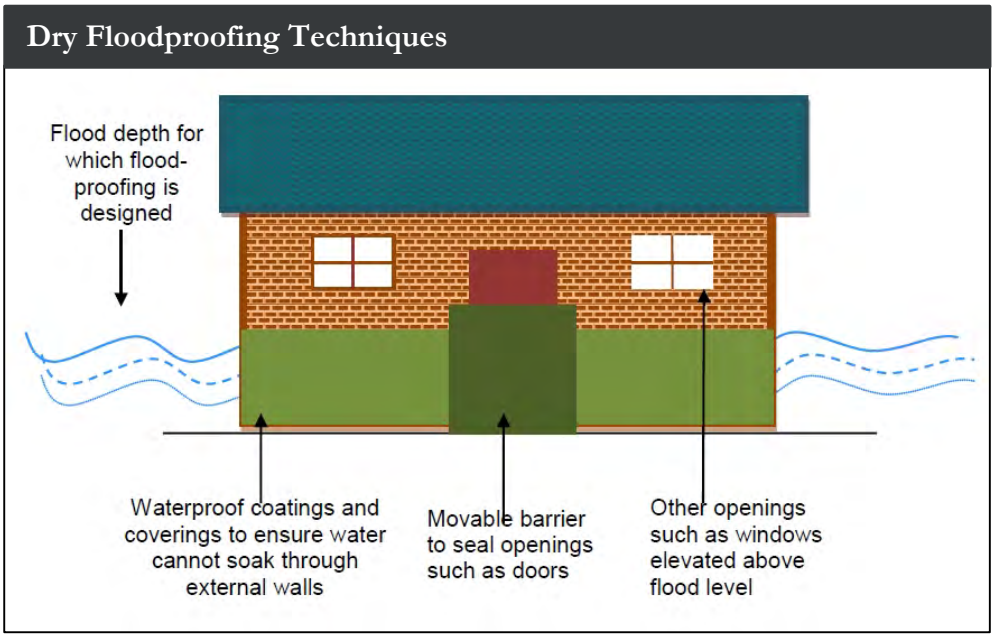
Wet floodproofing includes a variety of techniques that allow flood water to enter a building without damage to the building and its contents. Buildings must be anchored to the foundation and must have flood vents, or permanent openings, that allow water to flow in and out of the building without damaging the foundation. Vulnerable items, such as utilities, equipment and inventory are typically relocated to higher parts of the building or protected in place. Building materials resistant to flood damage, such as concrete and gypsum wallboard are used for those parts of the building that will be flooded. Automatic shut-off valves are installed on sewer and fuel lines and well casings are sealed to protect them from contamination. Fuel and propane tanks are also anchored to prevent them from being swept away and potentially creating additional damages to the property or downstream.

**Wet Floodproofing Techniques**




## Dry Floodproof Your Building

Sealing a building to prevent water from entering is called "dry floodproofing." Dry floodproofing involves sealing building walls with waterproof materials or coatings to make the building watertight. This technique can only be used when the walls and foundation floor are strong enough to withstand the pressure and strength of the floodwaters. Removable barriers are installed to seal off doors, windows, and other openings to keep the water out. An interior drainage system must also be installed to collect water that leaks through the water barrier materials and shields. This system typically requires a sump pump and a portable generator to allow operation during a power failure. It may only be suitable for heavy masonry buildings constructed of block, brick or reinforced concrete and is usually only used for non-residential buildings. For a margin of safety, a standard dry floodproofing design typically extends at least one to two feet above FEMA's Base Flood Elevation (BFE) for the location.




- **Protect Your Basement**
  Even if the building is above the BFE or outside the floodplain, basements are prone to floods because water may flow into them. When the surrounding ground is saturated with water, basements may become wet from the increased water pressure exerted upon them. There are a number of additional measures business owners can take to reduce the likelihood and scope of basement flood damage. These include inspecting your basement for water leakage or entry, and correcting potential problems, such as re-grading the land to slope away from the building or caulking cracks, installing a sump pump or installing automatic shutoff valves on wastewater or other building infrastructure. It is critically important not to store valuable equipment, documents, or inventory in any crawlspace or basement where flooding is possible.

- **Buyouts and Demolition**
  While not as common as the other options, removing flood-prone building and relocating a business to a flood-safe location is a permanent solution to a flooding problem. This is most often done after a major flood as an alternative to costly repairs. State and federal grant funding for a "buyout" may be available to cover some of the costs.

## Got Flood Insurance?

Careful implementation of the strategies above may qualify a business for lower insurance rates and premiums. While insurance does not prevent flood damage, it can protect your financial investment. Annual premiums for flood insurance can be expensive, and costs vary depending on the location, age, and elevation of the building. Nevertheless, the investment in insurance and the improvements necessary to be eligible for lower rates may significantly reduce your financial burden when flood damage occurs.

The National Flood Insurance Program (NFIP) coverage limits are up to $500,000 for a commercial building, and up to $500,000 to protect its contents. Additional insurance coverage for business interruption and may also be purchased to minimize losses and help speed business recovery. The best way to learn more about flood and other insurance benefits, costs, and options is to contact your insurance agent.

## Next Steps

Developing an appropriate strategy for protecting your business from flood hazards requires evaluation of the risks, technical considerations, costs, and personal preferences.

- **Local Floodplain Regulations:** Consult with your city or town planning or zoning officials, as well as consultation with VT Floodplain Program staff about local regulations and floodproofing options. If an existing building in the regulated floodplain has been deemed to have "substantial damage" after a flood or construction is proposed that would be a "substantial improvement" (costing more than 50% of the value of the building), regulations require that the entire building be brought into compliance with current floodplain development standards. Those standards typically require the floodproofing techniques outlined above. Other regulations may also apply to the project.
- **Assess the hazards and identify options:** A building owner should hire a professional engineer or architect who can help them determine what floodproofing options are feasible for their building. An owner should also consider the amount of warning time need to deploy various protective measures. For example, buildings in areas prone to sudden flash flooding may not be a good candidate for dry floodproofing because of the time required to prepare the barriers to repel the flood waters.
- **Assess the costs and benefits:** Some floodproofing options may be too costly and others may not provide the desired amount of risk reduction. The decision regarding a floodproofing project must also be based on the personal preferences and potential day-to-day impacts to the business. Other considerations in determining the type and extent of floodproofing include: safety of customers and employees, the amount of time it would take to get the business back up and running after a flood, the effect on flood insurance rates, ADA accessibility of the building, whether the structure is a considered to be a bona-fide historic structure and the time and staffing required to deploy flood protection measures.

As noted on the previous page, a building owner should hire a professional engineer or architect who can help them determine what floodproofing options are feasible for their building. They can also help the owner select a knowledgeable contractor and certify important application materials that can reduce insurance premiums.

## Funding Options

- **Hazard Mitigation Grants**: Private buildings and facilities are eligible for grants to floodproof buildings. HMGP grants cover 75% of a project's cost and 25% of the work may be matched through donated hours or materials.
- **Vermont Economic Development Authority Emergency Flood Assistance Loan Program**: In the wake of disasters, VEDA often offers emergency loans to replace furnaces and other machinery and equipment and repair of structural damage and other costs directly related to flood damage.
- **Small Business Administration Disaster Loan**: Businesses of any size and most private non-profit organizations can apply for Business Physical Disaster Loans to cover disaster losses not fully covered by insurance. Floodproofing improvements are eligible costs.

# Floodproofing Regulations for Municipalities

There are a number of ways cities and towns can reduce damages and losses and help its citizens reduce their risks, save money and bounce back more quickly from flooding. Most Vermont communities have regulations and standards in place to floodproof buildings and infrastructure.

## Why it Matters

Flooding causes the largest annual disaster costs in Vermont. From tropic storm Irene alone, local and state costs were $153 million with an additional $603 million in federal outlays. In a number of communities, roads, bridges and critical facilities are located in or near areas vulnerable to flooding. Municipal regulations that require vulnerable buildings to be flood proofed when they are improved can help reduce the costs of flood damage to individuals, organizations and governments.

## Floodproofing Options to Protect Buildings

Municipalities participating in the National Flood Insurance Program (NFIP) must adopt and enforce floodplain management and floodproofing regulations that meet or exceed the minimum NFIP standards and requirements. The NFIP establishes design criteria and performance requirements for buildings located within the Special Flood Hazard Area (SFHA). The criteria specify how a building will be constructed in order to minimize or reduce future flood damage. A primary requirement is to elevate buildings above the Base Flood Elevation (BFE). Depending on the location, non-residential buildings may also be protected with wet or dry floodproofing measures (see floodproofing techniques for business)

### NFIP General Requirements for Dry Floodproofing

- Permitted only in non-residential buildings in special flood hazard areas.
- Must be designed so the building is watertight below the BFE with walls substantially impermeable to floodwater.

## DEFINITION

**Special Flood Hazard Area** (SHFA) is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also referred to as the base flood). SFHAs are useful tools for identifying the risk associated with the inundation of floodwater. However, the potential for flood damage due to bank erosion, inadequate drainage, runoff, and storms larger than the base flood are not taken into account on these maps. To fill this gap in flood risks, the state has developed River Corridor maps that show the community's risk of flood damage due to erosion. Municipalities have the option of enacting local regulations that are more restrictive than the minimum NFIP requirements. For example, a municipality may prohibit new development within the state-designated River Corridor.

- Must completely floodproof utilities and sewer lines below the BFE.
- A registered design professional must develop and/or review structural designs, specifications, and plans and certify that the design and methods of construction are in accordance with accepted standards of practice.
- Dry floodproofed properties are eligible for favorable insurance rates only if floodproofing extends to at least 1 foot above the BFE.

**NFIP General Requirements for Wet Floodproofing**

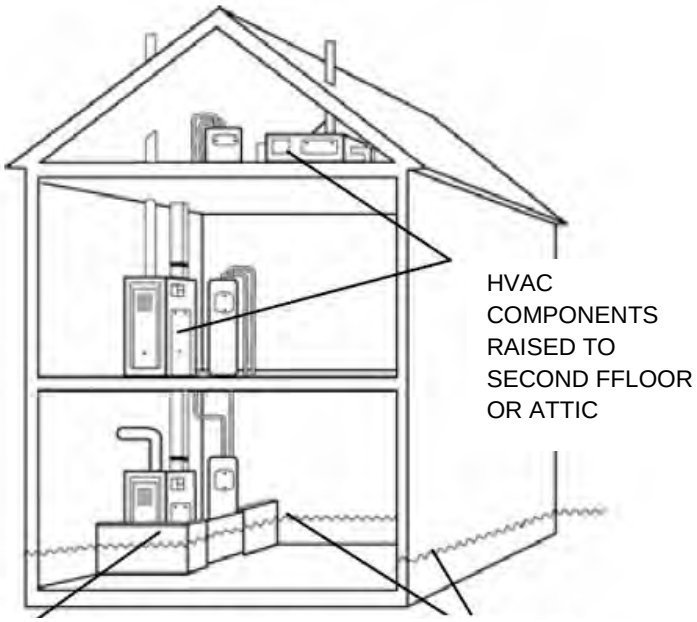
- Permitted only for attached garages or parking, access, and storage areas below the BFE.
- Some historic buildings, outbuildings, and agricultural buildings may be wet floodproofed.
- All portions of the structure below the BFE must be constructed of flood-resistant materials.
- Must be designed to allow for automatic entry and exit of floodwaters.

**DEFINITION**

**Base Flood Elevation** (BFE) is the calculated elevation to which floodwater is anticipated to rise during the base flood. BFEs are shown on Flood Insurance Rate Maps (FIRMs) and on the flood profiles. The BFE is the regulatory requirement for the elevation or floodproofing of building. The relationship between the BFE and a building's elevation determines the flood insurance premium.

## Bylaws

Most Vermont municipalities meet the NFIP requirements with a special purpose floodplain ordinance. These are often part of the zoning bylaw but can also be stand-alone regulations for towns without zoning. The state has created several variations of model flood hazard regulations that municipalities can adapt to their particular circumstances. All include the minimum floodproofing requirements but range in the degree of administrative complexity and the level of regulation imposed on new development. The Vermont Rivers Program or your Regional Planning Commission (RPC) can help develop and review your ordinance for NFIP compliance.




## Building Codes

Adopting building code requirements for structures built or reconstructed in or near flood plains can help protect structures and people. In Vermont, the state administers building codes for commercial buildings and multi-family housing, but not for single family homes. The state also allows municipalities to have stricter building codes than what the state requires and allows municipalities to adopt codes for single family homes.

Municipalities that have adopted building codes and have the resources to administer such codes effectively should consider upgrading their standards to provide an extra margin of safety from flood damage. The International Building Code and International Residential Code, which most state building codes adopt or use as a foundation, requires higher design and construction standards for flood-prone areas.

# Burnham Hall
## Lincoln, Vermont
## Dry Floodproofing Case Study

### Overview

Burnham Hall, Lincoln, Vermont's community center, was built in the 1920s within 10 feet of the New Haven River. On average, it has flooded once every 12 years. In 1998, after the hall flooded with over five feet of water, the library had to be relocated. As the waterlogged books were being moved from the lower floor, Harriet Brown, a long-time Lincoln resident, rallied the community to support a project to protect Burnham Hall from future floods.

A volunteer community group obtained a grant from the Agency of Natural Resources to study how to relocate or retrofit the building. The goal was to "live with the river for the next 100 years." After reviewing the report, the committee decided to incorporate floodproofing techniques with a Hazard Mitigation grant from the State of Vermont and the Federal Emergency Management Agency (FEMA).

### Pre-Disaster Mitigation Measures

Fifteen tasks were completed to protect Burnham Hall from future floods. The work was done between 2006 and 2009, at a cost of approximately $425,000. These tasks included the following:

- Relocation of the furnace and hot water heating system to the attic.
- Replacement of electrical wiring with water resistant cable to withstand floodwaters.
- Replacement of interior insulation and wallboard with water resistant materials.
- Inclusion of drain notches in the sill plates.
- Replacement of the heaters with cast iron radiators.
- Replacement of the kitchen components with flood-proof parts.
- Installation of watertight barriers on windows and doors on a temporary basis to keep out water during a flood. The barrier system is designed for a maximum flood water depth of seven feet.
- Construction of a stairway between the lower and upper floors, and the attic, where the furnace had been relocated.

- Individual planks, weighing approximately 15 pounds each, are carried to and installed at each window or door site.
- Sealing of holes made for utilities - electricity, telephone, and fuel – where water can enter.
- Installation of a backflow valve in the septic line to prevent flooding from the drainage system.
- Installation of pop-up valves in the floor to eliminate damage from water pressure under the floor to prevent it from buckling.
- Installation of a sump pump to collect water entering from the pop-up valves and leaks in the barriers and seals on the windows and doors.
- Installation of a discharge pump to help remove water during a flood.
- Installation of alternative electrical lines from the discharge pump to a back-up generator.
- Improvements to the river bank to protect the row of trees along the riverbank to decrease erosion and keep rushing water from striking the foundation.

On Saturday August 27th, Tropical Storm Irene headed for Vermont, with heavy rains and flash floods predicted for Lincoln. At 5:00 PM, it was still a sunny afternoon in Lincoln. A group of eleven community members spent 30 minutes to install the flood protection barriers over the windows and doors of Burnham Hall.

The rain arrived during the night and continued throughout Sunday at a fast and furious pace. Local rain gauges registered between six and eight inches of rain. The New Haven River rose quickly, flooding its banks, then the lawn of Burnham Hall, and finally up the walls to a level 47 inches above the first floor.

