Town of Sunderland
Hazard Mitigation Plan

Sunderland, Vermont

Plan Date: April 30, 2021
Adopted May 10, 2021

TOWN OF SUNDERLAND, VERMONT
104 Mountain View Road, Sunderland, Vermont 05250

Resolution of Adoption

Date of Adoption: May 10, 2021

A Resolution adopting the Town of Sunderland Hazard Mitigation Plan

WHEREAS, the Town of Sunderland has worked with the Bennington County Regional Commission to identify hazards, analyze past and potential future losses due to natural disasters, and identify strategies for mitigating future losses; and

Whereas, the Town of Sunderland has developed a hazard mitigation plan that provides a series of potential projects and actions to mitigate damages from disasters that could occur in the Town, and

Whereas, the Town of Sunderland has provided an opportunity for members of the public, surrounding towns, and other agencies and organizations to comment on the draft hazard mitigation plan, and

Whereas, both Vermont Emergency Management and the Federal Emergency Management Agency reviewed and provided substantive comments on the draft plan, and

Whereas, changes requested by Vermont Emergency Management and the Federal Emergency Management Agency have been incorporated in the Town of Sunderland Hazard Mitigation Plan dated April 30, 2021, and

Whereas, a duly noticed public meeting was held by the Town of Sunderland Selectboard to formally adopt the Town of Sunderland Hazard Mitigation Plan dated April 30, 2021.

NOW THEREFORE BE IT RESOLVED, that the Town of Sunderland hereby adopts the Town of Sunderland Hazard Mitigation Plan dated April 30, 2021 and intends to implement the actions in this plan if funding is available.

Jon French (Chair)

Bruce Mattison

Bruce Mattison

Brenna Warren

Richard Zens

Andrew McKeever

Sunderland Town Clerk
Rocelved for record this
day of
ATTEST

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I. Introduction

A. Purpose

Hazard mitigation actions are intended to reduce potential losses from natural hazards such as flooding, landslides, wildland fire, and similar events. Hazard mitigation plans identify, assess, and prioritize those hazards and present actions that a community can undertake to reduce risks and damage from those natural hazards (Federal Emergency Management Agency 2013a).

This plan identifies, describes, and prioritizes potential natural hazards that could affect the Town of Sunderland in Bennington County, Vermont and provides specific measures to reduce or avoid those effects. The Federal Emergency Management Agency (FEMA), within the U.S. Department of Homeland Security and the Vermont Department of Emergency Management both advocate the implementation of hazard mitigation measures to save lives and property and reduce the financial and human costs of disasters.

The format of this plan is as follows. Section II provides a profile of the town, including a discussion of the environmental setting, demographics, and settlement patterns. Section III describes the planning process along with lists of members of the planning team and dates of meetings and public and agency review. Section IV analyzes the following hazards:

- Flooding and Fluvial Erosion
- Winter Storms
- High Wind Events
- Hail
- Temperature Extremes
- Drought
- Wildfire
- Earthquake
- Landslides and Rock Falls
- Invasive Species
- Hazardous Materials Spill
- Infectious Disease Outbreak

Section V assesses vulnerability, and Section VI discusses mitigation goals and actions, including current programs and town capabilities. Section VII describes how the plan will be maintained and updated.

B. Mitigation Goals

The Town identified the following mitigation goals:

1. Reduce injury and loss of life resulting from natural disasters.
2. Reduce damage to public infrastructure, minimize disruption to the road network and maintain both normal and emergency access.
3. Establish and manage a program to proactively implement mitigation projects for roads, bridges, culverts, water supply systems and other municipal facilities to ensure that community infrastructure is not significantly damaged by natural hazard events.
4. Design and implement mitigation measures so as to minimize impacts to rivers, water bodies and other natural features, historic structures, and neighborhood character.
5. Increase the economic resiliency of Sunderland by reducing the economic impacts incurred by municipal, residential, agricultural, and commercial establishments due to disasters.
6. Incorporate hazard mitigation planning into other community planning projects, such as Town Plan, Capital Improvement Plan, and Town Local Emergency Management Plan
7. Ensure that members of the general public continue to be engaged in the hazard mitigation planning process.

II. Town Profile

A. Regional Context

The Town of Sunderland is located in southwestern Vermont in Bennington County. It is bordered by the Towns of Arlington, Sandgate, Manchester, Winhall, Somerset, Glastenbury, and Shaftsbury (Map 1). The town is approximately 45.5 square miles in area.

B. Demography and Land Use

According to the 2018 Town Plan (Town of Sunderland 2018), Sunderland's population has grown from 601 in 1970 to 956 in 2010 or 12.5%. Projections indicate the population will increase to 1,012 in 2020 and 1,037 by 2030. A significant portion (22.8%) of the population is older than 62. Nearly all (96.7%) of the population is Caucasian (Town of Sunderland 2018).

Map 2 shows landcover with most of the town consisting of deciduous, coniferous, and mixed forests. Much of the land east of Route 7 is within Green Mountain National Forest. Given demographic projections and the large amount of the town that is conserved, development pressures can be considered to be minimal.

C. Economic and Cultural Resources

The Town has a small commercial base consisting of 21 employers with 101 employees as of 2010 (Town of Sunderland 2018). The largest include Orvis, Green Mountain Power, Casella Waste Management, Ira Allen House, Arcady at Sunderland Lodge, Christmas Days, Wilcox Ice Cream and Specialty Foods and Sunderland Elementary.

D. Critical Facilities

Sunderland is a small town with only a few critical facilities. The town contracts with the Arlington Fire Department for fire protection services and with the Vermont State Police and the Bennington County Sherriff for police protection.

Table 1. Sunderland critical facilities
Source: See Map 3

Name	Description
Town Offices	Town offices on Mountain View Rd.
Town Garage	Town highway maintenance facilities on Sunderland Hill Rd.
Sunderland Elementary	Elementary School on Bear Ridge Rd.
Communications Tower	Communications tower on North Rd.

III. Planning Process

A. Planning Team

BCRC staff had an initial meeting with the Sunderland Select Board on January 27, 2020. The Select Board decided to serve as the planning team and to invite others as needed, including the town emergency management director. Comments were also solicited from the road foreman.

Table 2. Planning committee members

Name	Affiliation
Jon French	Chair, Sunderland Select Board
Bruce Mattison	Sunderland Select Board
Richard Zens	Sunderland Select Board
Rick Timmerman	Sunderland Select Board
Andrew McKeever	Sunderland Select Board
Adam Annunziata	Sunderland Emergency Management Director

B. Public Involvement

Table 3 below shows the dates of meetings, all of which were public. Some meetings were held through Zoom due to the COVID-19 Pandemic guidelines on public gatherings.

Table 3. Dates of planning meetings and public and agency review	
Meeting	Date (s)
Initial meeting with Sunderland Select Board	27 January 2020
Sunderland Select Board	28 September 2020
Sunderland Select Board	26 October 2020
Sunderland Select Board	9 November 2020
Sunderland Select Board	14 December 2020
Sunderland Select Board	28 December 2020
Sunderland Select Board	25 January 2021
Sunderland Select Board	8 February 2021
Sunderland Select Board Sunderland Select Board	12 April 2021 May 10, 2021

The Town also solicited comments from members of the public through a survey on SureyMonkey that was noticed on the town website and Front Porch Forum on January 5, 2021. The survey had the following major findings:

- Twenty-eight individuals responded. The majority had not experienced a natural disaster.
- The primary hazards of concern were strong/high winds, thunderstorm winds, winter storm and ice storm.
- People (loss of life or injury), infrastructure and environmental damage were the primary concerns for vulnerability.
- Infrastructure improvements, avoiding new construction in hazard areas and working with property owners to understand and prevent damages were thought to be the most effective mitigation strategies.
- Social media, the U.S. Postal Service and Town publications or mailings were considered the most effective sources of information on preparing for natural hazards.

The plan was posted on the town website and comments were requested at planning team (Select Board) meetings and during Town Meeting in March. The plan was also sent to the Bennington County Regional Commission , Local Emergency Planning Committee #7 and the surrounding towns of Sandgate, Manchester, Winhall, Stratton, Somerset, Glastenbury, Shaftsbury and Arlington (see Map 1). One comment was received from the Sandgate Select Board Chair:

"Were there any particular spots in the plan that would imperil Sandgate?"

No hazards were identified that occurred in Sunderland that would affect the Town of Sandgate. The two towns border at the northwest corner of Sunderland and southeast corner of Sandgate, so they share a minimal boundary. No actions were developed in the hazard mitigation plan that would affect Sandgate.

At the April 12th meeting, the Select Board authorized BCRC to submit the draft to Vermont Emergency Management. VEM approved the plan pending adoption and the Select Board adopted the plan on May 10, 2021.

IV. Hazard Assessment

A. Hazard Assessment

The following sections provide a detailed assessment of each of the hazards based identified by the planning team based on data from the following sources listed in Section VIII References:

a. Local knowledge
b. The National Climate Center storm events database (National Oceanographic and Atmospheric Administration 2019 site)
c. Federal Emergency Management lists and descriptions of past disaster declarations
d. The Vermont Department of Forests, Parks and Recreation data on wildfires
e. HAZUS runs on potential earthquake damage.
f. Cooperative weather observer data and station normal where available (National Oceanographic and Atmospheric Administration 2020b)
g. Palmer Hydrologic Drought Index calculated from 1985 to 2019 from the National Oceanographic and Atmospheric Administration (NOAA)
h. Hazardous materials spills from the Vermont Agency of Natural Resources (VT ANR)
i. Infectious disease outbreaks listed from the Vermont Department of Health
j. Observations of invasive species compared to the state and federal lists of noxious species.
k. The Vermont Hazard Mitigation Plan (2018)
l. New England Weather, New England Climate (Zielinski and Keim 2003), Vermont Weather Book (Ludlum 1996)
m. Federal Emergency Management 2015 Flood Insurance Study, Bennington County, Vermont and Incorporated areas, Federal Emergency Management Agency Study Number 5003CV000A
n. Fuel types and potential for wildfire from LANDFIRE (http://www.landfire.gov/) and from the Vermont Department of Parks, Forests and Recreation
o. Earthquake data from the Northeast Earthquake Maps and Catalog (http://www.bc.edu/research/westonobservatory/northeast/eqcatalogs.html)
p. Vermont Agency of Natural Resources and Vermont Agency of Agriculture, Food and Markets on invasive species and surveys completed within Sunderland.

q. Identification of ranking of the potential for landslides by Josh Duncan (2015), a student at Green Mountain College using a modified protocol based on Clift and Springston (2012)

With respect to NOAA data, there have been numerous changes to that database in just the last few years. While NOAA data goes back to 1950, there was a dramatic change in 1996 in the way data were collected. The number of events recorded annually in years prior to 1996 is far less than from 1996 onward. Therefore, for the best reliable data, we used only data from 1996 onwards. We have also looked at the other sources of historical weather data. The cooperative weather observers for Peru, Sunderland and Pownal in Vermont have the most consistent long-term data. The only stream gauge is in Bennington near the New York border on the Walloomsac, which is in a different watershed than the Batten Kill, which encompasses Sunderland. The Batten Kill gauge in Arlington is recorded on an irregular basis. There are no weather stations that record or keep long term data records in Sunderland except for the cooperative weather listed above observers who record daily observations, but not the specifics of storm events. That station is apparently no longer operating.

We looked at the USGS high water marks for Irene (Medalie and Olson 2013), located only along the Batten Kill in Sunderland and portions of the Roaring Branch and Walloomsac in Bennington. These high-water marks appear to correspond to the outer boundaries of the base flood elevation shown in the final FEMA flood maps.

Finally, we reviewed several studies on potential impacts of climate change developed by the Intergovernmental Panel on Climate Change (Christensen et al 2013), the Vermont Agency of Natural Resources (Tetra Tech 2013), the University of Vermont (Galford et al. 2014), the Global Climate Change Research Program (Horton et al 2014), and the U.S. Forest Service (Rustad 2012). The relationship between climate change and the frequency and extent of natural hazards is a developing science, and we described, where appropriate, how climate change might affect hazards in the future.

B. Flooding and Fluvial Erosion

1. Description

a. Flooding

Flooding and associated fluvial erosion are the most frequent and damaging natural hazards in Vermont. The National Weather Service (2010) defines a flood as “any high flow, overflow, or inundations by water which causes or threatens damage.” A flash flood is …” a rapid and extreme flow of high water into a normally dry area, or a rapid water rise in a stream or creek above a predetermined flood level.” These are usually within six hours of some event, such as a thunderstorm, but may also occur during floods when rainfall intensity increases, thereby causing rapid rise in flow. The NWS uses the following impact categories:

- Minor Flooding - minimal or no property damage, but possibly some public threat.
- Moderate Flooding - some inundation of structures and roads near stream. Some evacuations of people and/or transfer of property to higher elevations.
- Major Flooding - extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.
- Record Flooding - flooding which equals or exceeds the highest stage or discharge observed at a given site during the period of record keeping.

Floods may reach these magnitude levels in one or more reaches, but not necessarily all. Runoff from snowmelt in the spring, summer thunderstorms, and tropical storms and hurricanes can all result in flooding in Sunderland. Ice jam flooding can occur on Vermont rivers when substantial ice forms followed by several days of warmth, snowmelt and any rainfall leading to ice breakup. As the ice breaks up on the rivers, chunks of ice form jams which cause localized flooding on main stem and tributary rivers. Ice jams are most prevalent during the January thaw (late January) and in March and April as spring approaches.

Flash floods can occur after spring melt of mountain snow, following large storms such as Tropical Storm Irene, or after significant thunderstorms. Digital flood zone maps have been prepared and are currently under review. Map 4 shows the location of both flood hazard zones and river corridors (formerly fluvial erosion hazard zones). As can be seen, there is substantial overlap between these areas.

Most development in Sunderland is located in the valleys along the Batten Kill. Headwaters of these streams can be very flashy, and while some flood losses are the result of inundation, more often flood losses are caused by fluvial erosion. Fluvial erosion can range from gradual bank erosion to catastrophic changes in the location of the river channel (Vermont River Management Program 2010). There are no dams located in Sunderland.

b. Fluvial Erosion

In Vermont, most rivers flow through relatively confined valleys, but still meander over time across the floodplain. River corridors provide an area within which a river can move across the landscape as it dissipates energy and transports and deposits sediments. Where rivers are constricted by bridges and other structures or rip rap, the water moves at higher velocity, resulting in downcutting and collapse of the banks. This may undermine structures within the corridor.

2. Previous Occurrences

Ludlum (1996) describes numerous storm events that have affected Vermont since settlement, but the local impacts of these are difficult to trace. The 1927 flood was the largest disaster in the history of the state. The state received over six inches of rain, with some areas receiving 8-9 inches. Following a rainy October, this storm occurred from November 2nd

through the 4th causing extensive flooding. Two storms occurred in March of 1936. Heavy rains and snowmelt caused significant flooding. Two years later, the 1938 hurricane caused both flooding and extensive wind damage.

Table 4 shows a total of 59 flood events in Bennington County from 1996 to 2018, using NOAA data. These have been primarily minor and affected either specific streams, such as the Batten Kill and the Walloomsac, or specific towns.

Table 4. Total number of flood events by type and year for Bennington County.
Source: National Oceanographic and Atmospheric Administration 2019

Year	Flash Flood	Flood	Total
1996	3	6	9
1997			
1998	1	3	4
1999	2		2
2000	4	1	5
2001			
2002	1		1
2003		2	2
2004	1	5	6
2005		5	5
2006			1
2007	1	1	2
2008			
2009	2		2
2010			
2011	3	3	6
2012			
2013	4		4
2014			
2015			
2016			
2017		1	1
2018		1	
2019		8	8
Total	22	37	59

Hurricanes and tropical storms that form in tropical waters have historically affected New England but are relatively infrequent. Besides the 1938 storm, Tropical Storm Belle (August 9-10, 1976; DR-518) brought significant rains to Vermont in 1976 and Hurricane Gloria brought rain and wind damage in 1985. Sunderland has been subjected to two major tropical storms in the past twenty years. Hurricane Floyd was a Category 4 storm before hitting North

Carolina, and then was reduced to a tropical storm when it reached southern New England. Tropical Storm Irene was the remnant of Hurricane Irene, which was a Category 1 hurricane. A category 1 storm has winds of 74-95 miles per hour and could damage roofs, down shallow-rooted trees, and damage power lines (http://www.nhc.noaa.gov/aboutsshws.php).

The following describes 14 moderate and extreme events that have occurred since 1996, using the National Weather Service (2010) categories, which affected Sunderland or nearby areas. These events were described in the National Oceanographic and Atmospheric Administration records (2019). It should be noted that only the January 1996 event occurred in the winter, with all other events in the spring, summer, or fall. Ice jam flooding does occur, and one instance of damage is described below.

January 19 to 20, 1996 (DR-1101 1/19 to 2/2 1996): An intense area of low pressure which was located over the Mid-Atlantic region on Friday morning January 19th produced unseasonably warm temperatures, high dew points and strong winds. This resulted in rapid melting of one to three feet of snow. In addition to the rapid snowmelt one to three inches of rain fell as the system moved northeast along the coast. This resulted in numerous road washouts and the flooding of several homes across the county. *Note that this was also categorized as a High Wind event.

April 24, 1996: Significant rains on Tuesday evening April 23 resulted in flooding along the Walloomsac and Batten Kill Rivers in Bennington County. The Walloomsac River crested 1.5 feet over flood stage at North Bennington and the Batten Kill crested one foot over flood stage at Arlington. The flooding resulted in several road closures but much of the flooding was minor.

May 11 to 12, 1996: Rainfall in excess of 2 inches fell during this period over much of Vermont. This resulted in flooding along the headwaters of the Batten Kill near Arlington in Bennington County.

September 16 to 17, 1999 (DR-13079/16-21 1999): The remnants of Hurricane Floyd brought high winds and heavy rainfall (3-6 inches) to southern Vermont. Many smaller tributaries reached or exceeded bankfull. Estimated wind gusts exceeded 60 mph, especially over hill towns. Power outages occurred across southern Vermont. A Cooperative Weather Observer recorded 4.94” of rain in Sunderland.

July 14-17, 2000 (DR- 1336 7/14-18 2000): Thunderstorms caused torrential rainfall with flash flooding washing out sections of roadways in northeast Bennington County and southern Bennington County. Route 7 was closed due to flooding and rockslides and Route 67 was closed due to flooding. Numerous other roads were closed, with some washed out. This rain produced enough runoff to cause the Batten Kill to exceed the six-foot flood stage by about a foot at Arlington, Bennington County, representing a 47-year high. The swelled river flooded the Batten Kill Canoe Company and adjacent river property. A Cooperative Weather Observer recorded 3.39” of rain in Sunderland.

March 29 to 30, 2003: Up to two inches of rain fell across southern Vermont. The gage on the Batten Kill in Arlington crested at 6.3 feet, which is 0.3 feet above flood stage.

July 21 to 18 August 2003 (DR-1488 7/21-8/18 2003): Severe storms and flooding affected Vermont including Bennington County (Note: this event does not appear in the NOAA data). A Cooperative Weather Observer recorded sporadic and sometimes large amounts of precipitation during that period in Sunderland.

March 31 through April 2, 2004: As much as three inches of rain fell from March 31st through April 2nd across southern Vermont. This rain combined with the last of the snow melt to produce an excessive runoff of water. As a result, flooding took place in Bennington County. The Manchester Schools were closed due to flooding. The gage on the Batten Kill River in Arlington, rose to 6.9 feet, nearly a foot above the 6-foot flood stage during the predawn hours of April 3rd.

January 14, 2005: The Batten Kill exceeded the 6.0-foot flood stage at the Arlington gage at 08:06 AM on the 14th.

November 30, 2005: On November 30, widespread rainfall of 1-1.5 inches and snow melt increased river levels resulting in minor flooding on the Batten Kill River at Arlington, Vermont. The river exceeded the 6.0-foot flood stage with a crest of 6.5 feet at 2:00 PM EST.

April 16 to 17 2007 (DR-1698 4/15-21 2007): An intense coastal storm spread heavy precipitation across southern Vermont, starting as a of mixture snow, sleet and rain which changed to all rain. Liquid equivalent precipitation totals ranged from three to six inches leading to minor flooding across portions of southern Vermont. A Cooperative Weather Observer recorded 3.54" of rain in Sunderland. Minor flooding occurred along the Batten Kill in Arlington, where the level crested at 6.80 feet at 05:30 EST on the 17th. This was 0.80 feet above the flood stage of 6 feet. The water level exceeded flood stage at 11:54 PM on the 16th.

August 28-29, 2011 (DR-4022 8/27-29 2011): Tropical Storm Irene produced widespread flooding, and damaging winds across the region. Rainfall amounts averaged four to eight inches and fell within a twelve-hour period. A Cooperative Weather Observer recorded 5.16" of rain in Sunderland. In Bennington County, widespread flash flooding and associated damage was reported countywide, with many roads closed due to flooding and downed trees and power lines. Strong winds also occurred across southern Vermont, with frequent wind gusts of 35 to 55 mph, along with locally stronger wind gusts exceeding 60 mph. The combination of strong winds, and extremely saturated soil downed trees leading to widespread long duration power outages.

September 7, 2011: Large amounts of moisture from the remnants of Tropical Storm Lee interacted with a frontal system producing heavy rainfall with total rainfall amounts ranging from three to seven inches. This led to widespread minor to moderate flooding across southern Vermont.

January 12, 2018: A warm air mass with periodic heavy rain of one to two inches resulted in flooding, including across Route 313 due to an ice jam.

The gauge along the Batten Kill in Arlington is not monitored continuously. In addition to the 2004 record, readings above flood stage occurred on April 1, 1998 (6.35 ft.), January 14, 2005 (6.3 ft.), October 9, 2005 (6.8 ft.), December 10, 2008 (6.0 ft.) and March 31, 2010 (6.5 ft.) (National Weather Service 2020).

c. Extent and Location

There are no stream gauges within the town of Sunderland. The closest is a gauge downstream in Arlington that is only periodically monitored. There are no stations measuring fluvial erosion. Several post Irene flood elevation data were collected along Warm Brook and the Batten Kill just across the border in Arlington. These generally correspond to the boundaries of flood zones mapped by FEMA. Sunderland has the Floodway and Zones AE and A mapped as well as some 500--year floodplain within the town. There have been no NFIP-designated repetitive losses within Sunderland. Therefore, based on local knowledge of past events and FEMA and VT ANR mapping, Map 4 show the most likely extent of damages from flooding or fluvial erosion.

The primary damages from past events have been from flooding and fluvial erosion with secondary damage from wind. There have been no NFIP-designated repetitive losses within Sunderland. Map 5 shows damages identified with Marc Johnson, the town road foreman, most of which occurred during Tropical Storm Irene. Damages are categorized based on the process: erosion or water undermining structures; deposition or where roads or structures are covered or plugged with materials; and inundation, where roads or structures are covered by water for sufficient time to close them.

The best estimates of extent are shown on Map 4 in the FEMA mapping of special flood hazard areas and the VT ANR mapping of river corridors. Based on local knowledge and past events, these maps show the most likely extent of damages from flooding or fluvial erosion.

In addition to the above events, the Peru, Pownal and Sunderland Cooperative Observer recorded precipitation. Table 5 shows those months by year where that value exceeded the 90th percentile, which varies by site and month. Several events of that magnitude have occurred where flooding was not recorded in NOAA records or local knowledge. High precipitation events could indicate unreported localized flooding events and, therefore, provide additional information on potential flooding extent.