The planks held tight. Water and mud were kept out of the building. As the river raged by, the pressure of nearly four feet of water outside the building activated the pressure pop-up valves, and kept the floor from buckling upward. By design, a small amount of sand filtered water came in through these valves, and was easily handled by the sump pump system. Power failure during the afternoon, necessitated bringing a generator online to keep the sump pump operating. By Monday, the river receded, and clean up started.

Thanks to Mark G. Benz for providing the information for this case study.

# New England Youth Theater
## Brattleboro, Vermont
## Wet and Dry Floodproofing Case Study

### Overview


The New England Youth Theatre (NEYT) was designed and built in 2006. The building includes a renovated trucking facility and part new construction. It is a low-lying building located within the floodplain of the Whetstone Brook in Brattleboro, Vermont. In August 2005, just one year before construction began, Hurricane Katrina brought national attention to the inherent dangers of construction in flood prone areas.

Prompted by FEMA regulations, and with the encouragement of the NEYT Building Committee, the project design team, headed by Greenberg Associates Architects of Putney, took a number of measures to protect the building from flood damage. Those measures proved successful in the heavy flooding associated with Tropical Storm Irene.

### Pre-Disaster Mitigation Measures

The flood defenses of the building included five significant construction elements.

- **Floor resistant to hydrostatic pressure.** The floor of the newly constructed part of the building is an 11" thick concrete slab – heavy enough to resist buckling from rising groundwater. The weight of the concrete, plus specifically designed reinforcements, contribute to its strength. In the renovated portion of the building, 6" of concrete was added to the existing slab (with 2" of rigid insulation in between) for the same purpose. A reinforced sump pump was put into the floor to contain water entering the building when flood barriers were breached.
- **High perimeter wall.** The height of foundation wall was increased three feet above the floor slab. Fortunately, the original garage building also had a high foundation wall providing a flood barrier at that section of the building. The perimeter wall protects against high water. The riverbanks outside of this corner was also strengthened with heavy stones.
- **Impact protection.** The southwest corner, closest to the brook and facing upstream, was the most susceptible to impact from debris carried by a flooding river. All other flood control measures would be ineffective if the perimeter wall was damaged by a floating tree trunk. To reduce this threat, an eight ton block of concrete, reinforced with steel bars, was constructed into this corner of the building.

- **Water resistant materials.** A Dry floodproofing design technique assumes that some water may get in. Therefore, there is a need to reduce the damage if it does. To this end, all the gypsum wallboard – a material that absorbs water – was removed and cement board was installed one foot above floor level. The cement board retains its integrity when wet, and it does not wick water up into other parts of the wall, which often causes mildew.

- **Floodgates.** Finally, the five doorways had to be protected from floodwaters. The solution was inexpensive and effective: flood gates were made for each door, the gates consisting of ¼" thick aluminum sheets that slide into tracks at each side of the door frame, and tighten against gaskets with a set of thumbscrews. The gates are located inside rather than outside to allow the doors to swing outwards and let people out. And the doors themselves bear the brunt of the surging water, relieving the gates of most of the water pressure.

## Withstanding Tropical Storm Irene

Although the 20" high floodgates exceeded FEMA requirements by almost a foot, waters from the overflowing Whetstone Brook came to 4" from the top of the gates. NEYT is now considering raising the gates another 10" higher. While many of the control measures described above were built into the foundation of the building, floodgates like NEYT's can fairly easily be adapted into an existing building that has adequate foundation strength to resist infiltration of floodwaters. In those cases, this technique may be the best insurance against "the next one."

# Jenkauskas Farmhouse

## Jeffersonville, Vermont
## Wet Floodproofing Case Study

### Overview

Jean and Sean Jenkauskas are proud of their Jeffersonville farmhouse, built in 1825 and listed on the National Register of Historic Places. Before they bought it, their home had seen many uses, including a nursing home and apartment building. The couple was determined to return it to its original state as a single family home.

Repeated flooding got in the way of their dream. "Flooding changed our lifestyle," says Jean. After a flood destroyed their furnace in 1995, they received Federal Emergency Management Agency (FEMA) assistance and advice to make their home more floodproof.

### Pre-Flood Mitigation Measures

FEMA recommended they raise their utilities at least 14 inches above the base flood elevation. They raised their furnace and their utility panel six and five feet off the ground, respectively. In the kitchen, they raised the refrigerator six inches. They also elevated an antique dresser on plastic milk crates.

Warped drywall in the living room was replaced with concrete board, which resists mold better. Empty plastic containers stored in closets are used to safeguard precious photos and other keepsakes, at a moment's notice.

The Jenkauskases are especially proud of their latest floodproofing upgrade–the water heater in their first floor bathroom. They raised it 14 inches off the ground and decorated it with a wood-trimmed, removable façade.

### Withstanding Tropical Storm Irene

After years of planning and hard work, the Jenkauskases achieved their dream of restoring their historic house while also protecting it from future floods. When Tropical Storm Irene hit Vermont in late August 2011, the Jenkauskases received six and a half inches of floodwater on the first floor and it did not affect their utilities.

The Jenkauskases now always look for a new mitigation project. Says Jean: "There's always something more you can do."

Thanks to FEMA for providing this case study.

# Dealing with Debris 101

After the storm has passed and floodwaters recede, the debris that remains can cause serious pollution problems and poses risks to public health and safety. The complexities of removing, processing and disposing of various types of debris presents a tremendous challenge to people who are already stressed by disaster response. In places where debris repeatedly causes flooding by damming ditches, bridges and culverts, measures can be taken in advance of storm events to clear and remove obstructions during periods of high water.

## Why it Matters

Beyond the high cost of cleaning up debris after a major disaster, large amounts of debris can threaten public health and safety by harboring rodents and disease, pose fire hazards, increase exposure to contaminated solid and hazardous waste, jam waterways leading to greater flooding and block road access for emergency and repair vehicles, as well as those bringing vital supplies. Clean-up operations not only improve general sanitation but are important signals to the public that recovery and restoration is underway.

## How to Deal with Debris

The wide variety of debris that lands on property after a flood poses significant challenges for removal. Debris can include muck and mud, yard debris and fallen trees, appliances, building materials, spoiled food, dead livestock, hazardous waste, tanks/gas cylinders and more. As feasible, debris should be segregated at the points where it accumulates into the following categories to allow for proper size reduction, recycling, composting, or disposal of the particular waste stream:

- Vegetative waste
- Construction and demolition waste
- Household hazardous waste

## DEBRIS TEAMS – A STATE SOLUTION THAT WORKS

Debris was a hot topic following Tropical Storm Irene with questions ranging from what material to remove and how, to who is responsible for debris removal, to how to recover the expense and whether FEMA would cover removal costs. To complicate matters, the type of debris – gravel, woody, or building material – could impact the response and solution.

In order to help communities manage the questions of what to do with woody debris, the Agency of Natural Resources, in partnership with the Agency of Transportation, initiated 'Debris Teams' to assess streams that had woody debris and to answer questions on removal and the potential impacts on the community. Response times to requests were quick – teams generally arrived and responded in less than a week after a call. Most communities were concerned about debris causing future jamming of the waterway and subsequent flood damage so the team was able to evaluate and determine whether the debris was better left in place or removed.

- Municipal solid waste with obnoxious odors and capable of attracting animals
- Household appliances
- Scrap metal
- Soil, sediment, silt and sand
- Electronic waste (e-waste)

Separating the debris into these categories before moving it, can reduce cost and result in more efficient reuse and disposal. For example, keeping clean woody debris separate enables it to be chipped for mulch, processed for fuel, or converted into compost bulking agent. Once different types of debris become comingled, it is very difficult to separate them into clean, recyclable or reusable sub-components. The only option for mixed debris is landfill and disposal capacity in Vermont and throughout the Northeast United States is limited and expensive.

Individuals may be able to handle their own debris clean up if it can be removed by hand on small properties, but when large amounts of debris need to be removed, individuals will need to find private waste haulers and contractors with heavy equipment to do the work. Municipalities may also need to hire private haulers and contractors to assist with removing debris.

## Leaving Woody Debris in Streams

Fallen trees and other large woody debris can be beneficial to streams and rivers systems, as they increase the roughness of the stream channel that can slow rushing stormwater and reduce the water's power to damage stream beds and banks. In addition, large woody debris is important to fish habitat and provides critical ecological benefits. During major storms or in narrow confined valleys where damming from accumulated debris can create serious damage to roads and crossing structures, removing this type of debris may be necessary, but in most situations large woody debris should be left in place. Contact the Department of Environmental Conservation Rivers Management Engineer serving your area for advice on whether or not large wood, gravel and other natural debris should be removed from stream channels.

| DEBRIS REMOVAL | WHO IS RESPONSIBLE? |
|---|---|
| On private property | Individual Landowners |
| On local roads, rights-of-way and public buildings and facilities | Municipality |
| Planning for statewide debris management (Comprehensive Debris Management Annex to the VT State Emergency Operations Plan) | Agency of Natural Resources and Vermont Division of Emergency Management and Homeland Security |
| Planning for local debris removal | Municipality |
| Guidance on solid waste disposal | Your local Solid Waste Management District or ANR Solid Waste Management Division |
| Guidance and permits on removal of natural debris from streams and rivers | Vermont Department of Environmental Conservation Rivers Program |

Stream alteration statutes were changed after Irene to require an ANR approval for all instream debris removal activities involving more than 10 cubic yards of gravel and debris. For details see technical guidance on sediment and debris removal (pages 129-148) from the Rivers Program.

# Reducing Disaster Debris

Much of the debris that accumulates in flooded areas can be prevented. Anyone who lives or owns a business or property in locations vulnerable to flooding can help themselves and their community by taking simple measures to move, secure and avoid storing floatable objects in places that might flood and have a plan of action for safe removal of debris after the flood.

## Why it Matters

Debris removal on private property is the responsibility of individual landowners. The accumulation of debris at culverts, bridges or other potential choke points during a rainstorm can dam the flow of water and increase the area of flooding. This type of flooding can be prevented by keeping debris out of flood prone locations. Once the flood recedes, leaving piles of debris, clean-up can be costly, hazardous and complicated, so preparing in advance will speed recovery.

## How to Reduce and Remove Disaster Debris

Businesses and property owners can take some or all of the following measures to reduce the amount of debris that flows downstream in a flood and to speed recovery after.

**Property Management:** to reduce damage and debris

- Avoid dumping brush and other yard debris on river banks or near the water.
- Store bagged hay bales and other floatable objects outside the floodplain.
- Tie-down propane tanks and other types of fuel containers and fill both above and below ground tanks with fuel to avoid floating during a flood.
- Flood-proof any sheds or other outbuildings by:
  - Anchoring the structure.
  - Install flood vents to allow for automatic entry and exit of flood waters.
  - Use floodproof materials for lower portions of the structure likely to be inundated.

### TIPS

#### What to do with Woody Debris

Wood is likely to constitute the largest portion of the debris you need to handle after a flood. Clean, untreated, unpainted wood can be beneficially reused by piling it up on your property, cutting and using it for firewood, or chipping it for use in landscaping, compost or as biomass fuel. If you need to dispose of it, check with the municipality to see if they will establish temporary staging or storage areas for clean woody debris.

#### Stay Safe when Handling Chemicals

Handle chemicals carefully. Use gloves, eye protection and secure from children and pets. If leaking, place container in a pail. Do not mix chemicals or pour on the ground, in water or down the drain.

- Elevate or floodproof any electrical equipment.

- Fix eroding sections of gravel driveways to prevent washouts.

**Before a Storm:** things to do on your property

- Move vehicles to high ground.
- Secure any items stored in the yard.
- Inspect your driveway and culverts to remove any blockages.
- Fill underground and above-ground fuel tanks to reduce the likelihood they will move or pop out of the ground.

**After a Storm:** getting rid of debris safely and efficiently

- Document all damage and debris with a camera and notes before beginning removal.
- Contact your municipality or solid waste management district to see if they are making any arrangements for disposal of debris.
- Sort debris into the following categories:
  - Tree limbs, branches and other clean, untreated wood.
  - Everything else, except the items listed below can be disposed of in one container.
  - Contact your area solid waste district about disposal procedures for:
    - Dangerous wastes – toxics, pesticides, explosives, gasoline, pool chemicals, acids, drain cleaners, fireworks, flares, ammo and unprotected "sharps"
    - Car batteries and rechargeable batteries
    - Electronics
    - Hazardous Waste
    - Mercury products – fluorescent bulbs, thermostats, thermometers
    - Oil, brake cleaner and other toxic car products
    - Oil-based paint, stain, varnish, paint thinner/stripper
    - Propane cylinders, other gas cylinders
    - Tires
    - Large appliances (refrigerators, washers, etc.) and scrap metal

### AVOIDING FLOOD DAMAGE ON FARMS

In addition to the other preparations for a storm, farmers should consider taking the following measures for preventing flood debris and damages.

- Store hay bales in locations that do not flood – floating hay bales can plug bridges and culverts and cause flooding that may not occur otherwise.
- If hoop houses are in the floodway, remove or elevate the sides to allow unrestricted flow of flood waters through the hoop house.
- Move feed, poultry and livestock and equipment to higher ground out of the floodwaters.

## Help Available

Your Solid Waste Management District can provide specific instructions on sorting and disposing of debris. Vermont has 16 inter-municipal solid waste districts and 14 individual municipalities that manage solid waste. The ANR Solid Waste Management Program can also provide technical assistance on debris management

List of Waste Transporters – haulers who have received permits for transporting solid, hazardous and recyclable wastes within Vermont can be obtained from the Agency of Natural Resources Solid Waste Division.

# Debris Management Plans

Tree branches, propane tanks, the shattered remains of buildings and other floating objects that are swept along by floodwater can jam at bridges and other choke-points and cause flooding during storm events. Once the storm is passed the logistics of getting rid of the debris that blocks roads, creates hazards and piles up in farm fields and neighborhoods can be overwhelming. Municipalities can anticipate the problems caused by debris during and after floods and prepare a plan to keep water channels clear of debris during floods and to organize a safe, efficient and cost-effective cleanup operation after.

## Why it Matters

Debris removal, including collecting and disposing of debris after a storm, is primarily a local responsibility. Municipalities must deal with debris on public property and in the public rights-of-way. There may also be situations where they need to help individual landowners assess and deal with debris. Debris can include a variety of materials – some hazardous, some reusable, and much of it somewhere in between.

Municipalities that have planned for debris management are better prepared to restore public services and ensure public health and safety in the aftermath of a disaster. Plus, they are better positioned to receive the full level of assistance available to them from FEMA, NRCS, and other funding organizations.

## How to Prepare a Debris Management Plan

For an effective Debris Management Plan, whether simple or complex, municipalities should aim to address the questions in the following checklist. This can be done as an extension of the Local Emergency Operations Plan (LEOP). For more detailed information, please review the Towns and Cities section of the State Debris Management plan in Support Annex 6 of the Vermont

**EXAMPLE**

**Barre City: lessons learned helped prepare for Irene**

Immediately after the 2011 spring floods that caused significant damage in Barre City, officials surveyed, documented and mapped the damage. The photos were very helpful for the city's Department of Public Works to assess areas that required immediate attention while the town examined patterns of damage over a longer term period. Based what was learned from these analyses, several months later, Barre City spent a week clearing culverts and preparing for Tropical Storm Irene. Backhoes were staged at bridges and culverts where debris typically accumulates and so it could be removed during the storm. Consequently, damages to Barre City from Irene were minimized.