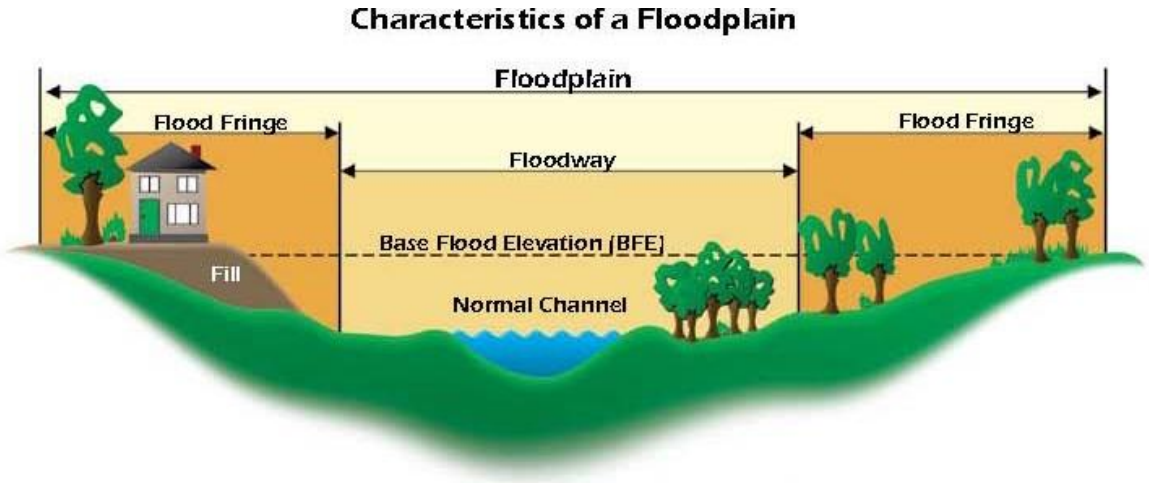
Table 5. Months where rainfall exceeded the 90th percentile (precipitation totals, in inches, in parentheses) of monthly precipitation at the Peru, Pownal and Sunderland Cooperative Observer Stations from 1990 to 2013 for Pownal, 1980 to 2017 for Peru and 1990 to 2013 for Sunderland.
Source: National Oceanographic and Atmospheric Administration 2020a

Sunderland		Pownal	Peru
Month	Year	Year	Year
January	1990, 1998, 1999 (5.97")	1996, 1998, 1999, 2006 (3.88")	1990, 1999, 2006, 2012 (5.04")
February	2002, 2008, 2011 (3.58")	1981, 1984, 2008 (3.54")	1981, 2002, 2008, 2016 (5.28")
March	2001, 2007, 2008 (5.35")	1980, 1999, 2001, 2007 (4.65")	1980, 1986, 2001, 2008 (6.13")
April	1993, 1996, 2002, 2007, 2011 (4.75")	1983, 1990, 1993, 1996 (4.80")	1983, 1996, 2007, 2017 (6.43")
May	1990, 2000, 2006 (6.31")	1984, 1990, 2013 (6.47")	1984, 1990, 2012, 2017 (8.29")
June	1998, 2002, 2006 (7.66")	1998, 2000, 2002, 2013 (7.32")	1998, 2006, 2013, 2015 (9.26")
July	1996, 2004, 2008 (6.87")	1984, 2004, 2010 (6.20")	1988. 1996, 2000, 2013 (7.31)"
August	1990, 2003, 2011 (7.37")	1990, 1991, 2003, 2011 (7.37")	1985. 1990, 2003, 2011 (8.32")
September	1999, 2003, 2011 (5.75")	1999, 2004, 2011 (6.03")	1987, 1999, 2003, 2011 (6.92")
October	2005, 2007, 2010 (7.05")	1987, 1995, 2010 (5.81")	1987, 1995, 2010 (9.02")
November	2002, 2004, 2005 (5.28")	1985, 1988, 2005 (5.81")	1983, 1986, 1988, 2002 (6.36")
December	1996, 2003, 2008 (6.42")	1983, 1990, 2003, 2011 (4.77")	1983, 1996, 2008, 2014 (6.74")

The average annual precipitation in Vermont has increased 5.9" since 1960. This trend is predicted to continue so that Vermont streams will have higher flows and possibly experience more frequent and greater flooding events (Galford et al. 2014).

Special Flood Hazard Areas: these are areas mapped by FEMA and using the LIDAR derived zones that were adopted in late 2015. Table 6 shows the number of structures, by type, in the special flood hazard and river corridors, and both areas are shown in Map 4. Figure 1 below shows the parts of a typical floodplain. The Vermont Hazard Mitigation Plan (2018) states that

Figure 1. Typical floodplain



large portions of the state have rivers with no mapped special flood hazard areas though damages from flooding still occur on those streams.

River Corridors: River corridors (Figure 2) have been mapped by the Vermont Agency of Natural Resources using geospatial data and will be modified by VT ANR river scientists using available field data. The data were used to calculate the "meander belt width" or area within which a river would move across the valley. As rivers shift their location both vertically and horizontally, erosion of adjacent lands can occur and threaten properties that may be outside of special flood hazard areas. The additional buffer allows for placement of structures beyond the meander belt width and provides for space for the changes in river geometry, bank stabilization and establishment of woody buffers to provide resistance to erosion from the movement of the channel (Vermont River Management Program 2010).

Figure 2. River corridors

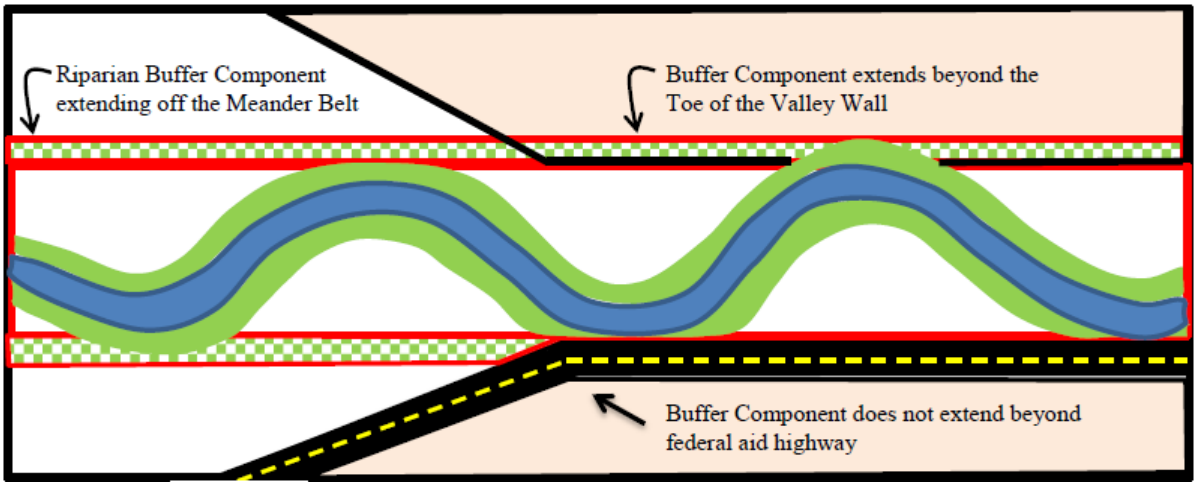


Table 6. Structures by type in flood hazard zones in Sunderland, VT.
Source: Vermont Open Geodata Portal 2020

Type	Number in special flood hazard zone	River Corridor
Single-Family	1	28
Mobile Home	1	1
Multi-family	1	0
Commercial	1	1
Industrial	0	0
Camp	0	15
Total	3	45

d. Probability, Impact, and Vulnerability

Based on data from 1996 to 2019, 14 moderate or major flood events have affected areas within or near Sunderland resulting in a 50-60% chance of such an event occurring. Table 6 tallies the number of structures by type within the river corridor and special flood hazard area. Sunderland has a total of 491 single family residences, 32 mobile homes, 2 multi-family dwellings, 26 commercial/industrial establishments, 39 camps, and 7 government, church and

school buildings and assorted other structures such as communication towers. As shown in Table 6, there are 3 structures in the special flood hazard area and 45 in the river corridor recently mapped by VT ANR, and since these areas overlap, some structures are in both. Therefore, the potential proportion damaged within the town from severe flooding would range from 1-10% with injuries of 1-10%. Most services recover in less than seven days, though help for specific property owners may take significantly longer.

C. Winter Storms

1. Description

Winter storms are frequent in Vermont. Winter storms may consist of heavy snow, mixed precipitation, or ice storms and all may be accompanied by strong winds. Potential damages can include power outages, traffic accidents, and isolation of some areas. For example, the October 4, 1987 storm stranded travelers in the area and knocked out power for several days. Members of the planning team recalled this storm as particularly troublesome as trees still had leaves on, so power outages were extensive. The "Blizzard of '93," one of the worst storms this last century, virtually shut down Vermont on the weekend of March 13-14, forcing the closure of roads and airports. This was one of the most powerful snowstorms on record. Snowfall amounts ranged from 10 to 28 inches across the state. In rare cases, the weight of snow may collapse roofs and cause other structural damage. Wind can also accompany snowstorms increasing the effect of the snow damages. In addition to snow, ice storms occur when the lower levels of the atmosphere and/or ground are at or below freezing, and rain is falling through warmer air aloft. The precipitation freezes upon contact with the ground, objects on the ground, trees, and power lines.

2. Previous Occurrences

Table 7 summarizes the 183 winter storm events that have occurred in Bennington County since 1996. As can be seen, a high number of events occurred in 1997, 2007, 2008, 2009, 2011, 2017, 2018 and 2019. Using NOAA data, we categorized the extent of each storm with storms ranked as "High" if they produced more than twelve inches of snow or were categorized by the NOAA as producing heavy or record snows or blizzards or significant icing. The Blizzard of 1993 was categorized as "Extreme." NOAA also reports numerous storms producing one to over three feet of snow in the Green Mountains, but these were not listed as they did not affect major population centers. The following is a summary of significant events.

Table 7. Total number of winter storm events by type and year for Bennington County.
Source: National Oceanographic and Atmospheric Administration 2019

Year	Blizzard	Heavy Snow	Ice Storm	Winter Storm	Winter Weather	Totals
1996		5		2		7
1997		1		7	2	10
1998				2	1	3
1999				4		4
2000		1		6		7
2001				6		6
2002				2		2
2003				5		5
2004				2		2
2005	1	3		2		6
2006						0
2007		3	1	6	4	14
2008		4	1	1	11	17
2009		3		1	10	14
2010		3		1	2	6
2011				5	5	10
2012				4	2	6
2013		2		1	3	7
2014		2		4		6
2015		2			6	8
2016		1			5	6
2017	1	3		1	7	12
2018		2		5	4	11
2019		1		5	4	10
Totals	2	36	2	75	68	183

January 2 to 3, 1996 Heavy Snow: A major winter storm developed over the Gulf Coast states on January 2nd and tracked northeast along the eastern seaboard during January 3rd. Heavy snow fell across southern Vermont with the average snowfall ranging from ten to twelve inches.

November 26, 1996 Winter Storm: Snow and heavy freezing rain brought down trees and power lines with 10,000 customers losing power.

January 6 to 7 2002 Winter Storm: Southern Vermont received over 12 inches of snow closing schools and businesses and resulting in some vehicular accidents.

December 25 to 26, 2002 Winter Storm: Snow fell at rates of 1-3 inches/hour and totaled 16.2 inches in Sunderland.

January 23, 2005 Blizzard: Frequent whiteout conditions were observed by plow crews.

January 15 to 16, 2007 Ice Storm: Freezing rain and sleet resulted in widespread downed trees and power lines with accompanying widespread power outages.

February 14, 2007 Heavy Snow: Snowfall in excess of two feet across portions of Bennington County resulted in closed schools and businesses. Strong winds created near blizzard conditions during parts of the event.

March 16-17, 2007 Heavy Snow: Widespread snow of 10-18 inches fell across southern Vermont resulting in adverse impacts to travel and businesses.

April 12 to 16, 2007 Winter Storm: Heavy, wet snow, ranging from 8-12 inches downed trees and power lines causing widespread outages.

December 16-17, 2007 Winter Storm: Heavy snow mixing with sleet and accumulating 8 to 14 inches resulted in difficult travel and the closing of schools and some businesses Monday morning with some power outages.

February 12 to 13, 2008 Winter Storm: Snow accumulated to 4-7 inches but was accompanied by freezing rain with ¼ to 1/3 of an inch of ice.

December 11 to 12, 2008 Ice Storm: Rainfall in rates of ¼ to 1/3 of an inch/hour fell creating ice accumulations of ½ to ¾ of an inch. Snow and sleet mixed in in some areas. An estimated 15,000 customers lost power and businesses and schools were shut for several days. Very cold temperatures followed the storm.

December 19 to 20, 2008 Heavy Snow: Heavy snow closed businesses and schools and caused treacherous driving conditions.

January 1 to 3, 2010 Heavy Snow: A strong storm brought 10 inches to over two feet of snow across Bennington and Windham counties.

February 23 to 24, 2010 Heavy Snow: Heavy snow totaling one to two feet fell across southern Vermont with highest amounts in elevations above 1500 feet.

February 26 to 27, 2010 Heavy Snow: Just after the storm described above, a second storm brought one to two feet in higher elevations with lesser amounts below 1000 feet in elevation.

December 26 to 27, 2010 Winter Storm: Heavy snow falling at rates of 1-3 inches/hour resulted in one to two feet of snow. Winds were strong and gusted to 35-45 mph.

January 12, 2011 Winter Storm: A strong storm resulted in 14 inches to three feet of snow falling at rates of three to six inches/hour.

February 1 to 2, 2011 Winter Storm: Snowfall was generally 10-18 inches but ranged to 25 inches in some areas.

February 25, 2011 Winter Storm: Snow fell at rates of one to two inches/hour with totals of 12 to 17 inches across southern Vermont.

October 29 to 30, 2011 Winter Storm: While not yet winter and with trees with much of their foliage still on, 5 to 14 inches fell across Bennington County. Trees and power lines came down due to the weight of the wet snow.

January 1 to 2, 2014 Heavy Snow: Widespread snow accumulated 8-17 inches followed by very cold temperatures.

February 13 to 14, 2014 Winter Storm: Snow fell at rates of up to three inches/hour. Over the two days of the storm, 8-21 inches fell in southern Vermont. At times, winds gusted to 40 mph as the storm left the area.

November 26 to 27, 2014 Winter Storm: An early storm affected southern Vermont over the Thanksgiving period with 8-15 inches of total accumulation.

February 2, 2015 Heavy Snow: Snow accumulations ranged from 9-15 inches.

February 7 to 10, 2015 Heavy Snow: One to two feet of snow fell, with higher amounts in higher terrain.

February 9, 2017 Heavy Snow: A Nor'easter left 8-14 inches of snow across Bennington County.

March 14-16, 2017 Blizzard: This significant coastal storm resulted in 18 inches of snow at low elevations and 35 at high elevations. High winds and blizzard conditions resulted in poor visibility.

January 3 to 4, 2018 Heavy Snow: Snowfalls of 7 to 15 inches accompanied by winds gusting between 30 and 45 miles per hour spread snow across the county. The event was followed by very cold temperatures.

February 4 to 5, 2018 Heavy Snow: Snowfalls of 5 to 14 inches were widespread across the county.

March 7 to 8, 2018 Winter Storm: Heavy snow with rates of up to three inches/hour resulted in one to three feet of snow in upslope locations.

March 13 to 15, 2018 Winter Storm: Snowfall rates of up to three inches/hour fell, especially in higher elevations.

November 26 to 28 2018 Winter Storm: Heavy, wet snow brought down trees and powerlines.

January 19 to 20 2019 Winter Storm: Heavy snow followed by wind chills of -20 to -40^{0}F resulted in closing of businesses and schools.

December 1 to 2 2019 Heavy Snow: A major storm brought accumulations of 18-28 inches across southern Vermont.

3. Extent and Location

As discussed above, we described extent based on snow depth from records from the National Oceanographic and Atmospheric Administration (NOAA). The National Oceanographic and Atmospheric Administration (NOAA) also publishes climate "normals" or averages for various stations including Pownal and Sunderland. The average annual snowfall for the period 1981 to 2010 was 60.8 inches for Pownal and 75.1 inches for Sunderland. December, January, February, and March as the primary months for snowfall. Extreme snowfall events for one, two-

and three-day events have ranged from 12 to over 20 inches (National Oceanographic and Atmospheric Administration 2020a). The skill of road crews in Vermont means that only the heaviest snowstorms (>12 inches) or ice storms affect the populations.

Increasing temperatures that are predicted to occur will likely reduce total winter snowfall. If precipitation falls as rain in the winter, winter river flows will be higher due to the lower evapotranspiration in the winter. Freezing rain may become more frequent, with resulting impacts to the transportation and power systems (Galford et al. 2014).

4. Probability, Impact and Vulnerability

There is a 100% probability of a moderate or greater snowstorm affecting Bennington County, including Sunderland in any given year. These are large-scale events, though local impacts may vary greatly. Roads and power lines are most vulnerable, with traffic accidents the most likely to create injuries.

D. High Wind Events

1. Description

High wind events can occur during tropical storms and hurricanes, winter storms and frontal passages. Thunderstorms can produce damaging winds, hail and heavy rainfall, the latter potentially producing flash floods. The NOAA recorded 158 wind events in Bennington County since 1996. Thunderstorms tended to occur in the spring and summer while Events categorized as “strong wind” tended to occur during the winter months.

Tornadoes are formed in the same conditions as severe thunderstorms. Intense, but generally localized damage can result from the intense winds. The primary period for tornado activity in New England is mid-summer (Zielinski and Keim 2003). Tornadoes will generally follow valleys in the northeast and dissipate in steep terrain. The NOAA recorded three tornadoes in Bennington County since 1990.

2. Previous Occurrences

Table 8 below summarizes the total number of significant wind events including thunderstorms, strong winds, and tornadoes from 1996 to 2018. The 1998 tornado registered F2 on the Fujita damage scale. The 2002 tornado in Bennington County registered F1 while the 2003 tornado was an F0 to F1 (National Climate Data Center 2015). The Fujita scale is based on wind speed and typical damage. An F0 tornado has winds of less than 73 miles per hour and could damage chimneys, branches, and down shallow rooted trees. An F1 tornado has winds of 73-112 miles per hour and could damage roofs, push mobile homes off foundations and blow cars off of roads. An F2 tornado has winds of 113-157 miles per hour and could tear off roofs, destroy mobile homes and snap trees (http://www.spc.noaa.gov/faq/tornado/f-scale.html).

Wind speed data is not available for most wind events due to the lack of weather stations. The only recording gauge is at the Bennington Airport. NOAA data (2015) rarely included estimates of wind speed. Generally, wind speeds of greater than 55 miles per hour are considered damaging (NOAA 2006). Events that occurred in or near Sunderland are described below.

Table 8. Summary of wind events in Bennington County.
Source: National Oceanographic and Atmospheric Administration 2019

Year	High Wind	Strong Wind	Thunderstorm Winds	Tornado	Funnel Cloud	Totals
1996	5					5
1997	2	2	6			10
1998	1		8	1		10
1999	2		4			6
2000	1		1			2
2001			3			3
2002			3	1		4
2003	1			1		2
2004						0
2005	1		3			4
2006	3		3			6
2007	3		6			9
2008		3	5			8
2009	2		1			3
2010	5		3		1	9
2011	1		8			9
2012			3			3
2013			6			6
2014			3			3
2015			2			
2016		1	7			8
2017	4	3	5			12
2018	2	5	7			14
2019	1	9	3			13
Totals	40	23	91	3	1	158

May 29 through 31, 1998 Thunderstorm Winds and Tornado: Strong thunderstorms generated an F2 tornado in New York, which became an F1 after crossing into Vermont. The tornado followed Route 67 through North Bennington and South Shaftsbury.

September 16 to 18, 1999 (DR-13079/16-21 1999): Remnants of Hurricane Floyd (see flooding and flash flooding) brought winds gusting to over 60 mph and downed trees and power lines in southern Vermont.

November 2, 1999 High Wind: A wind gust of 66 mph was recorded at the Bennington Airport, though no damages were reported.

July 1, 2001 Thunderstorm Wind: Strong thunderstorm winds downed trees and wires in Arlington.

August 9, 2001 Thunderstorm Winds: A supercell brought down trees in Bennington and Arlington.

June 5, 2002 Thunderstorm Winds and Tornado: Thunderstorms originating in New York produced an F1 tornado that touched down in Woodford Hollow.

July 21, 2003 Tornado: A supercell originating in New York created a tornado there, then created a second tornado in Pownal and Bennington. Those, along with thunderstorm winds, downed trees and caused minor damage.

October 15, 2003 High Wind: Destructively strong winds occurred in southern Vermont with trees reported down in Sunderland.

June 27, 2005 Thunderstorm Winds: A thunderstorm near Manchester Center blew down several trees.

April 23, 2006 High Winds: High winds from a low-pressure system uprooted trees in Arlington.

October 28- 29, 2006 High Winds: Strong winds, some reaching 60 mph, blew from the evening of the 28th through parts of the 29th with trees reported down in Sunderland and Arlington.

March 2, 2007 High Winds: High winds were associated with snow and freezing rain. Winds measured at Bennington Morse Airport reached 59 mph.

June 1, 2007 Thunderstorm Winds: Thunderstorms resulted in downed trees near the recreation center on Route 7A in Arlington.

December 16, 2007 High Winds: A snowstorm brought 8-14 inches of snow along with strong winds that combined to down trees and powerlines.

December 30, 2008 High Winds: Strong wind gusting 45-55 mph brought down trees and caused power outages.

December 9, 2009 High Winds: High winds, measured up to 59 mph at the Bennington Airport, caused power outages in Bennington, Dorset, Manchester, Pownal, Sandgate, Shaftsbury, and Sunderland.

May 8, 2010 Thunderstorm Winds: Thunderstorms generated winds in excess of 40 mph downing trees in Arlington and Manchester Center.

July 17, 2010 Funnel Cloud: A funnel cloud was reported on Route 279 in Bennington.

August 22, 2010 High Winds: Strong winds formed during passage of a cold front and downed trees and wires in Arlington, Bennington, Shaftsbury, and Sunderland.

September 30 to October 1, 2010 High Winds: A low-pressure system and remnants of an offshore Tropical Storm Nicole created winds gusting to over 55 mph with power outages reported.

May 26, 2011 Thunderstorm Winds: Thunderstorm winds resulted in downed trees in Arlington.

June 1, 2011 Thunderstorm Winds: Trees were reported down in Sunderland.

June 9, 2011 Thunderstorm Winds: A pre-frontal trough formed a line of severe thunderstorms that moved across eastern New York and southern Vermont.

August 28-29, 2011 (DR-4022 8/27-29 2011): Along with flooding described above, Tropical Storm Irene brought 35-55 mph winds with gusts exceeding 60 mph resulting in downed trees and powerlines.

October 29 to 30, 2012 High Winds: Superstorm Sandy brought strong winds of 40-60 mph, with a gust of 58 mph recorded at the Bennington Morse Airport.

July 19, 2013 Thunderstorm Winds: Thunderstorm winds downed trees in Sunderland.