Emergency Operations Plan (SEOP). A simple Debris Management Plan Template for Vermont municipalities is attached to this document.

Municipal Debris Management plans should comply with Appendix G of FEMA-325 Debris Management Guide and be consistent with the State Debris Management Annex. A Municipal Debris Management Plan is not required as eligibility for FEMA reimbursements.

| ✓ | TASK | CONSIDERATIONS |
|---|---|---|
| | **Define roles and responsibilities** – who does what when? | Identify a debris project manager and depending on the size of the community, assign local officials to administration, legal, operations and planning roles. |
| | **Situation and Assumptions** – What kind of debris do you expect and where? | Review the history and debris removal records of past disasters in your community or if records are limited, then access those of nearby jurisdictions. |
| | **Debris Removal and Collection Plan** – Where will you focus your efforts during and immediately after a disaster and during the recovery operations? | Determine if heavy equipment needs to be staged at bridges where debris has jammed and caused flooding previously. Check with the ANR River Management staff to determine in advance if debris should be removed from rivers and streams. Identify where you will prioritize your debris removal efforts and how to collect hazardous and other specialized waste. |
| | **Debris Management Sites** – Where and how will you create safe, effective sites for collecting, sorting and processing debris? | Unless there are special circumstances most municipalities do not need to identify collection sites because Vermont's current solid waste management system of private waste haulers, augmented by municipal forces or contractors will be capable of transporting waste to the existing, public and private collection and transfer facilities. |
| | **Contracted Services** – How will you obtain the assistance needed to complete the debris removal and who can provide those services? | By late 2015 the State of Vermont will establish comprehensive statewide debris management contracts and expects that municipalities will be able to procure services under these master contracts. Contact Division of Emergency Management and Homeland Security for further information. If a master contract is not available, or for smaller disasters, municipalities can benefit from preparing contracts in advance that will satisfy FEMA reimbursement requirements |
| | **Private Property Demolition and Debris Removal** – How and when will you condemn private property and assist with removal of hazardous materials? | Municipalities should not handle private debris removal unless it is necessary to protect public infrastructure or to ensure public safety. If the need to remove debris from private property arises, municipalities should first review relevant FEMA and State policies and consult with the Town Attorney. |
| | **Public Information Plan** – How will you get the word out to the public on how debris will be handled? | Determine who will serve as a Public Information Officer to coordinate information about safe debris removal and the municipality's removal process through multiple media. Target the message to residents, businesses, institutions and the media. |

## TIPS

### Maximize Reimbursements – Document Damages and Expenses!

Costs of municipal debris removal may be approved for federal reimbursement. In the event of a Federally-Declared Disaster, a percentage of Federal Emergency Management Agency (FEMA) disaster relief funds are spent on disaster debris related activities.

If possible, determine eligibility and any requirements before beginning work on debris removal. If work must proceed before, it is important to document why the debris removal is in the public interest. Take photos and track all expenses associated with debris removal. Main sources of funding are:
Federal Emergency Management Agency (FEMA) Public Assistance
Natural Resource Conservation Service (NRCS) Emergency Watershed Protection Program

In the event of a federal disaster declaration, the state and local communities generally share in the financial match required for federal assistance, and will work together to find the most cost-effective means to achieve the restoration of both the community and environment.

### Is the Debris Removal in the Public Interest?

To be eligible for FEMA reimbursement, debris work must be in the public interest, which is defined as work necessary to meet the following:

- Eliminate immediate threats to life, public health and safety;
- Eliminate immediate threats of significant damage to improved public or private property;
- Ensure economic recovery of the affected community to the benefit of the community-at-large; or
- Mitigate the risk to life and property by removing substantially damaged structures and associated appurtenances as needed to convert property acquired through a FEMA hazard mitigation program to uses compatible with open space, recreation, or wetlands management practices.

Inquiries regarding FEMA Public Assistance and eligibility should be directed to the Public Assistance Coordinator at the Vermont Division of Emergency Management and Homeland Security.

## Template

**Simple Debris Management Plan**

Municipalities of all sizes can create a simple debris management plan with the following template prepared by the Rutland Regional Planning Commission.

# Municipality
# Debris Management Plan (TEMPLATE)

(Town should fill in or revise underlined text as appropriate throughout plan)

**Town Point of Contact: _____**

**Phone Number: _____**

**Plan Overview**

The purpose of this plan is to provide for effective and efficient management of disaster generated debris within the Town/City/Village of _____. Vermont was struck by Tropical Storm Irene in August of 2011 and since that time several other declared disasters have occurred. The direct experience with debris management and the FEMA reimbursement process during these recent disasters underpins the format and principles in this plan.

This plan was developed by local officials in the Town of _____, including the Road Commissioner/Foreman, Emergency Management Director/Coordinator, Health Officer, and others. Resources utilized in the writing of this plan include: the State of Vermont Emergency Operations Plan Support Annex 6 – Debris Management, 2014 (the state Annex), Town of Loxahatchee Groves Disaster Debris Management Plan (2009), and FEMA resources.

A public meeting was held on __date_____ to present the Debris Management Plan and to gather input, and the Selectboard adopted this plan on _date_____.

## 1. Events and Assumptions

In the Town of _____, severe thunderstorms and wind, snow and ice storms, and flooding and fluvial erosion are the most likely events to occur. In recent years these types of storms have generated vegetated debris, in addition to structural debris, hazardous waste and sediment. The Town of _____ had _number_ cubic yards of debris from _Irene or other_____ storms, and can expect to have similar amounts of debris from future incidents that overload the municipalities waste management capacity and would require special debris management strategies.

The Town of _____ is mostly rural/urban with (Insert brief description of topography/terrain, land use and major roads in your town)

The town of ____ is a member of the ____ Solid Waste District. The majority of residents contract with private waste haulers for collection services. Residents also have access to the _____ household hazardous waste collection events, _____recycling center, and the _____ and _____transfer stations.

## 2. Debris Collection and Removal

### *Facilities*

The major facilities in Town that are likely to be impacted by disaster debris in order of priority are (for each category below specify facilities in your town):

1. Roads- specifically egress for fire and police; specify roads
2. Critical facilities- hospital, nursing home, utilities, shelter, etc. (specify)
3. Public buildings- town office, garage, schools, etc. (specify)
4. Private Property- homes, businesses, etc.

### *Response and Recovery Priorities*

During the response and recovery, operations to protect public health and safety will be given highest priority. The following are other *response* phase priorities:

- To remove debris to facilitate search and rescue efforts
- To clear roads to allow access to critical facilities
- To prevent or mitigate flooding

During the *recovery*, the following are the priorities:

- Collect the remaining debris
- Reduce or recycle debris to the extent feasible
- Arrange for disposal of the remainder of the debris

*Roles and Responsibilities*

The Selectboard/Legislative Body/Town Manager is the lead entity responsible for debris clearing and removal.

The ___Town_____ Highway Department is the lead entity that will carry out all operations of emergency debris clearance on essential transportation routes and town property, and for coordinating the permanent removal and disposal of all debris deposited in and along public rights of way.

The Emergency Management Director is responsible for the Town's Local Emergency Operations Plan and for coordinating all planning, training and disaster recovery activities.

The _identify local official___ is responsible for coordination the communication of critical information to residents, the public and the media.

The Town Clerk/Administrator/Other_____ will provide for the collection and compilation of all labor, equipment hours, materials/supplies and expenditures related to disaster response and recovery, and assure coordinated submittals for reimbursement. This task also includes assuring coordination of federal and state financial assistance, through available reimbursement programs. He/she will also manage the receipt and submission of all Debris Contractor payables via load tickets and load ticket data base information, as well as any labor and equipment hours eligible for reimbursement.

The Town will coordinate with other entities including the Solid Waste District, VTrans, Agency of Natural Resources, and Division of Emergency Management and Homeland Security.

*Methods to Remove Debris*

During the response phase, the __Town_____ Highway Department will clear key roads for emergency access by pushing debris to the edge of the right of way, rather than removing debris. This will be followed by collecting the remaining debris, reducing or recycling, and final disposal.

Large woody debris is beneficial in natural stream systems as it contributes greatly to the roughness of the stream channel, reducing the overall velocities and the stream power acting on the bed and banks of the stream. Importantly, large woody debris provides critical ecological benefits. Before removing debris from a waterway the town will contact the Vermont Department of Environmental Conservation Rivers Program for an assessment and removal authorizations: http://www.watershedmanagement.vt.gov/rivers/docs/RME_districts_12.14.pdf.

### 3. Temporary Debris Management Sites and Disposal Locations

As feasible, debris will be separated into the following categories at the site of generation:

- Vegetative Waste
- Construction and Demolition ("C&D") Waste
- Household Hazardous Waste ("HHW");
- Putrescible Municipal Solid Waste
- Household Appliances;
- Scrap Metal;
- Soil, Sediment, Silt and Sand;
- Electronic Waste (E-Waste)

Debris will be brought to the following certified solid waste facilities to be further segregated, reduced and recycled, with the remainder to be transported for disposal. (List Facilities). If existing local facilities lack operational capacity to manage the waste load, the ANR has designated and certified Temporary Debris Storage and Reduction Sites (TDSRSs) capable of upgrading operations in the event of a catastrophic debris-generating disaster. Contact ANR Solid Waste Management Program (802-828-1138) for the nearest, certified TDSRS.

### 4. Debris removal on private property

The Town shall not seek or accept requests from private property owners to perform debris clearing or removal activities. The Town of _____ will not remove debris from private property unless it threatens public infrastructure or public safety. If it is found to be necessary, it will be performed in keeping with 20 V.S.A. § 36, the Vermont Debris and Wreckage Removal statute. An attorney was consulted prior to taking action.

FEMA policy regarding:

- Demolition of private structures is set forth in FEMA DAP9523.4 which is found at: http://www.fema.gov/government/grant/pa/9523_4.shtm
- Debris removal from private property is set forth in FEMA DAP9523.13 which is found at: http://www.fema.gov/government/grant/pa/9523_13.shtm

The Town will seek federal reimbursement for this through FEMA and/or FHWA.

### 5. Use and procurement of Contracted Services

Beginning in late 2015, the State will have stand-by contracts for pre-qualified debris management contractors, which municipalities may utilize if debris management overwhelms State and local government resources.

### 6. Use of Force Account Labor

Force account labor will be used for debris management and monitoring. The Town staff will communicate with federal, state and local emergency officials, notify contractors to ensure response readiness and activate Town staff and equipment, provide public information, and other pre-event operations as needed. Post event, Town staff will take actions necessary to coordinate town-wide debris collection processing and disposal operations, provide public information, and prepare documentation necessary for reimbursement.

### 7. Monitoring of Debris Operations

All eligible work on public property and in the public right of way, and any municipally-owned solid waste management facilities will be monitored either by Town staff or contractors. This includes monitoring the collection of disaster debris, removal of hazardous trees, limbs and stumps, management of any municipally-owned solid waste management facilities household hazardous waste collection events, and the reduction, recycling, and disposal of debris, if applicable.

### 8. Health and Safety Requirements

Town staff and contactors will comply with all local, state and federal safety regulations. All contracts shall include safety requirements and safety of the contractor's personnel and equipment is the responsibility of the contractor. The Town or contractor(s) shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the necessary work.

### 9. Environmental Considerations and Other Regulatory Requirements

All debris operations shall comply with federal, state and local environmental laws. This includes the fueling of equipment, staging areas, removal of hazardous waste such as
asbestos and lead-based paint, debris removal from waterways, storage and segregation of debris, work at historic and archaeological sites, and debris disposal.

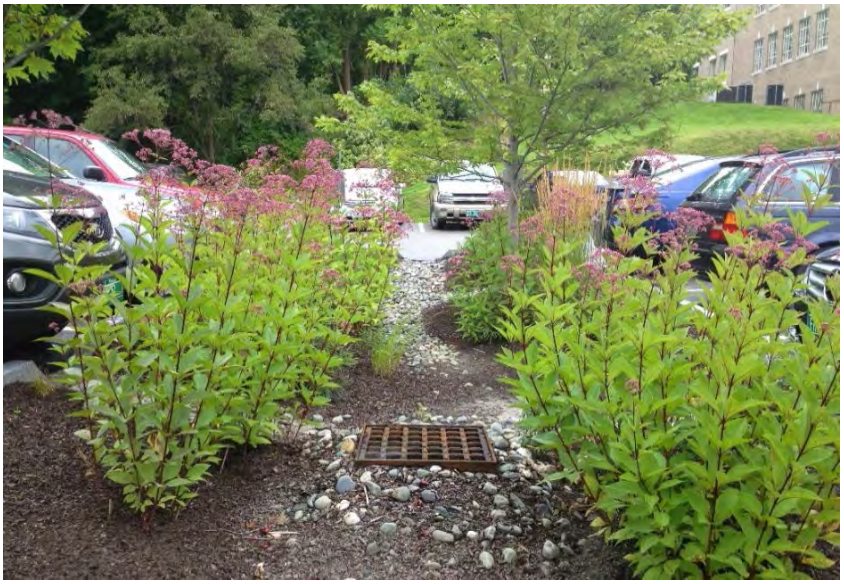
### 10. Public Information

The Town Manager/Administrator/Clerk/Emergency Management Director/Other will serve as the Public Information Officer and will be responsible for coordinating the communication of critical information to residents, the public and the media. Efforts will be made to use multiple outreach channels including notices at the town office, radio, internet (Town's website and Front Porch Forum, if applicable) and television.

### 11. Identification of Debris Removal Contractors

The Town has identified the following prequalified debris removal contractors for local emergency incidents that do not qualify for the state contracted debris management services addressed above:

- List one or more contractors



# Green Infrastructure 101

Larger, stronger storms are occurring more often and are expected to become still more frequent and intense. Rather than sending stormwater directly into rivers and streams, increasing the likelihood of flooding, communities and businesses can adopt policies and land management practices that help to slow stormwater, spread it out and allow it to infiltrate into the ground. Everyone in all parts of a watershed can and should participate in applying Green Infrastructure concepts to their property to reduce the volume of stormwater running into flood-prone areas.

## Why it Matters

By using multiple strategies to keep stormwater close to where it falls and using it or letting it infiltrate into the ground rather than rushing it off your property and into streams and rivers, flooding can be reduced and water quality in lakes and rivers can be improved. Less stormwater runoff helps reduce the cost of stormwater pipes, drains, ditches and treatment systems that are expensive to build and maintain, as well as to replace and upgrade. In places with combined stormwater and sewage treatment systems, less runoff can also prevent polluting sewer overflows during heavy storm events.

## How to Apply Green Infrastructure

Green infrastructure can function at two different scales that are both important for making our communities less vulnerable to flooding.

1. **Large Scale Green Infrastructure**. At the town or region-wide scale, green infrastructure means an interconnected network of waterways, wetlands, floodplains, woodlands and other naturally occurring and human-built features that manage stormwater, remove pollutants, reduce soil erosion and provide other ecological, and environmentally-sustainable services.

   Upland forests in a healthy watershed are one type of large-scale green infrastructure that have enormous flood control capabilities. Rain falling on forested hills is absorbed by trees and topsoil, much of it infiltrates into the ground recharging the aquifers while woody vegetation and uneven ground captures and slows the runoff, reducing the amount of stormwater flowing into rivers and lakes.

   The critical functions that forests, wetlands and other natural systems provide for flood control can be protected and enhanced through local conservation, land management and development regulation to promote the following measures:

- Preserve vegetation on steep slopes.
- Maintain vegetated buffers along streams, rivers and lakes.
- Preserve natural drainage features and natural depressions that help to hold stormwater.
- Conserve forests, wetlands and floodplains.
- Plan for compact development where buildings and pavement serve multiple functions and are designed for walkability.
- Implement urban forestry practices.

2. **Property or Neighborhood Scale Green Infrastructure**. At the property or neighborhood-level, green infrastructure refers to stormwater management approaches and technologies that mimic the ways that large-scale green infrastructure works to reduce flooding. These techniques help property owners infiltrate, evaporate, capture and reuse stormwater to maintain or restore the natural water systems and reduce the negative impacts of stormwater runoff in and around developed areas. When everyone participates in adopting green infrastructure practices on individual properties, damage from flooding can be reduced.

   Property owners can implement measures to promote green building and green site design, and municipalities can promote these measures through bylaws and incentives.

   - Minimize new pavement and impervious areas.
   - Minimize soil compaction and add organic soil amendments to lawns and gardens to improve the absorptive capacity.
   - Create depressions in the landscape such as rain gardens, vegetated swales, low areas in lawns and other measures to capture and infiltrate stormwater.
   - Route roof runoff over lawns and reduce the use of storm sewers and ditches.
   - Direct flow from impervious surfaces onto vegetated areas, where it can soak into or filter over the ground.
   - Capture roof runoff in rain barrels and cisterns for irrigation and other outdoor uses.
   - Install green roofs to absorb rainwater.
   - Install dry wells that release roof runoff and other collected runoff into the ground for infiltration in the surrounding ground.

## MULTIPLE BENEFITS OF GREEN INFRASTRUCTURE

Beyond flood control, protecting natural landscape systems and using green infrastructure to manage stormwater on your property offers a host of benefits that include:

- Natural filtering of pollutants from stormwater.
- Decreasing the need for expensive man-made stormwater treatment facilities.
- Minimizing landslides and other hazards.
- Providing habitat for wildlife.
- Improving air quality (forests and trees).
- Reducing energy use (shade and protection from trees and insulation from green roofs).
- Improving plant health by making rainwater more available (gardens and landscaping).
- Recharging groundwater for water supplies and to buffer against drought.
- Reducing the potential for pollution from sewer overflows in places where stormwater and wastewater treatment systems are combined.

These techniques are often called Green Stormwater Infrastructure (GSI) and the planning approach is referred to as Low Impact Development (LID). For more information and details, see the Agency of Natural Resources Green Infrastructure Fact Sheet and the Green Infrastructure page. See these concepts presented in an engaging, animated video on Sustainable Drainage Systems. All types of green infrastructure are about bringing together natural and built environments and using the landscape as infrastructure.

# Green Landscaping

Anyone who maintains property can take action to reduce stormwater runoff which can lead to flooding, by storing and infiltrating rain water where it falls rather than channeling the rain directly into pipes and waterways. Green landscaping, as shown in the photo of a rain garden above, involves beautifying a property to achieve multiple environmental benefits including the capture and use of stormwater on your property. These include some of the techniques referred to as Green Stormwater Infrastructure (GSI).

## Why it Matters

Green landscaping techniques not only help reduce flood risks, they also prevent water pollution. Green infrastructure helps keep oil from pavement, nutrients and toxins from lawns, harmful bacteria and other pollutants from entering drinking water sources and swimming areas. Green landscaping works because it slows, spreads and sinks stormwater, making use of that water for plant growth and to recharge groundwater.

## How to do Green Landscaping

Property owners can adopt a wide range of measures from retaining existing trees to adding compost to lawns during annual maintenance that can help reduce stormwater runoff from the site. The chart on the following page presents techniques, from simple and inexpensive property management to those that may be integrated into larger construction projects, to achieve the many advantages of green landscaping. Additional green landscaping practices suitable for Vermont are described on the Vermont Agency of Natural Resources Green Stormwater Infrastructure website and at Smart Water Ways.

### GREEN LANDSCAPING BENEFITS

Green landscaping can reduce property management costs and increase the usefulness of landscaping in the following ways:

**Less maintenance**: longer intervals between maintenance tasks such as watering and weeding.

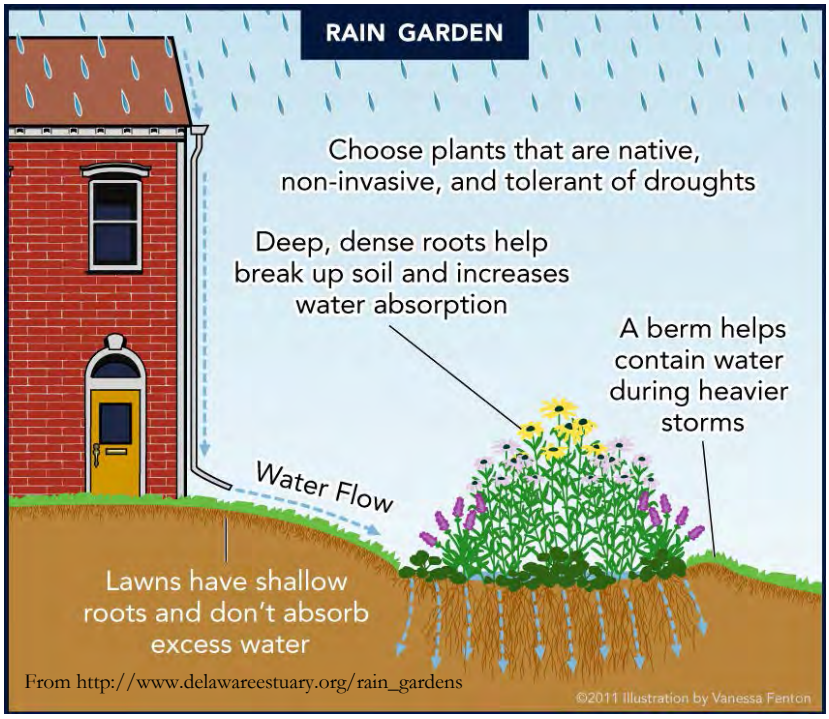
**Fewer inputs**: less watering, fertilizing, herbicides/pesticides, electricity, and fuel for equipment and maintenance vehicles.

**Less pollution**: reduction or elimination of landscaping pollutants such as synthetic fertilizers, toxic chemicals for biological control, and exhaust from landscaping equipment. Also helps filter polluted runoff from other sources.

**Healthier**: improved health and vigor for all living creatures such as soil organisms, plants and animals including pollinators and pets.

| PROPERTY MANAGEMENT TECHNIQUES | APPROXIMATE STARTING COST OF MATERIALS | BENEFITS BEYOND FLOOD RESILIENCE |
|---|---|---|
| **Direct rainspouts** into rain gardens, grassy areas or infiltration trenches to slow absorption into the ground. See these step by step instructions for disconnecting rainspouts. | Rain Downspout Diverter – $15 | Diverts water away from the building foundation and supports plant growth. |
| **Collect and reuse rainwater** in barrels and cisterns. Vermont design guidance for rain barrels. | Residential Scale Rain Barrel – $75 | Collects water for use during dry periods. Reduces cost of watering plants for properties served by public water. |
| **Build soil health** by annually applying compost on lawns and gardens and wood chips, bark or other organic mulch to cover planting beds and the root zone around trees. | Compost – $60/cubic yard (bulk) or $6/20 quart bag. | Improves plant health and retains soil moisture reducing need for fertilizers and watering and allows for better rain water infiltration. |
| **Fertilize lawns only when needed**; minimize soil compaction and use soil testing to any guide fertilizer use. Practical instructions for the care of lawns in Vermont. | No cost unless soil tests are needed. UVM soil tests cost $14 plus postage. | Reduced costs for fertilizing lawns and reduced pollutants in streams and lakes from excess nutrients in stormwater runoff. |
| **LANDSCAPE INSTALLATION OR RENOVATION** | **COSTS TO CONSIDER** | **BENEFITS BEYOND FLOOD RESILIENCE** |
| **Preserve existing topsoil** in place and protect from compaction during construction. | Temporary fencing and installation. | Reduces cost of landscaping and protects existing trees. |
| **Preserve existing drainage patterns**, place structures on less porous soils; minimize lawn; maintain naturally vegetated buffers from waterways. | Additional analysis and attention to natural features during site design. | Site development and maintenance may cost less. |
| **Create shallow depressions** in lawns and other open spaces, grading to slow runoff and increase infiltration. | Excavator, finish grading, seeding and mulching. | Water collection and infiltration achieved with little change in landscaping. |
| **Create rain gardens** – landscaped beds that capture stormwater and are planted with attractive, deep-rooted, water-thirsty flowers, grasses and shrubs. Vermont Rain Garden Manual explains it all: | Excavator, finish grading, plantings, compost and mulch. Regular maintenance. | Attractive, low maintenance landscaping. Prevents stormwater pollution and supports pollinators if native and flowering plants are used. |
| **Create vegetated swales** along roadways and around parking lots to slow and infiltrate stormwater while conveying it off-site. Details on vegetated swales for Vermont from the Agency of Natural Resources. | Design, excavator, grading, drainage, amended soil, planting. | Can be created in existing green strips and green spaces in around parking lots to beautify and employ otherwise under-used spaces. Benefits are similar to rain gardens. |
| **Install porous pavement** or pavers on parking lots, driveways and walkways. Details on how to install porous pavement from the EPA. | Specialized installation, materials and site preparation. Additional vacuum sweeping required periodically. | There is no standing water to freeze in winter and if installed correctly, extends life of pavement in cold climates and allows reduced use of salt. |

For more on these and other green landscaping tools, see the Vermont Low Impact Development Guide for Residential and Small Sites.




***"Healthy soil"*** *means soil that has a well-developed, porous structure, is chemically balanced, supports diverse microbial communities, and has abundant organic matter.* 6 V.S.A. § 4802 (3).
By avoiding soil compaction and applying compost and organic mulches to lawns and landscaping, you can build healthy soils that increase the capacity of the ground to absorb and retain rain water, improving flood resiliency, making water and nutrients available for healthy plants while reducing soil erosion and polluted runoff.

Lawns are the most commonly used ground cover in the United States but they provide the least value from a green landscaping point of view. Shallow grass roots and soil compaction from frequent mowing and maintenance mean that rainwater is more likely to run off the lawn than in locations with plants having deep roots and un-compacted soils. Consider using lawns only in locations where people are likely use an open grassy area to play or picnic. Improve the ecological functions of the lawn by taking the following steps:

- Minimize watering and fertilizer to encourage deeper grass roots.
- Aerate the soils as part of annual maintenance.
- Add compost annually to improve the health of the lawn and the soil porosity.
- Create shallow depressions in the lawn to capture and infiltrate rainwater.

Successful green landscaping and green infrastructure installations are flourishing in Vermont including the following examples:

## GREEN LANDSCAPING TIPS

### Retain and Plant Trees

Trees reduce the need for costly stormwater systems and treatment facilities by naturally managing runoff. They intercept falling rain and hold a portion of it on the leaves and bark, slowly releasing it to evaporation and the soil. The leaves that fall to the ground improve the soil texture allowing rain to be absorbed more effectively.

### Considerations for Clay Soils

Green landscaping techniques in places with clay soils, common in Vermont's Champlain Valley, need to be applied with special consideration for the natural imperviousness of the soils. For example, the storage volume of rain gardens need to be increased to accommodate more runoff and additional compost added to the soil beyond what is normally recommended for rain gardens (50 soil/50 compost).

ABOVE: A shallow bio-swale with a variety of plants is used in place of lawn in a tree-island next to a road to achieve an attractive border that reduces flooding and improves water quality.

## SOUTH BURLINGTON COMMUNITY LIBRARY RAIN GARDEN

Installed in the Spring of 2013 in front of the South Burlington Community Library, the rain garden was specifically designed to capture excess water from the parking lot, which was the cause of periodic flooding. For more information see: South Burlington Community Rain Garden Case Study.

## HANDY'S POROUS PAVEMENT PARKING LOT

The owner of Handy's Hotels and Rentals paved an 18,000 square foot parking lot with porous asphalt. The parking lot services a thirty-unit residential apartment building and two triplex condominiums. Runoff from the rooftops of the apartment buildings and condominiums is conveyed beneath the pavement surface for infiltration. The project is an alternative to the standard approach of capturing stormwater in a pipe, treating it, and discharging it to surface water. The porous asphalt helps to control runoff of pollutants and protects groundwater supplies. For more information see: Handy's Porous Parking Lot Case Study.

# Policies to Promote Green Infrastructure

All municipalities manage stormwater in some way whether it involves permitting new development, ditching and grading gravel roads, conserving a town forest or promoting a community-wide stormwater awareness program. By applying green infrastructure concepts to its bylaws, property management, road maintenance and conservation and outreach, municipalities can achieve more comprehensive and effective flood prevention in the long term.

## Why it Matters

Green infrastructure can help communities become more resilient to the impacts of climate change and help to address stormwater-related problems faced by towns and cities, such as erosion of streams, localized flash flooding, road washouts, and incidents of combined sewer overflows.

## How to Promote Green Infrastructure

Municipalities can take the following steps and apply the tools and examples below to harness the benefits of green infrastructure.

1. **Update Municipal Plan** – Include specific language in the plan to recognize the importance of forests, wetlands, floodplains and other natural features in preventing flood damage, and in applying green infrastructure and landscaping techniques for new development and redevelopment. Evaluate and propose the regulatory, conservation and funding strategies that work best for your community.
2. **Update Zoning and Subdivision Regulations** – Many local bylaws need updating to prevent new development from harming the natural features that help absorb stormwater and to require green stormwater infrastructure when new construction takes place. Municipalities can adopt the following types of bylaws for this purpose:

### REGULATE DEVELOPMENT ON STEEP SLOPES

**Warren, Vermont** regulates development on steep slopes with the following requirements:

- Conditional use review for development on slopes over 15%.
- Prohibition on development on slopes over 25% with some use exemptions.
- A grading and erosion control plan required.
- Standards defined for drainage, driveways, disturbance periods and cut and fill during and after construction.

See Warren Land Use and Development Regulations, Section 3.4 Erosion Control and Development on Steep Slopes.

- **Steep Slope Development Regulations** – Communities increasingly recognize that development on steep slopes can increase the flow of stormwater and are adopting standards that discourage or prohibit development on very steep slopes. In Vermont, many local bylaws impose a maximum slope requirement for roads and driveways but fewer regulate development of land with steep slopes.
- **River Corridor and Buffer Requirements** – In Vermont, River Corridor regulations are recommended for most rivers and streams, for the protection of areas along rivers and streams where they are likely to move. Disaster relief benefits are available to municipalities that adopt River Corridor regulations. Buffer regulations are usually designed to require a heightened level of review and impose restrictions on areas along streams and rivers or around wetlands, ponds and lakes. Effective buffer regulations typically restrict removal of vegetation and prohibit buildings and construction from disturbing the waterfront trees and soils.
- **Green Stormwater Infrastructure Requirements** – While the State of Vermont regulates stormwater runoff for development projects involving over one acre of earth disturbance or creating one acre of impervious surfaces, the stormwater from many developments of less than one acre can cumulatively cause flooding and pollution. Municipalities can fill the gap by regulating the stormwater impacts of smaller development projects through zoning and subdivision regulations.

3. **Conserve Key Parcels of Land** – Municipalities can acquire and conserve areas of upland forests, wetlands. River corridors and floodplains that hold and store stormwater can reduce the likelihood and intensity of downstream flooding. Land trusts and other conservation organizations may partner with municipalities to acquire the land or to purchase easements that restrict the use of portions of private land to activities that support flood resilience functions. In villages and cities, municipalities may target areas that frequently flood for federal buyouts to remove existing structures and convert the land to conservation use or for low-intensity recreation.