June 21 and 23, 2016 Thunderstorm Winds: Strong storms occurred throughout southern Vermont and trees were reported down in Sunderland.

October 22-23, 2016 High Winds: Winds with gusts up to 50 mph affected parts of southern Vermont.

January 10-11, 2017 High Winds: Winds of 40-60 mph caused some power outages in the county.

March 2, 2017 High Winds: Winds of 30-45 mph were widespread across the county.

May 5, 2017 High Winds: Winds up to 68 mph were observed in Bennington.

May 18, 2917 Thunderstorm Winds: Thunderstorms created winds that brought down power lines in some areas.

July 1, 2017 Thunderstorm Winds: A microburst brought down trees in Sandgate. The estimated windspeed based on the damage was 100 mph.

October 30, 2017 High Winds: Winds brought down trees, limbs, and wires across the county.

April 4, 2018 High Winds: Strong winds with gusts of 40-50 mph brought down power lines across southern Vermont.

April 15, 2018 High Winds: Peak gusts of 64 mph were recorded in Arlington with wires and trees downed.

June 18, 2018 Thunderstorm Winds: A hot airmass in the daytime lead to thunderstorms in the evening with numerous power outages and trees down. Route 7A between Dunham Rd. and Hill Farm Rd. in Sunderland was closed due to down trees and powerlines.

April 3, 2019 Strong Wind: Winds of 35-55 mph across the county resulted in downed trees and powerlines.

c. Extent and Location

Damaging winds, including the previous occurrences described above, are those exceeding 55 miles per hour (National Oceanographic and Atmospheric Administration 2006 and undated). There are no wind gauges that record windspeed data in Sunderland. Therefore, we used what was available from NOAA data described above for windspeed. During a November 1999 event, winds were measured at 66 mph at the Morse Airport in Bennington. Higher winds were likely created during the tornadoes. High wind events can strike anywhere. Where storms are funneled up the valleys, damage can be significant, but most likely less than 10% of structures would be affected. Again, power outages could last up to seven or more days. There are no weather stations nor any records of wind data in Sunderland.

d. Probability, Impact and Vulnerability

Wind events causing moderate or greater damage occur almost every other year (40-50%) in Bennington County, and can range from localized events from thunderstorms to wide ranging events from larger storms. The primary vulnerability would be power outages from downed trees and lines and the potential expected probability would be 10-75% in Sunderland.

E. Hail

The National Oceanographic and Atmospheric Administration has 30 reports of hailstorms in Bennington County between 1996 and 2019, all associated with thunderstorms. The following were within Sunderland.

July 18, 2000 Hail: Dime-sized hail was reported in Sunderland.

July 4, 2001 Hail: Half-dollar sized hail was reported in Sunderland.

June 16, 2006 Hail: A trained spotter reported penny-sized hail in Sunderland.

June 21, 2007 Hail: Nickle-sized hail was reported in Sunderland.

Hail was also reported by a Cooperative Weather Observers on May 25, 1999, May 8, 2000, July 18, 2000, July 5, 2001, August 4, 2001, June 2, 2002, August 1, 2008, and August 15, 2009 in Sunderland and on June 10, 2008 and May 8, 2010 in Peru.

c. Extent and Location

Hail can be very localized or can cover wide areas and has the potential for damaging crops, automobiles, or glass within structures, as well as causing injury. Generally, however, hailstorms affect relatively small areas as they form in thunderstorms, which are localized. As reported above, the largest hail was half-dollar sized occurring in 2001, though larger hail has been reported elsewhere in Bennington County.

d. Probability, Impact and Vulnerability

Hailstorms are generally local, affecting subareas within the town, though a group of thunderstorms can cause hail in multiple locations over a wide area. From past occurrences, one thunderstorm per year generates hail that was recorded. So, the possibility of hail occurring in Sunderland could range from 10-100%. The potential vulnerability would be localized to damage to structures or automobiles, though there could also be damage to vegetation. In general, these impacts would be localized.

F. Temperature Extremes

1. Descriptions

Temperature extremes entail periods of either excessive heat or extreme cold. Excessive heat is generally defined as periods when the normal high temperature is exceeded by ten degrees. So, in the summer, this would equal 88-89 degrees in Sunderland (Table 9). Excessive heat is recorded at other times but does not have the health consequences of summer periods. In addition, the heat index, which factors in the high relative humidity levels of summer, is also a factor. The Vermont Department of Health has determined that serious heat related injuries and deaths occur when the temperature reaches or exceeds 87^0 F (Vermont Department of Health 2016). Using the Sunderland Cooperative Observer data this occurred 151 times between 1990 and 2017 or about eight time per year.

Extreme cold is not well defined. For those involved in outdoor activities, extreme cold, accompanied by wind, is when exposed skin would be subject to frostbite. However, for periods of power outages that might accompany winter storms, extreme cold could be thought of as when temperatures fall below freezing as that would not only affect health but could result in pipes freezing and the loss of water supplies.

Table 9. Bennington and Sunderland normal temperatures and precipitation for 1981 to 2010.
Source: National Oceanographic and Atmospheric Administration: *http://www.NOAA.noaa.gov/land-based-station-data/climate-normals/1981-2010-normals-data*

Month	High Temperature (^{0}F)		Low Temperature (^{0}F)		Mean Temperature (^{0}F)		Precipitation (in)	
	Sunderland	Bennington	Sunderland	Bennington	Sunderland	Bennington	Sunderland	Bennington
January	28.5	30.7	9.5	11.6	19.0	21.1	3.44	2.75
February	33.7	34.7	11.2	15.3	22.5	25.0	2.82	2.24
March	40.9	43.8	19.5	22.7	30.2	33.3	3.55	3.15
April	54.3	56.7	31.0	34.3	42.7	55.1	3.47	3.27
May	65.8	37.0	41.3	43.3	53.5	55.1	4.33	3.66
June	75.3	75.0	49.6	52.4	62.5	63.7	4.66	4.13
July	78.5	79.4	54.5	57.0	66.5	68.2	4.55	4.34
August	77.1	77.7	53.0	57.0	65.0	66.4	4.40	4.00
September	69.6	70.4	44.2	47.4	56.9	58.9	3.83	3.57
October	57.3	58.7	34.4	36.4	45.8	47.5	4.28	3.69
November	45.9	47.5	27.9	29.7	36.9	38.6	3.98	3.11
December	34.4	35.7	17.2	19.5	25.8	27.6	3.95	2.79
Annual Average	55.1		32.8		43.9		47.26 Total	40.70 Total

The station normal reports for the Cooperative Weather Observers indicate an average of one day per year when the maximum temperature would equal 90 degrees in Sunderland and two days in Bennington, 55 days when the maximum temperature would be less than 32 degrees in Sunderland and 45 in Bennington, and 172 days when the minimum temperature would be less than 32 degrees in Sunderland and 156 days in Bennington.

2. Extent and Location

Extreme temperature is a widespread phenomenon. The populations affected could be small if one is considering outdoor workers alone or large if the entire town were subject to a

power outage. Temperatures above 90^0F occur approximately one or two days per year. The highest recorded temperature at the Sunderland Cooperative Weather Observer station was 95^0F on August 24. 2002. High temperatures of 94^0F were recorded on August 15, 2002, and again on July 22 and 23, 2011. The coldest recorded temperatures by the Sunderland Cooperative Weather Observer were -24^0 F on January 28, 2005 with -22^0 F recorded on both January 22nd and 29th in 2005.

Over the past several years, a phenomenon known as the "polar vortex" has affected the United States due to distortions in high level winds. These have resulted in prolonged cold periods in Vermont. Wind chill, which factors wind speed with air temperature, can result in greater effects of cold, including frostbite. Data on wind chill is not maintained, but temperatures of less than 0 degrees F and winds greater than 15 mph can result in frostbite in 30 minutes or less as temperatures fall and wind speed increases (Vermont Hazard Mitigation Plan 2018).

Average temperatures in Vermont have risen 2.7^0F since 1941 with an increase of 1.5^0F since 1990. Winter temperatures have risen more than summer temperatures. If these trends continue, the number of days above 90^0F will likely increase and minimum temperatures also increase (Galford et al 2014).

3. Probability, Impact and Vulnerability

Extreme heat is relatively rare with occurrences of approximately less than one day a year. Extreme cold, here defined as less than freezing temperature, is a frequent phenomenon in Vermont. Impacts of either type of event could be widespread, and vulnerability is dependent on the populations exposed.

G. Drought

1. Description

There are several types and definitions of drought: meteorological, climatological, atmospheric, agricultural, and hydrological. The latter is based on stream flow and groundwater availability and is probably most important from a natural hazard assessment perspective. Reductions in precipitation over long enough periods, particularly during the growing season when plants take up moisture, can result in hydrologic drought.

2. Past Occurrences

The Palmer Hydrologic Drought Index (PHDI) is an indicator of potential surface and groundwater availability based on climatic conditions. The categories of drought include moderate drought, severe drought, and extreme drought. Table 10 shows periods when the index showed severe and extreme droughts using data from 1985 to 2019. No drought

conditions were recorded from 2003 through 2015. However, members of the planning team reported that some wells were low in 2015, which did have some months with moderate drought conditions.

Table 10. Years and number of months when the PHDI indicated severe or extreme droughts from 1895 to 2019.
Source: National Oceanographic and Atmospheric Administration. Source: *ftp://ftpncdd.noaa.gov/pub/data/cirs/climdiv/* (Richard Heims, personal communication)

Year	Extreme	Severe
1901		
1905		
1907		1
1908	2	1
1909	1	2
1910		2
1911	5	4
1912		2
1913		5
1914		5
1915	3	1
1921		2
1922		1
1930		1
1931		1
1941		5
1942		2
1949		1
1953		2
1957		1
1959		1
1963		3
1964	1	6
1965	8	1
1995		2
1999		1
2001	2	1
2002	1	1

Table 10. Years and number of months when the PHDI indicated severe or extreme droughts from 1895 to 2019.
Source: National Oceanographic and Atmospheric Administration. Source: *ftp://ftpncdd.noaa.gov/pub/data/cirs/climdiv/* (Richard Heims, personal communication)

Year	Extreme	Severe
2016		1
Total	23 months; 8 years	59 months; 27 years

3. Extent and Location

The National Oceanographic and Atmospheric Administration calculates this index back to 1895. Since then, severe droughts occurred in 27 years or 22% while extreme drought occurred in 8 years or 6%. Severe and extreme droughts have been of short duration, except occurrences in the early 1960s. Mild to moderate droughts have been more frequent. Severe and extreme droughts are likely to affect those properties with shallow wells.

Based on well data from VT ANR, Sunderland contains the water supply wells for the Arlington Water Supply, public wells at Sunderland Elementary, Orvis and Applejack, and non-community wells at Hill Farm Inn and Arcady of Sunderland Motor Lodge as well as 321 private wells 27 of which have a depth of less than 100 feet. Map 6 shows private and public water supplies. Thirty-one residential properties in Sunderland are served by the Arlington Water Supply along with two commercial properties (Source: Sunderland Town Clerk).

4. Probability, Impact and Vulnerability

Source protection areas were mapped by the Vermont Agency of Natural Resources and are primarily dependent on topography, and the only one in Sunderland is for the Arlington Water Supply (Map 6).

Based on the Palmer Drought Severity data, there is a 22% chance of a severe or extreme drought occurring in any one year. Except for long-term drought, most wells should supply sufficient water, though structures with shallow wells are most likely to be affected. Drought may affect the potential for wildfire, which is discussed below. Increasing temperatures or changes in precipitation patterns due to climate change may affect the frequency, length, and degree of drought.

Table 11 below shows categories from the U.S. Drought Monitor for Vermont. Much of southwestern Vermont, including Sunderland, has been under the D0 category (Abnormally

dry). The planning team has not observed the types of conditions listed in Table 11 for that category, though they may have occurred at times and in scattered locations.