## REGULATE LAND ALONG WATERWAYS

**Williston, Vermont** creates watershed protection buffers along waterways and water bodies where the following restrictions apply:

- Buffers are 150 feet above the ordinary high water mark of named waterways, ponds and lakes, and 50 feet from any wetlands and unnamed streams.
- The land area within the buffer cannot be used for density calculations.
- Restrictions defined on cutting and removing vegetation, creating impervious surfaces, outdoor storage and use of lawn chemicals.
- Provides specific provisions for variances and nonconforming uses and structures.

See Section 29, Watershed Health, in the Williston Unified Development Bylaw.

## MODEL BYLAWS FOR LOCAL STORMWATER REGULATION

The Vermont League of Cities and Towns (VLCT) provides model bylaws and other tools on its Water Resources Assistance webpage for municipalities that want to protect and improve green infrastructure through riparian buffers, low impact development (LID), stormwater standards, shoreland protection and general environmental resource standards for subdivisions. An updated stormwater management bylaw will be available in Fall 2015.

### Resources:

- Vermont Land Use Planning Implementation Manual:
  - Open Space and Resource Protection Programs – explains how municipalities can undertake land conservation activities.
  - Green Infrastructure - describes green infrastructure from a historical standpoint and how the term is now more often associated with stormwater management practices that use or mimic natural processes.
- VNRC Video on Using Natural Flood Protection, How the Otter Creek Floodplain Responded to Irene – shows how conserved wetlands above Middlebury minimized flood damage.

4. **Fund Green Infrastructure Initiatives -** Municipalities in Vermont and around the country are finding ways to fund projects and programs that address stormwater concerns. In larger communities, stormwater user fees may be an option while in both large and small towns state and federal grants may be available to help.

### Resources:

- Vermont Flood Ready Funding page – access to the wide range of funding sources available to assist Vermont communities with becoming more flood resilient.
- Vermont Ecosystem Restoration Program – provides grants and other resources for green infrastructure projects.
- EPA Green Infrastructure for Municipalities Funding page – provides an overview of funding opportunities.

### PARTICIPATE IN URBAN AND COMMUNITY FORESTRY

Vermont towns and cities, large and small can keep street trees, park plantings and town forests healthy and functioning in top form as green infrastructure for stormwater control by participating in the Urban and Community Forestry Program. Information, training, technical assistance and grants are all available to help municipalities.

Photo at right – Land recently conserved within the Third Branch river corridor will allow the river to move and help reduce flooding in downtown Bethel, Vermont. See the toolkits for River Corridors and Preparation Matters for more on what municipalities can do to conserve land and use green infrastructure to prevent flood damage to settlements.

## GREEN INFRASTRUCTURE PLANS FOR NORTHFIELD


Northfield plans to address the flood devastation along Water Street through the creation of a new park that will provide downtown Northfield with an outstanding new recreational amenity that will protect the floodplain function, offer other green infrastructure benefits and enhance the livability and resilience of the community.

Tropical Storm Irene flooded 80 out of 100 homes along Water Street in the village. The town worked diligently with landowners to obtain Hazard Mitigation Grants from FEMA, securing buyouts for 12 houses with assistance from the state and regional planning commission. Besides helping landowners to move out of harm's way, the buyouts allowed the town to assemble a 4-5 acre contiguous area of floodplain next to the Dog River.

In 2013, Northfield hosted a Vermont Downtown Action Team (V-DAT) project that brought a team of design, planning and economic development experts to help foster economic recovery. Based on what they learned from residents in a multi-day workshop, the V-DAT team developed ideas for how Northfield could improve the vitality and resilience of their village. The resulting master plan includes a proposed park for the buyout area with community gardens and neighborhood open space, pathway connections between downtown and Norwich University and streetscape enhancements along Wall Street, better linking the new park with the Common.

Northfield's work to create a place where the river can flood, where once there were homes, offers a good example of green infrastructure restoration, but the plans for the park go even further to propose a wide range of green landscaping techniques to help slow and store stormwater, such as riparian buffer plantings along the river and bio-retention swales and rain gardens to accommodate runoff from parking areas.

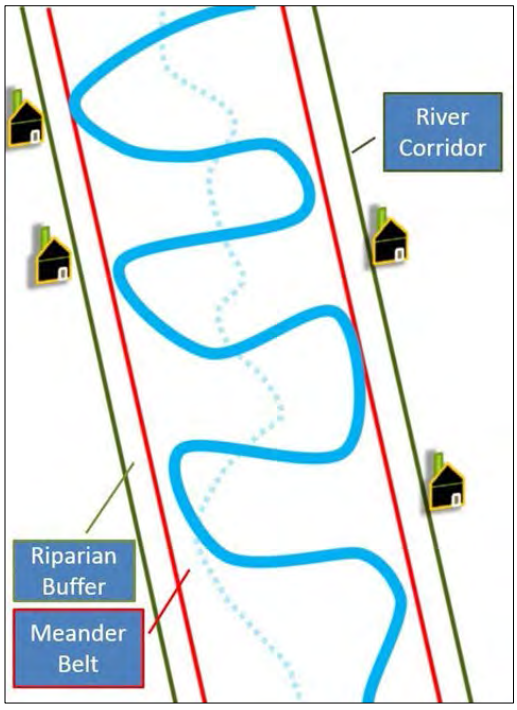
# River Corridor Protection 101

Because of Vermont's hilly landscape, flood damage to businesses, homes, roads and other infrastructure is more often caused by the erosive force of fast-moving water rather than from the rise and spread of flood water. Federal maps of areas that flood that are used for flood insurance only address inundation risk. Vermont learned the hard way from Tropic Storm Irene and numerous other storms that rivers and streams need room to move, and if they are constricted by development along river banks, erosion damage will occur. The solution? Define and protect river corridors – land along rivers where raging waters have room to expend their force and overflow the banks without destroying lives and property.

## Why it Matters

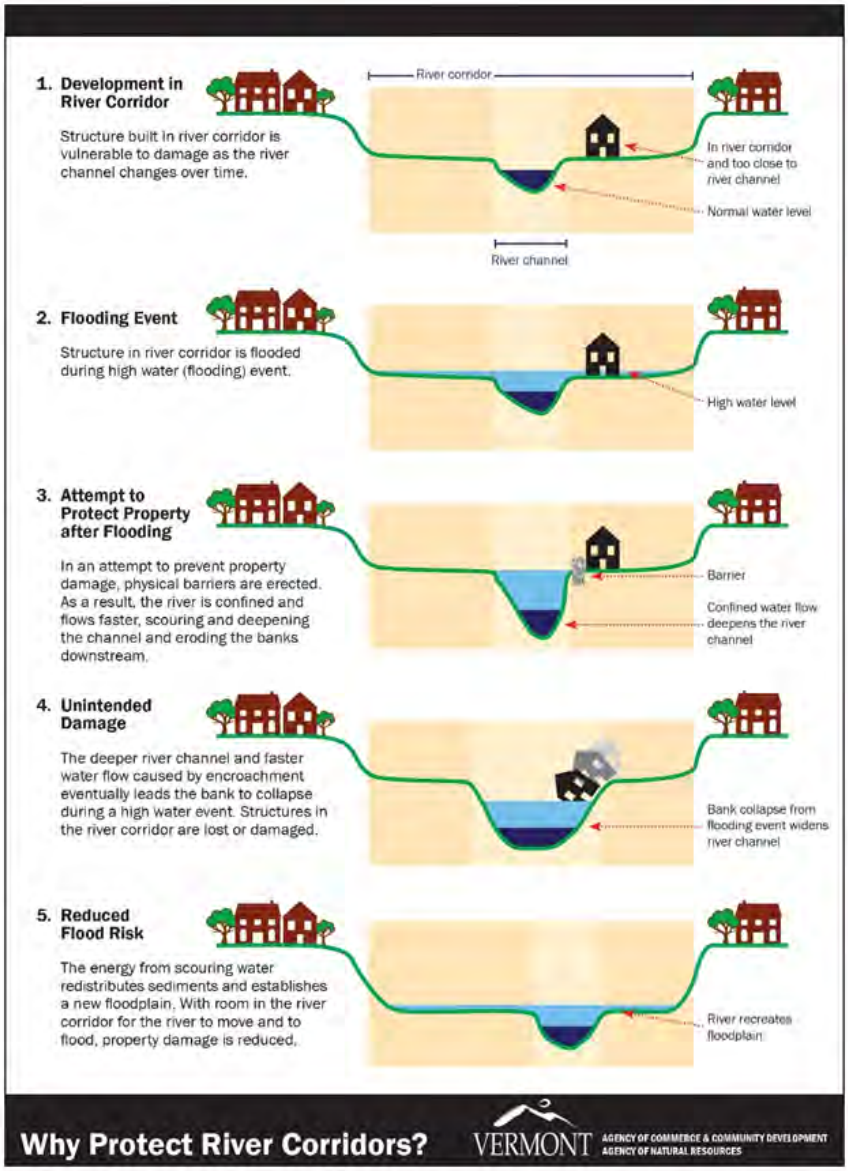
Most of the damage from natural hazards in Vermont is due to the erosive power of fast moving water that can destroy homes and businesses, but most of all, damaging roads, culverts and bridges. For individuals and communities this not only creates an unscheduled budgetary crisis but it also affects emergency response, public safety, and the ability of people to get to work, school and services.

River corridor protection allows streams and rivers to achieve greater stability, maintain the ability to release flood waters in places where there are not structures to damage and reduce the stream's erosive volume and power before arriving at a vulnerable culvert or a village. Vermont state statutes recognize river corridor protection as a key statewide strategy to reducing state, municipal, and private losses due to flooding.




## How to Identify and Use River Corridors

River corridors are identified through a technical exercise that identifies a "meander belt" based on the length, width and slope of a river and the shape and the geologic composition of the river valley. The meander belt defines a corridor that gives the river some "wiggle room." A river flowing through steep bedrock walls will likely be contained but when it reaches a plain of gravelly soils the channel is likely to move over time. Some communities have delineated the corridors within which the river channels are likely to move. These meander belts are also referred to as fluvial erosion hazard (FEH) areas.




Rivers that were straightened or have had roads structures or berms built on the banks lose their natural stability because they no longer have room to meander and access open land where floodwaters can spread and energy can dissipate. With an appropriate amount of land adjacent to an unstable river, it can eventually develop a stable meander pattern. Meanders may shift within the corridor over time, but the river will be less susceptible to dramatic channel movements and extreme erosion.

In addition to the meander belt or FEH, a river corridor needs additional protection to ensure that the banks of the river corridor maintain their stability. This creates added setback space for development so that when a meandering river moves to the edge of the meander belt, there is still room for a naturally vegetated buffer that can resist further stream bank erosion.

The Vermont Rivers Program established procedures for river corridor protection on how they are mapped, used in state regulatory proceedings and how to apply in municipal planning. The State also produced Statewide River Corridor mapping to help developers, landowners and municipal officials see where flood risks are likely and where additional permitting restrictions may apply. The State River Corridors can be viewed on the Flood Ready Atlas.

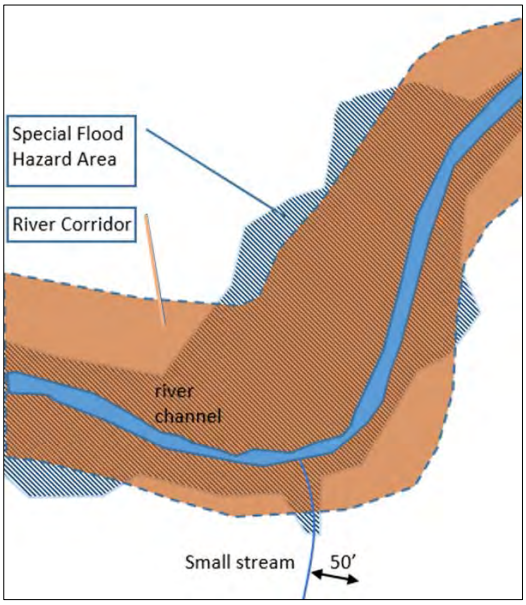
The river corridor maps are helpful to municipalities in preparing hazard mitigation plans and the flood resilience element of the municipal plan. Municipalities are strongly urged to adopt river corridor protection regulations to better protect the community and to qualify for the maximum public assistance funds after a disaster. Municipalities can also work to reduce flood damage by conserving land in River Corridors and restoring of floodplains. For more information about River Corridors, see Frequently Asked Questions on the Vermont Flood Ready site.

# River Corridor Protection – Regulatory Approaches

Too much water naturally produces flooding but flooding does not need to result in disaster. Floods become disasters when we place our lives, homes, workplaces and infrastructure in harm's way. Development that occurs in river corridors and floodplains – the places where rivers should be given room to move and overflow – will not only be vulnerable to flood damage but can increase the instability of the river and its destructive force, threatening other properties. Allowing small rises in flood elevation and blockages to river movement here and there, accumulates into significant and hazardous changes, subjecting the community to greater risks. Municipalities can prevent needless flood damage by prohibiting development and fill in river corridors and floodplains.

## Why it Matters

Adopting regulations that prevent landowners from developing their property is a difficult action for local officials to take. While the property rights of those owning land near rivers and streams may be affected, preventing development in those locations protects the whole community from harm. Flood damage results in the largest annual disaster costs in Vermont. Municipalities have a responsibility to do what they can to keep citizens safe, prevent damage to essential public facilities, avoid shut-downs of the transportation network and the resulting disruptions to businesses and reign-in the ballooning costs associated with disasters.




Municipalities have the legal authority to prevent loss of life or property, even when protective measures restrict some uses of private property. If no action is taken, local governments may be liable for damages that unregulated development may cause. The legal system recognizes that property owners who increase flooding or erosion, or violate reasonable watershed or floodplain standards are intruding on the property rights of others. Municipal regulations preventing development in river corridors and floodplains offer a first line of defense against this intrusion.

## How to Regulate Development in River Corridors

In Vermont, there are two primary means of identifying areas subject to flood hazard: the areas mapped by the Federal Emergency Management Agency (FEMA) as areas of special flood hazard; and areas mapped by the State of Vermont Department of

Environmental Conservation known as the Statewide River Corridors. The FEMA maps primarily identify areas of inundation (rising floodwaters), while the Statewide River Corridors focus on areas subject to fluvial erosion hazards (when fast moving water in a river or stream erodes the streambank and adjacent land). These areas overlap much of the time but can vary. Together, floodplains and river corridors show areas affected by all types of flooding in Vermont.

## Comparing River Corridors and Special Flood Hazard Areas Bylaws

| | BYLAWS PROTECTING SPECIAL FLOOD HAZARD AREAS | BYLAWS PROTECTING RIVER CORRIDORS |
|---|---|---|
| **PROGRAM AUTHORITY** | Federal Emergency Management Agency (FEMA), National Flood Insurance Program (NFIP) | State of Vermont Agency of Natural Resources, River Management Program |
| **FINANCIAL BENEFITS FOR MUNICIPALITY** | • Eligible for ERAF 12.5% state contribution.<br>• Additional benefits available for municipalities that participate in the Community Rating System (CRS). | Eligible for ERAF maximum - 17.5% state contribution. |
| **FINANCIAL BENEFITS FOR INDIVIDUALS** | • Eligible for flood insurance through the National Flood Insurance Program (NFIP).<br>• Without flood insurance, obtaining a mortgage or loan is difficult. | • Less likelihood of damage and disruption from flooding.<br>• Over time may lower taxes by reducing increased costs of flood damage. |
| **MAPS OF PROTECTED AREAS** | • Federal Insurance Rating Maps (FIRM) are old with varying degrees of accuracy.<br>• Only available for 20% of Vermont streams and focusses on a particular sized flood (1% chance of flooding each year).<br>• Maps can be amended for individual sites through a Letter of Map Amendment (LOMA). | • State River Corridor Maps (SRCM) are available statewide for all rivers and streams with a watershed over 2 square miles.<br>• Streams in smaller watersheds have a 50' setback from the top of bank.<br>• Local Fluvial Erosion Hazard maps may be used as the basis for river corridor regulations.<br>• SRCMs can be revised and ANR will update on a regular basis. |
| **REQUIREMENTS** | <u>Minimum Requirements:</u><br>• Reduce damage to ensured structures (elevating, etc.)<br><u>Recommended Requirements:</u><br>• Restricting new structures and fill. | • Directs new fill and structures out of river corridors, but makes exceptions for stream crossings, redevelopment and certain types of infill. |

The federal program for local regulation of development in floodplains has long been available to municipalities that choose to make federal flood insurance available to landowners. While 89% of Vermont municipalities participate in FEMA's National Flood Insurance Program (NFIP), the NFIP was designed with insurance in mind and not for floodplain management. For this reason, municipalities are urged to go beyond the customary minimum NFIP standards to prohibit development in flood hazard areas. The maps used for defining the floodplains for NFIP purposes are often not complete and may not accurately show areas subject to inundation

and are not intended to show areas subject to flood damage through erosion, so it is also important to go beyond the NFIP to regulate development in river corridors as well.

Municipalities can choose to protect river corridors and floodplain as a part of their zoning or land use bylaw or as a stand-alone bylaw, for those municipalities that do not have any land use regulations. Those regulations are not retroactive, so they do not affect land uses and structures that existed when the regulations took effect.

**Limited State Regulation of River Corridors**

Some state authority exists to enforce river corridor protection but it is limited to the following:

- Act 250 regulates land use in both floodways and river corridors for applications that come under its jurisdiction.
- ANR regulates structures and fill that are exempt from municipal regulation such as state-owned facilities, utilities regulated under Section 248, agricultural structures and silvicultural structures.
- ANR applies the Stream Alteration Rule to regulate the installation of berms along rivers.

**MODEL BYLAWS**

The Agency of Natural Resources (ANR) offers several model regulations for a variety of municipal circumstances that address both Special Flood Hazard Areas and River Corridors.

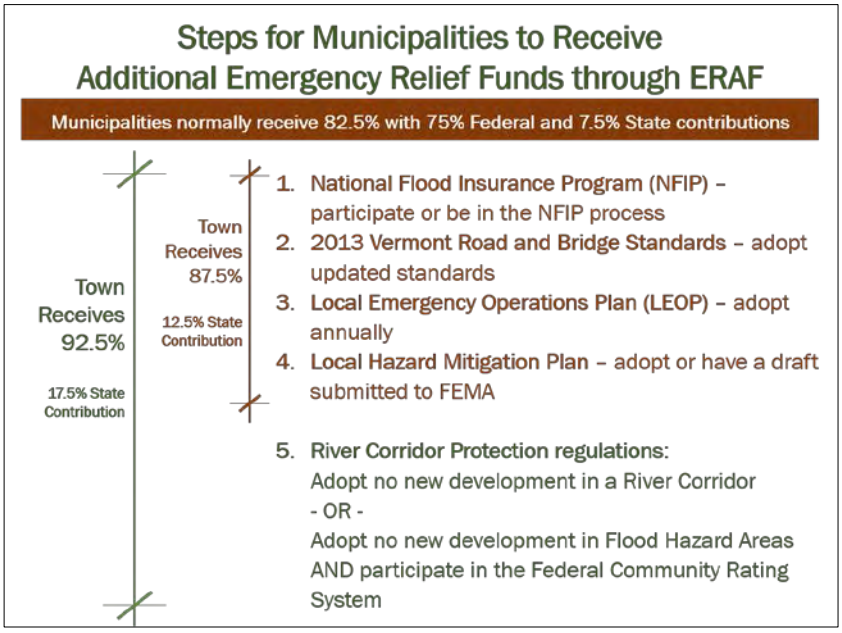
Even with these state regulations, municipal river corridor protection bylaws offer the most comprehensive approach to preventing development in locations that are likely to increase flood damage.

## Help and Incentives Available

Contact a state floodplain manager or regional planning commission for assistance in adapting the model regulations or to obtain a Word version to adapt. For municipalities that adopt river corridor bylaws, ANR staff is also available to provide technical reviews and recommendations on any local applications for a permit to develop in the river corridor.

**Vermont Emergency Relief and Assistance Fund (ERAF)**

Following federally-recognized disasters, public assistance funding is released to help municipalities cover their financial losses, typically covering 75% of eligible costs. The Vermont Emergency Relief Assistance Fund (ERAF) provides further relief by adding funds (7.5%) toward the non-federal portion, leaving 17.5% of the cost of repairing local roads and facilities to municipalities. As of October 23, 2014 municipalities can take four or five specific mitigation steps to reduce flood damage are eligible for more emergency relief funding through ERAF. By adopting river corridor protection regulations in addition to the four other measures, municipalities are eligible to receive maximum disaster assistance funding.



Besides the funding benefits under ERAF, each of the four required elements are beneficial on their own. Municipal membership in the NFIP enables residents to secure flood insurance, which is required if a federally-backed mortgage is sought for the property. It also lowers rates for all flood insurance policy holders in the municipality. The updated road standards may have a short-term financial impact on the municipality, but long-term will ensure less flood damage occurs. Preparing for flooding and other emergencies, by adopting a Local Emergency Operations Plan and a Hazard Mitigation Plan will help promote safety of residents during a disaster, reduce the damage and speed recovery.

## Community Rating System

Municipalities can also consider joining the Community Rating System (CRS). The CRS is a voluntary program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions. For CRS participating communities, flood insurance premium rates are discounted between 5% and 45%. In Vermont, Brattleboro, Bennington and Montpelier currently participate in the CRS program.

## Flood Resilience Checklist

The Regional Planning Commissions use a flood resilience checklist when municipalities are developing municipal plan updates to ensure that flood resilience is front and center in the minds of local decision makers and that plans, policies and program updates are identified and prioritized.

This checklist includes overall strategies to improve flood resilience, as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

## TERMS USED FOR RIVER CORRIDOR REGULATION

Terms used for floodplain and river corridor protection can be confusing. Technical definitions need to be relied upon when writing regulations but this offers a quick overview of the most commonly used terms.

### 100 Year Floodplain = Flood Hazard Zone = Special Flood Hazard Area

These terms refer the flood hazard areas defined by NFIP Flood Insurance Map Program, most commonly called the 100 year floodplain. In local zoning regulations they are often referred to as Flood Hazard Zones. FEMA currently refers to the mapped floodplains as Special Flood Hazard Areas.

### Meander Belt = Fluvial Erosion Hazard Area (FEH) = River Corridor Protection Area (RCPA)

This is the land along a river or stream, defined according to specific technical guidelines to indicate the likely area where a river channel is likely to move and erode the land. Meander belt is used for descriptive purposes, FEH for technical studies and planning and RCPA is the term used in Vermont statutes.

### Meander Belt + Riparian Buffer = River Corridor

River Corridors for the purposes of regulation are defined as the meander belt of a river or stream with an added riparian buffer on either side to ensure the stability of banks.

# River Corridor Protection: Non-Regulatory Approaches

Communities that experience flood damage on a regular basis can reduce the volume and velocity of floodwaters threatening roads and settlements by preserving the natural capacity of the land along rivers to accept and store excess water and to dissipate the energy of the flood. Conserving functioning river corridors and the associated wetlands and floodplains is a cost-effective, preventative measure to preserve the natural disaster prevention systems in the landscape. Additional flood control capacity can be created by restoring floodplains blocked by berms or by fill, and through thoughtful, well-informed management of the way roads are repaired after damage to create more space for the rivers to move and flood.

## Why it Matters

Enacting river corridor bylaws prevents future flood risks from worsening but regulations cannot improve existing conditions or reverse errors of the past. Furthermore, regulations are only as effective as those administering them. Non-regulatory measures provide an important compliment to river corridor regulations. Municipalities that are proactive in seeking opportunities to restore floodplains that have been cut off from the river by farming practices, roads and driveways, fill or to protect development, prevent future flood damage. Investment up-front in preserving and expanding lands that provide critical flood prevention services will help buffer the community against disruption and the high financial, economic and personal costs of damaging floods.

While berms and stream bank armoring are used to protect existing homes, businesses, transportation infrastructure and agricultural lands from flood damage, barriers typically transfer flood water, stream sediments, and erosive energy to another location, increasing flood elevations and velocities and triggering sudden channel adjustments and erosion that causes damage downstream.

## How to Apply Non-Regulatory Approaches

River corridor protection works best when it starts with a firm understanding of the systems and streams that contribute to flood damage and identifying projects that can to prevent future flood disasters. Partnerships with state and federal agencies and non-profit organizations can provide the expertise that municipalities need and may provide some or all of the funding needed to get the work done.

**River Corridor Planning**

Start conservation and restoration efforts with a comprehensive assessment of the river corridor and the contributing watersheds to inform decisions about where to spend time and focus funding (see Chapter 2 of the

VERI Report). Vermont has well-established procedures for conducting technical river corridor assessments as detailed in the Agency of Natural Resources (ANR) River Corridor Planning Guide. ANR River Scientists are available to assist communities with organizing an assessment project and local conservation commissions, watershed associations and the Natural Resources Conservation Districts may be available to help move the project to completion. River corridor planning includes the following steps:

**Phase 1 Geomorphic Assessment**: analysis of the physical form of the river or stream takes place in an office and involves the collection and examination of existing studies, maps and other data.

**Phase 2 Geomorphic Assessment**: involves field work to collect data from measurements and observations taken along defined river segments or reaches.

**Project Planning and Development**: may involve further assessment and obtaining more detailed information about the feasibility of projects and the options for implementing improvements.

**Alternatives Analyses & River Corridor Planning**: consists of prioritizing projects, obtaining preliminary commitments from landowners, and developing and selecting alternative approaches.

ANR also produces Tactical Basin Plans to manage surface waters in the 17 basins in Vermont. Basin plans focus primarily on water quality but because river erosion is a major contributor to decreased water quality, the plans provide a context for river corridor plans as well as for the flood resilience element of municipal plans. By aligning the recommendations of all three plans, municipalities can increase the likelihood of obtaining funding and assistance for implementation.

**Conserving Places where Rivers can Move and Flood**

Communities can permanently protect river corridors through outright purchases of land conservation easements. Easements might be for a strip of land along a waterway, or on an entire parcel depending on the functions to be protected and landowner preferences. The land with an easement remains as private property but permanently protected from development and guaranteed to continue serving the intended flood prevention functions. Often a non-profit organization like the Vermont Land Trust or the Vermont River Conservancy will co-hold the easement on the land with the ANR, and together they take responsibility for stewardship, defending the terms of the easement against any future violation. They visit the site on a regular basis, to verify that the terms of the easement are being followed.

**BENEFITS REPORTED BY LANDOWNERS WHO CONSERVE LAND**

- Personal satisfaction and peace of mind comes from knowing that the things they value about their land will remain forever to benefit future generations.
- Landowners who donate conservation easements or give their land to a land trust or a similar non-profit entity, benefit from income and estate tax deductions. Conservation easement donations can offset capital gains taxes, reduce estate taxes, and help landowners achieve their philanthropic goals. See this explanation from the Vermont Land Trust for more about tax implications.
- For farmers or others who sell their development rights, conservation can help to reduce debt, enable the purchase of additional land, or facilitate the transfer of land or a farm to the next generation.

For conservation projects defined through a river corridor plan, easements may take the form of purchasing channel management rights, either as a first-time easement or by amending an existing easement, such as an easement protecting agricultural lands or wildlife habitat. By selling the channel management rights, landowners are restricted from intervening with erosion and channel adjustments within the river corridor. River corridor easements may be transacted as part of larger river restoration projects and in conjunction with the other conservation practices and programs. Agriculture and forestry is commonly permitted within river corridor easement areas.

**Restoring Floodplains and River Corridors**

Floodplains are cut off from the river for a variety of reasons such as to prevent floodwater from entering a farm field, to create a railroad grade, or to protect a flood-prone structure. Municipalities and their partners can work with landowners in these situations to remove or lower those obstructions.

- On land that is no longer farmed and where the landowner is willing to allow the land to be periodically flooded, existing agricultural berms can be removed. While flooding fields can be a problem if it isn't planned for, farmers can adopt management practices that tolerate or even benefit from flooding. Some farmers appreciate "poor man's fertilizer" that floodwaters bring in the form of nutrient-rich deposits.
- Where roads and railroad grades pass through river valleys, they can create dams, preventing rivers from overflowing into adjacent floodplains. In some cases, the grades can be lowered to allow flood waters to over-top them and still allow for light uses such as rail trails. Larger and more frequent culverts and bridges can also be installed under these "dams" to help facilitate the movement of floodwater into the floodplain.
- Floodplains can be restored even in settlements where homes and other structures have been removed due to flooding, and floodwaters can be allowed to enter parking lots, parks and other such places that can be flooded without damage.

## CREATING NEW FLOOD CAPACITY AND A PARK IN WARREN

Before Irene, the Town of Warren took steps to prevent flood damage. Warren was devastated by flooding in 1998 when heavy rains fell on already saturated soils in late June, swelling the Mad River. Following the flooding, FEMA Hazard Mitigation funds were used to buy out three homes along the Mad River. A part later became the town-owned Riverside Park. Over the years, gifts and additional purchases helped the park expand. A 2008 plan for the park identified a primary goal of allowing the river channel to return to a balanced state. Over time, the river would top its banks, erode and deposit sediments along its channel and in the park, which it did in during the 2011 floods. According to Caitlin Maloney, formerly of Friends of the Mad River, Riverside Park area offers one of the first opportunities downstream from Warren Village, for "the river to blow off some steam" during high flow.

**Training for Managing Roads to Reduce Flood Damage**

Municipalities – especially road crews and selectboards – frequently make decisions about roads and streams that can, over time, profoundly improve the condition of streams and rivers and make them less destructive. The Vermont Agency of Natural Resources (ANR) together with the Vermont Agency of Transportation (VTrans) produces a comprehensive online and in-person Rivers and Roads training that explains the workings of rivers and how to design, construct and maintain roads and bridges to create greater river stability and more flood resilient roads. Both state and local road personnel who have participated in this program find the program useful and say they are able to directly apply the learning to their road work.

Anyone can access the introductory online training that provides a general awareness and understanding of river processes, aquatic habitat and how transportation infrastructure affects and is affected by dynamics of rivers. Announcements of classroom and field training opportunities and classroom materials are available on the ANR Rivers Program page.

## Funding and Support Available

- Vermont Clean Water Initiative Program (VCWIP) offers an annual grant program and technical and educational assistance. Funding for river corridor plans to implement those plans through both conservation and restoration projects are available.
- Hazard Mitigation Grant Program offers funds to implement river corridor plans that are integrated into the local Hazard Mitigations Plan.
- For smaller projects, the VT Watershed Grants can be useful. Awards are made up to $15,000.