Table 11. Potential impacts of drought in Vermont.
Source: United States Drought Monitor – Vermont, Available via https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?VT

Category	Impact
D0	Crop growth is stunted; planting is delayed
	Fire danger is elevated; spring fire season starts early
	Lawns brown early; gardens begin to wilt
	Surface water levels decline
	Irrigation use increases; hay and grain yields are lower than normal
	Honey production declines
D1	Wildfires and ground fires increase
	Trees and landscaping are stressed; fish are stressed
	Voluntary water conservation is requested; reservoir and lake levels are below normal capacity
	Specialty crops are impacted in both yield and fruit size
	Producers begin feeding cattle; hay prices are high
	Warnings are issued on outdoor burns; air quality is poor
D2	Golf courses conserve water
	Trees are brittle and susceptible to insects
	Fish kills occur; wildlife move to farms for food
	Water quality is poor; groundwater is declining; irrigation ponds are dry; outdoor water restrictions are implemented
	Crop loss is widespread; Christmas tree farms are stressed; dairy farmers are struggling financially
	Well drillers and bulk water haulers see increased business
D3	Water recreation and hunting are modified; wildlife disease outbreak is observed
	Extremely reduced flow to ceased flow of water is observed; river temperatures are warm; wells are running dry; people are digging more and deeper wells
D4	Vermont has had little or no experience in D4, so no impacts have been recorded at that level in the Drought Impact Reporter

H. Wildfire

1. Description

Wildfire or wildland fire is any unplanned fire affecting open lands including forests, grasslands, or other features. The potential for wildland fire is dependent on fuel types, which vary with vegetation, topography, and weather. Fire intensity, measured by the amount of energy released in a fire and exhibited by the length of flames, and rates of spread dictate the degree of wildland fire hazard and methods of control. Table 12 shows how wildfires can be categorized based on size.

Table 12. Wildland fire size classes. Source: National Wildfire Coordinating Group 2011		
Magnitude (Size)	Description	Probability
Class A	< ¼ acre	High
Class B	¼ to 10 acres	High
Class C	10 to 100 acres	Moderate
Class D	100 to 300 acres	Low
Class E	300 to 1000 acres	Very low
Class F	1000 to 5000 acres	Very low
Class G	>5000 acres	Very low

In Vermont, forests tend to be dominated by northern hardwood species such as sugar maple (*Acer saccharum*), birch (*Betula* spp.), white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*). These species tend to create relatively low flammability fire, so that surface fires have low intensity and rates of spread, thereby limiting fire hazard (Anderson 1982). Most of the land area in Sunderland is covered by broadleaf litter fuels that exhibit fires of low intensity and slow rates of spread.

In both forested and open settings, structures may be threatened by even small wildfires. These wildland-urban interface areas are the most likely areas where resources will be needed to suppress wildland fire and to reduce potential hazards. Generally, the interface is defined on distance embers from a wildfire can travel. Due to the proximity of forested areas and intermixing of development and forest, most of Sunderland is within the urban interface. (Batcher and Henderson 2013).

Fire behavior is most extreme during periods when the relative humidity is low, generally less than 35-45%. These conditions are most prevalent in the spring, following snow melt, between March and late May or early June. After that, vegetation becomes increasingly green, and the resulting moisture in the live vegetation (fuel) reduces flammability significantly. Precipitation and evapotranspiration increase ambient relative humidity levels so that fires in the summer are generally rare and limited in size.

Fall again brings drying fuels and weather conditions increasing fire hazard. However, relative humidity levels increase after dark, and shorter days also limit the amount of time for fuels to dry and intense, fast moving fires to occur (North Central Research Station 2005).

2. Past Occurrences

According to records from the Vermont Department of Forests, Parks and Recreation, from 1992 to 2019, 169 wildfires occurred in Bennington County, the largest of which was 110 acres in Sandgate in 1994. Three fires occurred in Sunderland, all approximately 0.25 acres, and they occurred on April 28, 1993, April 19, 2005, and April 26, 2005.

3. Extent and Location

Low intensity fires with relatively slow rates of spread could occur in the forested areas which comprise most of Sunderland's land cover. Fires on steep slopes could present control problems due to terrain and as fire will spread more rapidly. Throughout the town there may be pockets of heavier fuel loads, such as brush, or more flammable fuels, such as cured herbaceous vegetation and shrubs. These areas are generally located in the valleys near developed areas.

4. Probability, Impact and Vulnerability

Sunderland likely has some structures within the "wildland urban interface," which represents areas where structures directly abut wildland fuels (Federal Register 2001). The community wildfire plan completed for Arlington, Glastenbury, Sandgate, Shaftsbury, and Sunderland (Batcher and Henderson 2013) mapped urban interface boundaries of 0.1, 0.2 and 0.5 miles from existing structures based on calculations of potential fire spread given typical fuel types (Map 7). As discussed below, the risk of wildfire in Sunderland is low except for higher potential in old field vegetation.

Map 7 shows wildfire risk, as determined by the Vermont Department of Forests, Parks and Recreation (2010) and mean fire return interval from LANDFIRE. For most of the forested area, the return interval exceeds 100 years, meaning that the natural return interval is relatively long. This return interval is shorter for areas dominated by herbaceous vegetation in the fields within valley, and these areas tend to be the locations of the small, more frequent brush fires that are suppressed by the Arlington Fire Department. Overall, the wildfire risk is low or nonexistent, especially in developed areas where there is little or no fuel.

Deciduous and coniferous forests create litter that is relatively low in flammability so that wildfires have relatively low intensity and rates of spread. The main hazard is for wildland fire fighters working in steep terrain. The natural fire return intervals in most forests in Vermont are more than 50 years and greater as shown in Map 7 (Malamud et al. 2005). Recurrence is likely related to precipitation rather than the buildup of fuels, so drought recurrence is already factored into these interval estimates. Therefore, the potential for large fires is very limited due to the fuel characteristics. However, large roadless areas and steep topography can make suppressing wildland fires that do occur very difficult. Settled areas have a low vulnerability to fire.

I. Earthquake

1. Description

Vermont has no active faults but has experienced minor earthquakes. Table 13 below shows the most recent occurring within the state, though there have been others, located outside, that have been felt in Vermont (Springston and Gale 1998). The U.S. Geological Survey predicts a two percent probability of an earthquake causing considerable damage in Vermont sometime in the next 50 years (Springston and Gale 1998).

2. Past Occurrences

Data from the Weston Observatory at Boston College (Northeast Earthquake Maps and Catalog) was used to identify earthquakes occurring within 100 miles of Bennington County since 1990. No earthquakes occurred in either Sunderland or Bennington County during that period. Figure 3 below plots the number of earthquakes by year by magnitude, which is described in Table 13 below.

Table 13. Earthquake magnitude and intensity scale descriptions.

Source: *http://earthquake.usgs.gov/learn/topics/mag_vs_int.php*

Magnitude	Modified Mercalli Intensity	Description
1.0-3.0	I	I. Not felt except by a very few under especially favorable conditions
3.0- 3.9	II-III	**II**. Felt only by a few persons at rest, especially on upper floors of buildings. **III**. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck.
4.0-4.9	IV-V	**IV**. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably. **V**. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.

Table 13. Earthquake magnitude and intensity scale descriptions.

Source: *http://earthquake.usgs.gov/learn/topics/mag_vs_int.php*

Magnitude	Modified Mercalli Intensity	Description
5.0-5.9	VI-VII	**VI**. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. **VII**. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
6.0-6.9	VII-IX	**VII**. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken. **VIII**. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. **IX**. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
7.0 and higher	VIII or higher	**VIII**. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. **IX**. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. **X**. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent. **XI**. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly. **XII**. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Figure 3. Plot of earthquake and magnitude for occurrences within 100 miles of Bennington County, VT. Source: Northeast Earthquake Maps and Catalog 2015

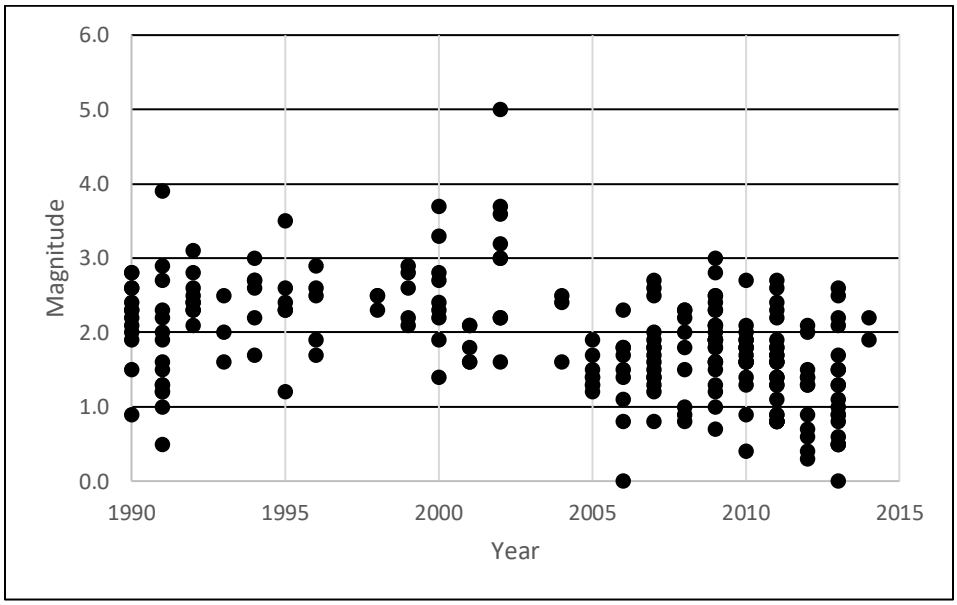


Table 14. Earthquakes in Vermont. Source: Vermont Geological Survey (Ebel et al. 1995) http://www.anr.state.vt.us/dec/geo/EBEL.htm consisting of excerpts from: A Report on the Seismic Vulnerability of the State of Vermont by John E. Ebel, Richard Bedell and Alfredo Urzua, a 98-page report submitted to Vermont Emergency Management Agency in July 1995; Vermont Hazard Mitigation Plan 2018.

Location	Date	Magnitude	Mercalli Intensity
Swanton	July 6, 1943	4.1	Felt by nearly everyone; many awakened with some dishes and windows broken and unstable objects overturned
Brandon	March 31, 1953	4.0	Felt indoors by many, but by few outdoors. Sensation would be similar to a heavy truck striking a building
Middlebury	April 10, 1962	4.1	Felt by nearly everyone; many awakened with some dishes and windows broken and unstable objects overturned
Plattsburgh	April 20, 2002	5.1	Resulted in shaking in Vermont

3. Extent and Location

Table 14 shows earthquakes that have occurred in Vermont based on the 1995 report. No earthquakes have been recorded in Sunderland or in Bennington County. Those occurring within 100 miles have ranged in magnitude from barely registered to 5.0, with most in the range of 1.0 to 3.0 (Figure 3). No damage was recorded in any of these in Sunderland. In 2003, the Vermont Geological Survey completed simulations using FEMA HAZUS software of potential damage within Bennington County from a 500-year recurrence earthquake centered in Middlebury, VT, Tamworth, NH and Goodnow, NY. The results indicated minimal damage and injury from any of these events to Sunderland (Kim 2003).

d. Probability, Impact and Vulnerability

Based on the 2003 HAZUS analyses, both the probability and impact of an earthquake of a magnitude that could potentially occur in Vermont are low. However, earthquake prediction science is very limited.

J. Landslide

1. Description

Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompanies these events. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. Gravity is the force driving landslide movement. Factors that allow the force of gravity to overcome the resistance of earth material to landslide movement include saturation by water, steepening of slopes by erosion or construction, and alternate freezing or thawing. Table 15 shows how landslides can be categorized.

Table 15. Landslide and debris flow types.
Source: USGS 2006

Magnitude	Description	Probability
Localized	Falls: abrupt movements of rocks and boulders, generally on steep slopes	Low to moderate
Topples	Topples: movements involving some forward rotation as material moves downhill	Low to moderate

Table 15. Landslide and debris flow types. Source: USGS 2006		
Magnitude	Description	Probability
Flows	A range of land movement generally involving a mass of loose soil, rock, organic matter, air, and water moving downhill rapidly and possibly covering a wide area. One form called creep involves slow movement of material and is often recognizable by trees growing so as to remain vertical while bent near the ground as they grow to keep up with the slow material flow.	Highly variable but can be fairly common.

2. Past Occurrences

Several washouts occurred along the Kelly Stand during Tropical Storm Irene. None were reported from previous storm events. However, there are multiple mass failures, which could be considered landslides, along several streams, especially the Roaring Branch and the Kelly Stand Road (Map 8). A landslide occurred on Mount Equinox in 2000 (Rick Ladue, personal communication), but did not threaten any settled areas or roads. A small landslide also occurred in early 2019 on NYS 313 in Arlington.

3. Extent and Location

Using a protocol developed for the Vermont Geological Survey (Clift and Springston 2012), Dale (2015) used geographic information system data and analyses to develop a potential landslide map for the town. Map 8 shows that the areas of medium and high potential for landslides are primarily on the steeper slopes. There are only very limited areas of high landslide potential, and these far from settled areas, the road system and other infrastructure. . The total area of high potential is less than 0.5% of the area of the town or approximately 141 acres. Mass failures were mapped as part of river corridor studies by the Vermont Agency of Natural Resource and by Michael Batcher as part of a transportation study (Map 8). No rockfall areas were identified by VT AOT (Eliason and Springston 2007).

4. Probability, Impact and Vulnerability

Map 8 shows few areas of high potential for landslides, so the probability of those affecting settled areas is low and therefore the potential impact and vulnerability are both low. The major exception is along the Kelly Stand. The potential for rockfalls is limited as well.

K Invasive Species

1 Descriptions

Invasive species are organisms that are not native to a geographic area and which can or do cause economic or environmental harm. Invasive species are characterized by organisms that spread rapidly, can displace native species, and have few or no predators to keep their populations in check. At the same time, they have characteristics that may reduce the value and use of natural resources. For example, bush honeysuckle can become a dominant shrub in some forests reducing the potential for tree regeneration. Japanese knotweed colonizes stream banks, and does hold soil well, leading to increased streambank erosion (Vermont Invasives 2016).

Vermont has two invasive species lists: Class A species are on the Federal Noxious Weed List. These are listed in 7 C.F.R. 360.200, a section of the Code of Federal Regulations and in Table 16 below. These are not known to occur in Vermont.

Table 16. Designated Class A noxious weeds.
Source: Vermont Agency of Agriculture, Food and Markets
https://agriculture.vermont.gov/public-health-agricultural-resource-management-division/plant-health-and-pest-management/plant-0

Scientific Name	Common Name
Cabomba caroliniana	Fanwort
Egereia densa	Brazilian elodea
Hydrilla verticillata	Hydrilla
Hygrophila polysperma	East Indian Hygrophila
Myriophyllum aquaticum	Parrot feather
Salvinia auriculata	Giant salvinia
Salvinia biloba	Giant salvinia
Salvinia herzogii	Giant salvinia
Salvinia molesta	Giant salvinia
Vincetoxicum hirundinaria	Pale swallow-wort

Class B species are known to occur in the state and are considered a threat (Table 17). The table also indicates species observed in Sunderland.

Table 17. Designated Class B noxious weeds in Vermont.
Source: Vermont Agency of Agriculture, Food and Markets: http://agriculture.vermont.gov/plant_pest/plant_weed/invasive_noxious_weeds/noxious_weeds_list Those with a * have been identified in Sunderland. Source: Early Detection and Mapping System: http://www.eddmaps.org/tools/query/;
Those marked with ** have been identified within the Town of Sunderland. Sources: Mary Beth Deller, USFS provided data; Michael S. Batcher observations.

Scientific Name	Common Name
Acer ginnala	Amur maple
Acer platanoides	Norway maple
*Aegopodium podagraria**	Bishop's goutweed or goutweed
Ailanthus altissima	Tree of heaven
*Alliaria petiolata * **	Garlic mustard
Berberis thunbergii **	Japanese barberry
Berberis vulgaris	Common barberry
Butomus umbellatus	Flowering rush
*Celastrus orbiculatus***	Oriental bittersweet
Euonymus alatus	Burning bush
*Fallopia japonica *	Japanese knotweed
Hydrocharis morsus-ranae	Frogbit
Iris pseudacorus	Yellow flag iris
Lonicera japonica	Japanese honeysuckle
*Lonicera maackii **	Amur honeysuckle
Lonicera morrowii **	Morrow honeysuckle
Lonicera tatarica	Tartarian honeysuckle
Lonicera x bella	Bell honeysuckle
*Lythrum salicaria **	Purple loosestrife
Myriophyllum spicatum	Eurasian watermilfoil
Nymphoides peltata	Yellow floating heart
*Phragmites australis **	Common reed
Potamogeton crispus	Curly leaf pondweed
*Rhamnus cathartica**	Common buckthorn
Rhamnus frangula **	Glossy buckthorn
Trapa natans	Water chestnut
Vincetoxicum nigrum	Black swallow-wort

The bush honeysuckles (*Lonicera* spp.) have been observed along roadsides. Buckthorn (*Rhamnus cathartica*) and Japanese barberry (*Berberis thunbergii*) have invaded forests and wetland edges and Japanese knotweed (*Fallopia japonica*) has invaded stream banks and other disturbed areas. Table 18 shows aquatic invasive species listed by the Vermont Agency of Natural Resources.

In addition to the species listed above, the following should be considered invasive species:

Wild parsnip (*Pastinaca sativa***) is abundant along roadsides and can cause skin burns when chemicals in the plant on exposed skin interact with sun, which can harm those who work on or along roads or utility rights of way. Spotted knapweed (*Centaurea stroebe***) can also invade old fields and roadsides. Privet (*Ligustrum* sp.*) can also invade forest edges. Cow parsnip or wild chervil (*Anthriscus sylvestris*) can dominate roadsides and invade meadows. Reed canary grass (*Phalaris arundinacea***) has been observed in Sunderland and can invade wetlands and crowd out native plants and has been observed. Privet (*Ligustrum* spp.*) while not listed above can invade forests. Multiflora rose (*Rosa multiflora***), also not listed as an invasive, is an invasive species in many states and has invaded roadsides and areas along the Batten Kill.

Table 18 lists aquatic invasive species listed by the Vermont Agency of Natural Resources.

Table 18. Aquatic invasive species in Vermont.
Source: Watershed Management Division, Department of Environmental Conservation: http://dec.vermont.gov/watershed/lakes-ponds/aquatic-invasives/

Scientific Name	Common Name
Dreissena polymorpha	Zebra mussel
Alosa pseudoharengus	Alewife
Orconectes rusticus	Rusty crayfish
Didymosphenia geminata	Didymo
Bythotrephes longimanus	Spiny Waterflea
Corbicula fluminea	Asian clam
Didymosphenia geminata	Didymo[1]
Nitellopsis obtusa	Starry Stoneword
Myriophyllum heterophyllum	Variable-leaved Watermilfoil

2. Past Occurrences

Invasive species are present and represent a continuous hazard that will vary with their abundance and their impacts on structures and infrastructure.

3. Extent and Location

Except as described above and on Map 9, the extent of invasive plants in Sunderland and in Bennington County has not been fully mapped. Insects and pathogens have the potential

[1] Recently this species has been determined to be native, but that status may change.

for dramatically altering the composition and structure of forests as well as affecting trees in settled areas. Hemlock wooly adelgid (*Adelges tsugae*) has dramatically reduced hemlock trees south of Vermont and has been found in Pownal, VT. Emerald ash borer (*Agrilus planipennis*) is a significant threat to forests as it kills all ash species. Borers are often dispersed through movement of firewood. Emerald Ash Borer was recently found in Stamford and Pownal in 2018 and in Bennington and Shaftsbury in 2020.

In addition to the above insects, there are other insects and pathogens that are affecting Vermont forests. These may constitute an emerging hazard (Schultz et al 2015). Climate change may increase the abundance and ranges of forest pest species such as hemlock wooly adelgid and invasive species currently found in more southerly locations (Rustad 2012).

4. Probability, Impact and Vulnerability

The likelihood of increased abundance of invasive species is 75-100% and potential impacts to forested areas are very high. Invasive insects that can cause tree death, particularly the emerald ash borer, could result in road closures, power outages and property damage. Increases in the abundance of invasive plant species could limit regeneration of native trees and shrubs and affect the long-term integrity of the forests (Vermont Department of Forests, Parks and Recreation 2010, Vermont Invasives 2016). Invasive species such as Japanese knotweed along streams can exacerbate fluvial erosion. That species outcompetes native species that have a greater capability of holding soil in place (Vermont Hazard Mitigation Plan 2018).

L. Hazardous Material Spill

1. Descriptions

Hazardous wastes are materials that are flammable, corrosive, toxic, or labeled with warning or caution labels. These materials are used in industry, in the home or on farms and are transported regularly.

2. Past Occurrences

The Vermont spill site list indicates there have been 1158 spills reported in Sunderland since 1978, and these are listed in Table 19 below.

3 Extent and Location

All of the spills listed in Table 19 affected small sites or areas. US Route 7, though not in the town, VT Route 7A and VT Route 313 carry substantial traffic, and a spill on these roads could affect a large portion of the town. Of particular concern in any hazardous materials spill

would be the impact on water resources. Map 10 shows the transportation system (roads, railroad lines and crossings) in relation to surface waters including streams and wetland and groundwater protection areas. Hazardous intersections have been identified by the Vermont Agency of Transportation and the planning committee. Roads with average grades greater than 10% also present hazards, particularly when roads are wet or during winter storms.

4. Probability, Impact and Vulnerability

Given the number of past spills, hazardous materials spills occur less than annually and affect very small areas. Increased truck traffic also increases the possibility of a major spill. However, many areas are vulnerable due to the extensive transportation system and proximity of surface and groundwater resources to that system. Most hazardous materials are transported via US Route 7. However, all local roads carry materials that could spill and affect aquatic resources as well as individual wells.

The overall likelihood of a hazardous materials spill on an annual basis is probably between one and ten percent. The likelihood of injuries, except in the case of direct injuries from a traffic accident, is likely low. However, the long-term impacts of a spill could be extensive if aquatic resources and/or water supplies were affected.