## JEFFERSONVILLE PLANS STRATEGIES TO REDUCE FLOODING IN THE VILLAGE


After the spring 2011 flooding, the Village of Jeffersonville launched an extensive hazard mitigation plan process and flood model to address recurring flooding in the historic village. A Mitigation Master Plan with multiple strategies for reducing flood impacts resulted and the flood resilience principles were integrated into the municipal plan. Strategies include restoring flood storage areas doubling as public green space, upsizing two bypass culverts under a state highway, and replacing a bridge to reduce flood constriction but retaining recreation functions. The Village applied for funding to implement priority projects and continues to work collaboratively with adjacent municipalities, the school, private businesses, and the Lamoille County Planning Commission to implement additional projects.

# Preparation Matters for Municipalities

Municipal officials find themselves on the front line when disasters hit. Local government leaders – particularly those who have been through a flood disaster – recognize that water combined with Vermont's steep hills and narrow valleys can quickly devastate a community. Vermonters count on their local governments to prepare and lead the immediate response and take action to prevent future damage.

## Why it Matters

Local leaders know that planning and preparation save lives, avoids property and infrastructure damage and speeds recovery efforts. It also improves the ability to obtain federal and state assistance. Planning for flooding can help the community mount an effective disaster response, direct future development away from high hazard areas and attract funding that can make the community safer and can even identify opportunities to apply disaster prevention efforts into addressing broader community concerns.

## Prepare for Emergencies

Experience from the 2011 floods clearly demonstrated that municipalities that prepared for emergencies and were committed to local safety and resilience, responded and recovered faster and better than those that did not. Municipalities are now encouraged to prepare a plan to manage disasters and then follow-through with regular training and updates. Where local resources are insufficient to adequate respond to disasters, mutual aid agreements with nearby municipalities can help fill the gap.

### Local Emergency Management Director

In Vermont, each city and town is required to establish a local organization for emergency management and appoint a director. In most communities this is the fire chief or an individual with the

### COMMUNICATION HELPED WATERBURY RESPOND

Tropical Storm Irene hit Waterbury hard, damaging 220 homes and businesses, but the community immediately mounted an effective response, helping those in need, removing debris, restoring services and making plans for recovery. Efforts to build social ties and a culture of open communication before the flood contributed to the community's success in navigating the chaos of the disaster. Town officials stepped forward immediately to provide leadership, making these critical decisions that enabled a speedy recovery:

- Choosing a central meeting place for daily meetings and to offer services;
- Selecting radio and daily newsletters as the ways to keep people informed;
- Collaborating with adjoining towns, and the state, federal and non-profit entities offering assistance; and
- Setting priorities to direct resources to the most urgent needs.

Investing in waste removal on day one, clearly communicated that the town was committed to improving conditions, boosting community confidence and morale.

skills and experience to respond in an emergency situation. Typical responsibilities of the local Emergency Management Director include:

- Acting as local point of contact for emergency management issues.
- Developing an emergency operations plan and community continuity of operations plan.
- Conducting tests and exercises and coordinating training programs for emergency volunteers.
- Maintaining a communications system to alert key officials in the event of an emergency.
- Coordinating the establishment of an emergency shelter with the American Red Cross.
- Helping develop mutual aid agreements.
- Acting as a liaison to the Department of Emergency Management and Homeland Security.

**TIPS**

When developing emergency plans, consider individuals with special needs and those with pets, or livestock. Often emergency shelters cannot accommodate individuals' special needs or pets. Documenting those with special needs can also help identify medical or service needs if roads and power are out.

### Training for Emergencies

Preparing to respond usually involves significant training, drills and practice to ensure that key leaders and volunteers are ready to jump into action quickly and that local residents understand their roles and responsibilities in preparing for and responding to disasters. Communities should also consider coordinating regular trainings with neighboring towns and with state partners.

### Local Emergency Operations Plan (LEOP)

Among the key documents your city or town will want to have in place when an emergency strikes is a Local Emergency Operations Plan (LEOP). These plans contain the legal authority for emergency operations, explain the general concept of operations and assigns responsibilities for emergency planning and operations. Residents and business have a critical role and shared responsibility identifying local risks and familiarizing themselves with the plan so they can take proactive steps to protect themselves and their property.

Most emergency plans also include a municipal Continuity of Operations Plan (COOP) – a written document that outlines how the local government will respond and recover from a major emergency or disaster as well as standard operating procedures and contacts. When identifying key contacts in the plan, be sure to appoint alternates for important response positions so if the primary contacts are not able to perform their duties, or the work demands 24 hour attention, someone else is trained and informed to step in.

Communities should test and refine their Local Emergency Operation Plans (LEOP) annually and submit them to their Regional Planning Commissions after Town Meeting Day and before May first. A person trained in the National Incident Management System (NIMS) offered by FEMA is responsible for certifying that the LEOP has been adopted by the municipality.

**Resources:**

- FEMA offers a general LEOP template that includes recommended content as well as general guidance on creating and adopting a plan is responsible for certifying.
- Vermont Department of Emergency Management and Homeland Security provides details on preparing an LEOP.

### Mutual Aid Agreements

Mutual aid agreements, also known as interlocal agreements, are contracts among local governments that increase the capacity to respond to an emergency situation by sharing resources (staff, supplies equipment) before, during, and after an emergency.

The conditions of the agreements typically outline the policies and procedures for reimbursement and compensation in advance. Fire department mutual aid agreements are the most common type of interlocal agreement used by Vermont municipalities. FEMA also requires written mutual aid agreements as a condition of certain grants.

**Resources:**

- Vermont Department of Emergency Management and Homeland Security provides a mutual aid template (opens in WORD).

## Plan for Avoiding Flood Damage

Since the devastating floods of 2011, Vermont communities gained a heightened awareness of the need to avoid future flood damage. This requires planning and a number of different types of plans are required to access federal and state benefits. Communities can use these planning processes to prepare for and prevent flooding, serve as guideposts for municipal decision-making and help direct state and federal funding towards projects that will lessen flood damage in the community.

### Local Hazard Mitigation Plan

Flood-damaged roads and bridges can wipe out a town's entire year's road budget in a matter of hours. Local Hazard Mitigation Plans (LHMP) identify local policies and projects that reduce key vulnerabilities and the repetitive repair costs to infrastructure that impact community. Once FEMA has approved the LHMP, projects like floodproofing public buildings, elevating private and public buildings, property acquisitions and culvert improvements are eligible for federal funding. Communities must update their LHMP every five years and can obtain regional planning commission assistance for preparing the plan.

Although flooding is the primary hazard faced by Vermont communities, the LHMP needs to address not just flooding but all important hazards facing the community. The plan is particularly oriented to identifying priorities for the Hazard Mitigation Grant program. The flood resilience section of the municipal plan is oriented to protect existing landscape features that already function for the community before dwelling on spot by spot fixes. Future LHMPs can address the flood resilience goals and contribute substantially to helping to meet the flood resilience element of municipal plans so efforts do not need to be duplicated.

**Resources:**

- FloodReady.vt.gov provides guidance to communities for developing an LHMP.

FEMA's Hazard Mitigation Grant Program offers a significant source of funding for community flood resilience projects identified in the Hazard Mitigation Plan.

**Municipal Plans (Town Plan)**

For municipalities to qualify for certain grants and incentives, their municipal plans must include, among other components, a flood resilience element that identifies their vulnerabilities and risks and outlines strategies and projects to reduce those risks. In order to reduce the risk of flood damage to infrastructure and property, the plans must designate areas for protection, including floodplains, river corridors, and land adjacent to streams, wetlands, and upland forests. They must also recommend policies and strategies to protect the areas identified to decrease risks to public safety, critical infrastructure, existing buildings and municipal investments.

This means that in flood-prone communities, the vision expressed in the plan, including the parts that address land use, transportation, public facilities and even economic development need to address flood resilience. The municipal plan, as the over-arching plan for the community, also needs to connect and harmonize with the LEOP and LHMP. Those plans can be acknowledged and incorporated by reference.

**EXAMPLES OF FLOOD RESILIENCE PLANS**

Municipal plans adopted after July 1, 2014 need to include a flood resilience element to be eligible for benefits. Examples of plans that address flood resilience include the following:

- West Windsor – flood resilience amendment to the plan
- Unified Towns and Gores of Essex County - part of updated plan
- Greensboro – part of an updated plan

**Resources:**

- The purpose and requirements for Vermont's Municipal Plans are found in 24 VSA Chapter 117. The municipal plan describes the community's goals and how the community will work together to prioritize, fund and make the changes envisioned.
- Any plan updated after July 1st, 2014 must include a flood resilience element.
- Municipal Planning Grants are available for planning and implementation.

**REGIONAL PLANNING COMMISSIONS CAN HELP**

Regional Planning Commissions receive funding to assist municipalities with Hazard Mitigation Plans and Local Emergency operations Plans. They may also be able assist with municipal plans.

**Capital Improvement Program**

Once projects are identified, municipalities need to determine how they will pay for the flood resilience upgrades recommended in the municipal and hazard mitigation plans. The schedule of capital investments over a number of years is generally called a Capital Improvement Program (CIP). This allows the community to prioritize capital projects and to optimize financing. In order to protect public safety, reduce disruption and damage from flooding and foster flood-safe development, the municipal plan and capital improvement program can identify and prioritize many kinds of public facility improvements, including those that are identified in other plans such as:

- Municipal plan priorities for infrastructure including those needed to promote safer places for future development;
- Local Hazard Mitigation Plan priorities;
- River Corridor Plan priorities;
- Culvert, bridge and road priorities;
- Critical facility and public buildings' needs; (including water supply, wastewater facilities, equipment);
- Emergency operations needs;

Consider establishing a CIP reserve fund to match and leverage FEMA Mitigation Assistance. The Hazard Mitigation Grants cover 75% of a project's costs so it is important to prepare a fund specifically to provide the match funds for priority mitigation projects funded by FEMA.

### Resources:

- Flood Ready provides extensive resources on Capital Programs and Budgets for flood resilience.
- For a primer on facilities and capital improvement planning see the Implementation Manual: Vermont Land Use Planning, specifically the papers on Capital Improvement Program and Facilities Management (340 kb)

## Comparison of Plans for Flood Resilience and Preparation

| PLAN | AUTHORITY | LOCAL LEAD | ADOPT BY | UPDATE | FUNCTION | BENEFITS |
|---|---|---|---|---|---|---|
| **Municipal Plan (Town Plan)** | 24 V.S.A. Chapter 117 §4381-4387 | Planning Commission | Governing Body | 5 years | Comprehensive Plan with Land Use focus, incorporating a Flood Resilience element. | • Eligible for MPGs<br>• Eligible for State Designation |
| **Local Hazard Mitigation Plan (LHMP)** | FEMA | Governing Body with help from RPC | Governing Body | 5 years | Identify important hazards and prioritize projects for reducing risks. | • Eligible for FEMA Hazard Mitigation Assistance Program<br>• Part of ERAF eligibility |
| **Local Emergency Operations Plan (LEOP)** | FEMA | Governing Body with help from RPC | Governing Body | 1 Year | • Legal authority for emergency operations<br>• Assigns responsibilities during disaster planning and response | • Prepared for disasters<br>• Part of ERAF eligibility |
| **Capital Improvement Program (CIP)** | 24 V.S.A. Chapter 117 §4430 | Planning Commission and/or Selectboard or Public Works Director | Governing Body | 1 year for Budget, 5 years for Program | Plan beyond one year for how to pay for flood resilience upgrades | Spreads costs over multiple annual budgets |

**ANR** – Agency of Natural Resources, Watershed Management Division

**ERAF** – Emergency Relief Assistance Fund

**FEMA** – Federal Emergency Management Agency

**Governing Body** – Municipal Selectboard, City Council, Town/City Manager, Village Trustees

**MPGs** – Municipal Planning Grants

**RPC** – Regional Planning Commission

**State Designation** – State Incentive Programs for Downtowns, Village Centers, etc.

**V.S.A.** – Vermont State Statutes

## Coordinating Plans

It can be difficult, especially for small towns that rely on volunteers, to produce plans that are coordinated. The people who work on hazard mitigation plans and local emergency operations plans may be made up exclusively of emergency services personnel, while the municipal plan may have an entirely different group involved. Anticipating the potential for this disconnect, FEMA produced guidance on Integrating the Local Natural Hazard Mitigation Plan into a Community's Comprehensive Plan. A short scoring tool at the end of the document may be particularly useful for evaluating whether important issues concerning hazards are addressed in the municipal plan.

For evaluating coordination between all the other plans discussed above, consider adapting this evaluation tool produced for local plans in New Jersey: Getting to Resilience, A Coastal Community Resilience Evaluation Tool.

Responding to the need for greater community collaboration and social cohesion in the face of disastrous floods, some Vermont towns are now forming Community Resilience Organizations. CROs aim to bring diverse sectors of a community together for projects that improve local resilience and at the same time celebrate and build community spirit.

### BENNINGTON AVOIDS DAMAGE THROUGH EFFECTIVE PLANNING

Bennington's Roaring Branch River flows through its downtown and as the name implies, it periodically brings destruction in its path. Bennington had used all the typical strategies to make the downtown safer from flood damage such as building berms and deepening the river channel but after millions of dollars in damage and reconstruction, town leaders began to see that these methods only made matters worse. Starting in 2008, Bennington began a new approach to managing the river starting with a plan using the following steps:



- Conducted public outreach and obtained agreement from residents to protect the town's economic center and ensure public safety.
- Identified areas of economic activity that might be impacted by a major flood, noting key employers, infrastructure and support functions such as police and town offices.
- Analyzed the flood risks in specific locations in their community.
- Identified physical changes that could reduce or eliminate risks to key areas by reducing the river's energy during flooding and spreading flood water on open land.

Bennington put the plan into action by:

- Adopting new flood hazard zoning regulations to keep people and buildings out of harm's way and preventing development that causes worse flooding on other properties.
- Restoring floodplains by acquiring land next to the river, removing berms and allowing room for the river to move and flood without causing damage.

The new flood hazard regulations made the town eligible for increased disaster relief funds and additional funds to finance the floodplain restoration.

While other parts of Bennington were hit hard by Tropical Storm Irene in 2011, the Park Street Bridge and the downtown area were largely saved by the restored floodplain. The Town's planning director, Dan Monks later said, "Without the floodplain restoration in that area, the bridge would've likely been destroyed." The Town estimates that it avoided $93 million in damages to property, roads, bridges and other infrastructure. In comparison, the floodplain restoration cost around $725,000. Clearly it was a worthwhile investment.

# Preparation Matters to Businesses

It's easy to think that disasters always happen somewhere else to someone else, but disasters can strike any business or community anywhere and at any time. While we cannot know when or where the next disaster will strike, every town in Vermont has experienced flooding and the state has had at least one federally-declared disaster in 20 of the past 25 years. The good news is that businesses can take steps today to prepare, respond and recover from these risk and put themselves in a position to bounce back more quickly.

## Why it Matters

The cost of not preparing for disasters can pose serious risk to any organization. According to FEMA, nearly 40% of businesses do not reopen after a disaster and data from the US Small Business Administration shows that over 90% of businesses fail within two years after being struck by a disaster.

While most organizations, both public and private, cannot afford unplanned and prolonged downtime from an unforeseen emergency, many struggle with getting started on their emergency plans and disaster preparations.

Simply identifying business risks can significantly reduce potential damages and business recovery costs. Understanding what the risks of flooding are for your business will help you:

- Make sure that you have the right insurance coverage for business interruption.
- Plan ahead and take steps like developing a continuity of operations plan (COOP) to limit potential damage (see Business Continuity Plans below for details).
- Train employees so they know what actions to take in the event of a disaster or after receiving a flood warning.