Table 19. Hazardous materials spills that have occurred in Sunderland. Source: VT ANR							
Report #	Facility Name	Address	Year	Product	Nature of Incident	Quantity	Responsible Party
022	N/A	Penocks Store	1974	Gasoline	Car Hit Gas Pump	Unknown	N/A
076	N/A	Creative Concepts	1982	NA	Burning Plastics and Laquer	Unknown	N/A
199	Schmaler Brothers Construction	Bacon Hollow Rd	1992	NA	Dumping Construction Debris	Unknown	Schmaler Bros Construction
WMD187	Morse Residence	North Rd	1997	Roofing Tar, Painted Wood	House Burned for Fire Training	Unknown	N/A
WMD191	RT 7A	RT 7A, North of Arlington	1998	Hydrofluoric Acid	Truck Accident	2 Gallons	LMS Distributing
WMD369	Casella Waste Management	Sunderland Hill Rd	1998	diesel fuel	Spill during refueling	5 Gallons	Casella Waste Management
WMD323	Line 264, Pole 32	South Rd	2003	non-PCB transformer oil	Storm damage	7 Gallons	CVPS
WMD360	N/A	Barney Orchard Rd	2005	Transformer oil	Transformer leak	1.5 Gallons	CVPS
WMD324	N/A	RT 7	2007	hydraulic oil	Blown hydraulic	2 Gallons	Vtrans
WMD380	CVPS Service Center	193 Old Camp Rd	2007	anti-freeze	Leak from cooling system	Unknown	CVPS
WMD327	Casella Transfer Station	4561 Sunderland Hill Rd	2010	hydraulic oil	Hose failure	3.5 Gallons	Casella Waste Management
WMD771	Sunderland Goo	228 Schoolhouse Woods Road	2011		Orange Goo on Water	--	Unknown
WMD100	roadway/roadside	RT 7 North	2014		Blown motor oil hose	5-10 Gallons	VTrans
WMD247	Roadside	Sunderland Hill Road & McKee Road	2014		Blown hydraulic hose on GMP truck	2 Gallons	GMP

Table 19. Hazardous materials spills that have occurred in Sunderland. Source: VT ANR							
Report #	Facility Name	Address	Year	Product	Nature of Incident	Quantity	Responsible Party
WMD439	Estate of Adam John Mugni Sr.	2715 North Road	2015		Contamination found from previously closed HO LUST and leaking AST	unknown --	Estate of Adam John Mugni Sr.
WMD231	Roadside	304 Dunham Road	2017		Transformer oil spill	3 Gallons	GMP
WMD320	Roadside	3694 Sandgate Rd	2017		Pole-mounted transformer downed in major storm	10 Gallons	GMP
WMD411	Nemchek Property	99 Flynn Hollow Rd	2017		Heating Oil UST leak	--	Ed Nemchek

M. Infectious Disease Outbreak

1. Description

Infectious diseases are caused by bacterial infections, viruses, fungi, and other organisms that can spread through the human population. COVID-19 is currently affecting much of the world. From . As of March 30, 2021, there have been 19,109 cases in Vermont with 225 deaths. In Bennington County, there have been 1,669 cases and 10 deaths. No information was available for the Town of Sunderland. (https://www.healthvermont.gov/covid-19) . Vermont has ramped up vaccinations, making them available to ever widening age groups.

The potential for transmission of COVID-19 has required people to wear protective masks and practice social distancing. As a result, businesses have been disrupted and, in some cases, closed; schools have been closed with students learning remotely, and many work from home if they can. The United States and Vermont went through a spike in cases in the spring and are experiencing a second spike with fall and winter. A vaccine has been developed, but distribution may take many months. The pandemic has become politicized with many viewing it as a hoax, and how many will actually accept vaccination is in question. However, vaccine doses are becoming more available and there is a major push to vaccinate much of the U.S. population.

2. Past Occurrences

The most prevalent infectious disease in Bennington County has been Lyme disease, carried by and transmitted by ticks. The symptoms can range from minor to very severe and are a clear threat to anyone in the town. Figure 4 shows those diseases tracked by the Vermont Department of Health.

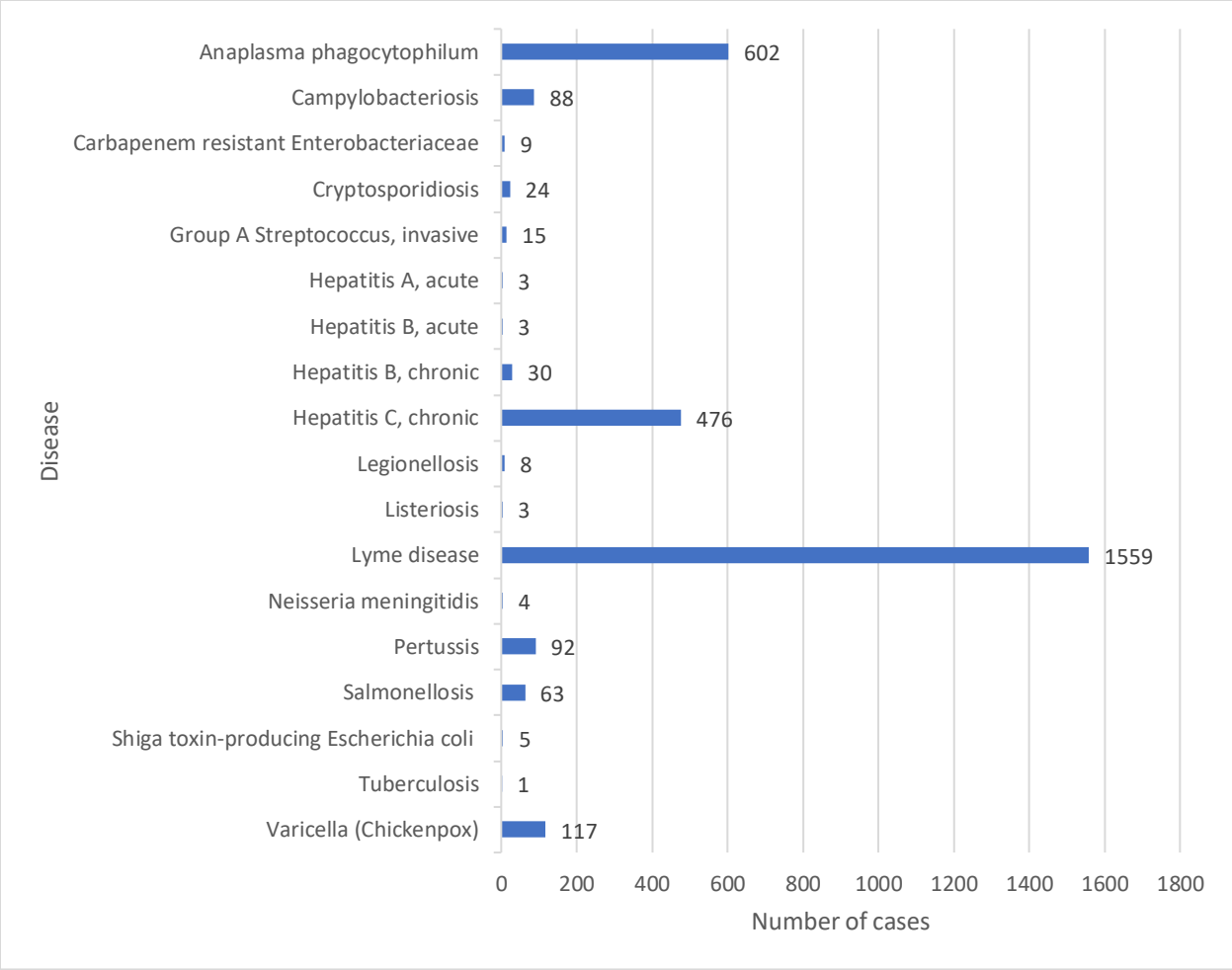


Figure 4. Disease cases in Bennington County from 2006 to 2019.
Source: Veronica Fialkowski, Vermont Department of Health

3. Extent and Location

In general, individuals and families are most affected by infectious diseases, but schools and businesses could be affected as well.

4. Probability, Impact and Vulnerability

Prior to COVID-19, there has been a low probability of a disease affecting a large portion of the town. However, COVID-19 has affected the state, regional and national economies, which has in turn affected Sunderland. Lyme disease presents at high probability of continued, isolated occurrences. Lyme disease, and other tickborne diseases could affect residents and those using recreational trails and visiting natural areas. Many of the carriers of infectious disease, such as ticks and mosquitoes, may be exacerbated by climate change and increased abundance of invasive species (Vermont Hazard Mitigation Plan 2018)

V. Vulnerability Assessment

A. Prioritization of Hazards

The information described above was used to prioritize hazards using criteria form the Vermont Hazard Mitigation Plan as described in Table 20 below.

Table 20. Vulnerability assessment factors (Vermont Hazard Mitigation Plan 2018)
Frequency of Occurrence: Probability of a plausibly significant event
1 = Unlikely <1% probability of occurrence per year
2 = Occasionally 1–10% probability of occurrence per year, or at least one chance in next 100 years
3 = Likely >10% but <75% probability per year, at least 1 chance in next 10 years
4 = Highly Likely 75% probability in a year
Potential Impact: Severity and extent of damage and disruption to population, property, environment, and the economy
1 = Negligible: isolated occurrences of minor property and environmental damage, potential for minor injuries, no to minimal economic disruption
2 = Minor: isolated occurrences of moderate to severe property and environmental damage, potential for injuries, minor economic disruption
3 = Moderate: severe property and environmental damage on a community scale, injuries or fatalities, short-term economic impact
4 = Major: severe property and environmental damage on a community or regional scale, multiple injuries or fatalities, significant economic impact

B. Priority Hazards

As can be seen in Section IV, the planning team undertook an exhaustive assessment of hazards that could affect Sunderland. They then scored those hazards based on the criteria in Table 20 to determine for which hazards actions would be needed. Table 21 shows the results of the scoring, with Flood/Flash Floods, Winter Storms, High Wind Events, Drought, Infectious Disease Outbreaks, and Invasive Species ranked highest. Geographic area affected and potential impacts were key criteria in determining whether mitigation actions would be developed for specific hazards. The planning team determined that, while earthquakes ranked high, the score was likely due to the short warning time and, therefore, was not an accurate representation of the threat of this hazard.

Table 21. Vulnerability *assessment*
Rows in grey indicate highest ranked hazards

Hazard	Number of Events	Frequency of Occurrence	Potential Impacts	Total Score
Floods and Flash Floods	59 events from 1996 to 2019	3	3	6
Winter Storms	183 events from 1996 to 2019	4	4	8
High Wind Events	158 events from 1996 to 2019	3	3	6
Hail	12 events from 1996 to 2019	2	1	3
Temperature Extremes	Annual >90 F – 1 day on average Annual maximum <32 F – 55 days Annual minimum < 32 F – 172 days	2>90 3< 32	2	2-3
Drought	Severe droughts have occurred in 27 years from 1895 to 2019	3	3	6
Wildfire	3 events from 1992 through 2019	1	1	2
Landslides and Debris Flows	No records	1	3	4
Earthquake	No events causing damage	1	1	2
Hazardous Materials Spills	18 events from 1979 to 2019	2	1	3
Infectious Disease Outbreak	Annual	4 and ongoing	3	7
Invasive Species	Ongoing	4	3	7

The primary area of concern is the Kelly Stand Road, which was severely damaged during Tropical Storm Irene and has several mass failures along the length of the road (Maps 5 and 8).Several maps can be viewed to show composite hazard areas. Map 4 shows special flood hazard areas and river corridors. Map 5 is shows damages documented during Tropical Storm Irene and roads identified by the planning team as areas of potential accidents, difficult areas for snow plowing, and other issues. Clearly the transportation system has been vulnerable in the past and continues to require monitoring, maintenance, and upgrades. Map 10 shows the transportation system in relation to water resources indicating areas where potential spills could be problematic. The landslide potential (Map 8) also shows vulnerabilities to the transportation system. Map 9 shows invasive species locations other than forest insects such as the Emerald Ash Borer, which can range widely. Other priority hazards such as infectious diseases could not be mapped as those hazards would likely affect the entire town and beyond.

VI. Mitigation Measures

A. Hazard Mitigation Goals

As part of the planning process, the Town identified the following mitigation goals:

1. Reduce injury and loss of life resulting from natural disasters.
2. Reduce damage to public infrastructure, minimize disruption to the road network and maintain both normal and emergency access.
3. Establish and manage a program to proactively implement mitigation projects for roads, bridges, culverts, and other municipal facilities to ensure that community infrastructure is not significantly damaged by natural hazard events.
4. Design and implement mitigation measures to minimize impacts to rivers, water bodies and other natural features, historic structures, and neighborhood character.
5. Increase the economic resiliency of Sunderland by reducing the economic impacts incurred by municipal, residential, agricultural, and commercial establishments due to disasters.
6