## Steps Businesses Can Tale to Reduce their Risks

1. **Identify Flood Risk.** Identifying your risk is a good place to start. Floodplain maps are available at most town offices, or click here http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your business is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.
2. **Review Insurance Policies.** Many types of disasters are not covered under normal insurance policies and funding or loans from government agencies is often too little and too late. All insurance policies have overall policy limits and specific limits for different types of coverage and any business located in a flood-prone area should carry flood insurance. Also check to make sure your insurance includes business

interruption coverage and that it reimburses other unexpected costs (like service interruptions from lost power or Internet access, lawsuits and unemployment compensation claims filed by employees). Business interruption insurance compensates a business for lost income, expenses and profits if a disaster, such as a flood, closes your doors. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage. See Insurance Checklist for Business for additional details.

3. **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money.
4. **Plan Ahead.** There are also a number of low-cost steps you can take to reduce the impacts of a flood. At a minimum, regularly back-up computer data and store important tax and financial records and information such as your insurance policy details in a flood safe place. Documenting your building, furnishings, equipment and inventory with photos or video can speed the insurance claims process.
5. **Train and Practice.** Employees need to understand flood warnings and what to do when they get one. This includes understanding the dangers of flooding and how to evacuate the building safely. Train all staff on procedures to shut down the business and how to deploy loss reduction measures, like relocating equipment and inventory to upper floors and deploying door and window dams to reduce flooding. Finally, remember that flooding can also affect employees' ability to work, as their priority may be to protect their home and family first.
6. **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. Having a business continuity plan and a few extra minutes to evacuate can save lives and your business.

Tools to help businesses prepare in the event of flooding or other disasters can be found on the following pages. They include:

- Details on preparing a Business Continuity of Operations Plan (COOP) with access to templates and resources for help
- A disaster preparation checklist specifically for farms. This is intended to help farmers prevent losses from flooding and other disasters that can destroy a farm's viability.
- An Insurance Checklist for businesses to help determine what insurance is needed

# Business Continuity Planning

A business continuity plan (also called a continuity of operations plan or COOP) is a written document that outlines how an organization will respond and recover from a major emergency or localized disaster like server failure or burst water pipes. When disaster strikes, having a plan in place and being able to put it into immediate action can mean the difference between staying open to serve the needs of customers or shutting down for a few days or weeks.

## What's included in a business continuity plan?

At a minimum, a continuity plan should include critical information:

- A list of important contacts including your insurance company, key customers and vendors and staff contacts.
- A map showing locations of important equipment to relocate (computers and servers) and where to shut off electricity, gas and other services.
- Procedures to protect your property and minimize business disruption – e.g., remote back-up of computer files, a plan to relocate inventory or livestock.
- A back-up location to conduct business while the building is being repaired.

Most have also have step-by-step instructions to:

- Understand operations and supply chain;
- Maintain the workforce;
- File an insurance claim;
- Ensure delivery of goods and services;
- Assess facility operations;
- Assess risk for reopening and likelihood of success; and
- Finance recovery operations.

### STEPS TO PROTECT BUSINESS OPERATIONS

**To do before a disaster:**

- Ensure safety lights, smoke detectors and fire extinguishers are in place.
- Develop systems to work off site.
- Identify alternative sites for business operations.
- Locate critical objects up off the floor and out of basements.
- Create a communications plan for employees and key contacts.
- Digitize business records and keep an off-site copy.
- Have a website.
- Talk with your town about their continuity planning.
- Help your employees be more prepared at home.

Having a continuity of operations plan can help business identify and assign essential tasks that will help minimize the damage and reduce recovery time and expense.

To be effective, ongoing training and practice with the plan helps assure the plan is tested, updated, and employees are properly trained.

## Continuity of Operations Templates and Information

The US Small Business Administration https://www.sba.gov/content/disaster-preparedness offers has an online tool to help business create a continuity of operations plan http://www. preparemybusiness.org/planning as well as more detailed information on how to prepare and protect your employees and business and from disasters and floods.

FEMA also has online tools to help businesses develop a plan to address the impact of natural and human made disasters http://www.ready.gov/business.

Other free resources to help businesses prepare for natural disasters, including business continuity plan templates, include:

- Insurance Institute for Business and Home Safety – general information and templates – https://www.disastersafety.org.
- American Red Cross Ready Rating Program – business and organizational disaster readiness self-assessment tool – http://www. readyrating.org
- Internal Revenue Service – short video introducing COOP – http://www.irsvideos.gov/Individual/DisasterInformation/BusinessContinuityPlanning
- Vermont Division of Emergency Management and Homeland Security – http://vem.vermont.gov/sites/vem/files/Business%20Workbook%20Fillable%202014.pdf
- CERF+ (Craft Emergency Relief Fund + Artists' Emergency Resources) offers tailored disaster guidance and recourses for artists – http://studioprotector.org/OnlineGuide/DisasterPlanning/DisasterSpecificPlanningResources.aspx.

## Additional Assistance

The Vermont Small Business Development Center http://www.vtsbdc.org and many of Vermont's Regional Development Corporations http://accd.vermont.gov/business/partners/rdc and Regional Planning Commissions http://www.vapda.org can also provide training and one-on-one assistance to help your business develop a continuity of operations plan.

# Disaster Preparation for Farms

While farmers share many of the same challenges after flood events as other businesses, like the loss of electricity and lack of access to markets, farmers must consider the effects of flooding on their most valuable asset – farmland. Flooding of farmland creates unique problems – the cost to remove silt and debris, contamination of current crops as well as the loss of land from erosive flooding.

The financial and emotional costs of recovering from flooding and other types of farm disasters are high. One proven way to reduce the impact of disasters is to be prepared.

In addition to planning ahead, farmers can best protect the land and crops from flood damage by planting cover crops or trees and shrubs along riverbanks to reduce the effects of flood scour and erosion. Trees, shrubs, and deep-rooted grasses planted along the river as a buffer between the water body and the crops help to retain the riverbank and reduce soil loss.

Use the following list to help prepare for minimizing farm losses in a flood disaster.

**Crop-related Preparations**

- Harvest early vegetable crops that can be harvested and are in floodplain fields. (The edible portion of any crop that comes in contact with flood water is considered adulterated and may not be sold.)
- Hoop houses in the flood way should have the sides elevated to allow the flow of flood waters.

**Power and Food/Water Preparations**

- Check monthly to see that your generator is in good working order. Consider purchasing a generator if you currently don't have one.
- Purchase sufficient amounts of fuel to operate your generator and other equipment on the farm.
- If a generator is required for emergency agricultural purposes (i.e. milking cows, cooling milk tanks, poultry house ventilation, etc.), notify town officials. Ensure a transfer switch is properly installed (disconnect the house or barn from the grid) in order to use a generator.
- Charge batteries on cell phones and cameras.
- Pump and store adequate supplies of drinking water for humans and animals in the likelihood of power outages. A 36-hour reserve is recommended.

**Livestock Preparations**

- Check feed inventory and order extra if needed.
- Move feed, including round bales to higher ground, or to a more accessible place in case floodwaters close roads or limit access.
- Move livestock and poultry to higher ground out of the way of floodwaters.
- Mark animals with an identifier so they can be easily returned if lost.
- Store medicines in a secure location safe from flooding.

**Equipment Preparations**

- Remove hoop houses from flood prone areas (floodplain maps are available at most town offices, or click here http://floodready.vermont.gov/assessment/vt_floodready_atlas).
- Move equipment to the highest, open ground possible away from floodwaters.
- Secure hazardous substances, e.g., fuel and propane tanks, fertilizers, and pesticides, so they are safe from flooding.

**General Preparations**

- Create a farm map and include buildings and structures and the contents of each, access routes (include farm roads, lanes, fences, gates), locations of livestock, locations of all hazardous substances, and electrical shutoff locations.
- Develop a response plan to address manure, fuel, fertilizer, pesticide, or other chemical spill.
- Make a list of important phone numbers ahead of time in order to make calls following a storm. Include contact information for all employees, suppliers or service provides, e.g., livestock or milk transport, feed delivery, fuel delivery, town Emergency Management District, county extension agent, insurance agent, county Farm Service Agency and private veterinarian.
- Develop an emergency plan and test the plan to ensure that its workable, updated, and employees are properly trained.
- Annually review your insurance coverage. Consider coverage for "all-hazard" situations (e.g., flood, hail damage).
- Listen to local news and weather reports for any potential flood warnings in your area.

## Additional Assistance

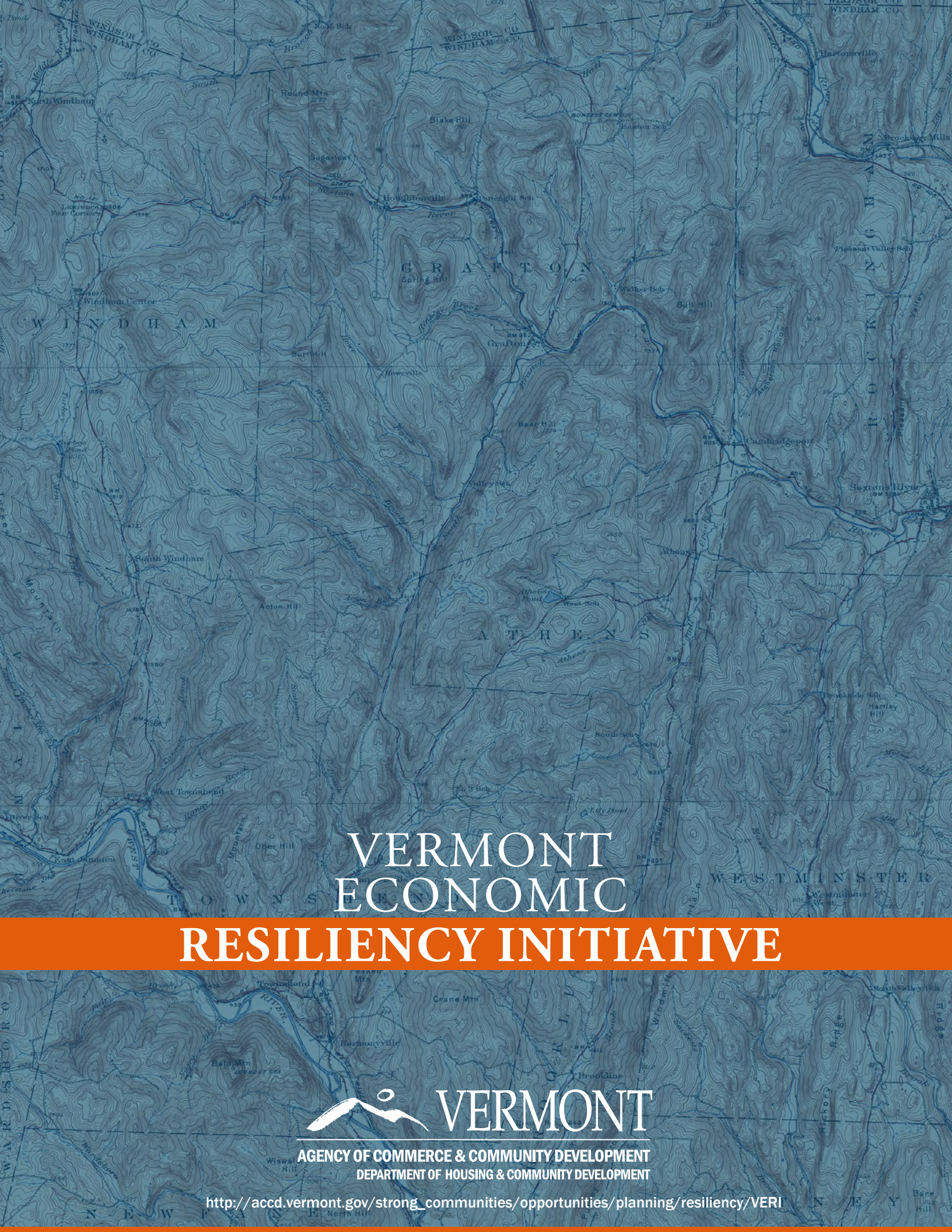
For more detail on emergency preparedness for agricultural operations go to http://readyag.psu.edu/

# Insurance Checklist for Businesses

This checklist is designed to help businesses assess the types of insurance coverage that can help the business survive and recover after a flood.

| ✓ | CONSIDERATIONS |
|---|---|
| | **Do you have coverage for flood?**<br>The National Flood Insurance Program (NFIP) provides coverage for up to $500,000 for damages to the building and $500,000 for contents. Flood coverage for business interruption is not available through NFIP. |
| | **Do you have coverage for Business Interruption?**<br>Business Interruption insurance covers policyholders for lost profits plus continuing expenses after an insured loss, subject to specific limits in the policy. |
| | **Do you have coverage for Service Interruption?**<br>Service Interruption coverage provides coverage for lost power. However, coverage is often excluded if the loss of power is caused by damage to overhead power lines within a certain distance from the insured property. |
| | **Do you have coverage for Civil Authority?**<br>Civil Authority coverage insures for business interruption losses, should your business be impacted by an action by the government that restricts access to your location. This coverage has specific restrictions and limitations so be sure to carefully read your policy. |
| | **Are the limits under your policy sufficient?**<br>All insurance policies have overall policy limits and specific limits for different types of coverage. Be sure to review your policy carefully to make sure your coverage is reasonable. |
| | **If you have any key customers or suppliers, do you have Contingent Business Interruption coverage?**<br>What would the impact to your business be if one of your key suppliers or customers is impacted by a significant incident like a flood or a fire? If a significant portion of your revenue is dependent upon a key supplier or a key customer, you should consider Contingent Business Interruption coverage. |
| | **What is the deductible under your policy?**<br>Insurance policies often have a single dollar deductible (e.g. $25,000 per occurrence) for most losses. However, some policies have specific deductibles for high risk types of losses. For example, if you are in a high risk area, you may have a deductible that is "5% of insured values". Be sure to check your policy carefully and understand what your deductible can be. |

| | |
|---|---|
| | **Is the value of your building underreported?**<br><br>Coinsurance is a penalty imposed by the insurance carrier for under reporting/declaring/insuring the value of tangible property. The penalty is based on a percentage stated within the policy and the amount under reported. As an example:<br><br>A building's replacement cost actually valued at $1,000,000 has an 80% coinsurance clause but is insured for only $750,000. Since its insured value is less than 80% of its replacement value when the loss occurs, the insurance payout will be subject to the underreporting penalty. For example, if it suffers a $200,000 loss, the insured would recover $750,000 ÷ (0.80 × 1,000,000) × 200,000 = $187,500 (less any deductible). In this example, the underreporting penalty would be $12,500.<br><br>The most commonly issued coinsurance percentage would be 80% but it can be as high as 100%. For this reason, it is vital for values of property to be updated annually to reflect inflation and other increases in cost. |
| | **Do you have any assets that have a long lead time and may take significant time to replace should a loss occur?**<br><br>If some key assets may take a long time to replace, consider having spares or vendors ready to execute a purchase order should a loss occur. |
| | **If you have more than one location, have you considered how an incident at one location will impact the other location?**<br><br>For some businesses, a significant loss at one location can result in additional losses to another location due to interdependencies. For other businesses, if one location suffers a loss, another location can help offset that loss by shifting employees and other resources. Businesses should think through how a catastrophic loss at one location can impact other locations. |



# VERMONT ECONOMIC RESILIENCY INITIATIVE

VERMONT

AGENCY OF COMMERCE & COMMUNITY DEVELOPMENT

DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI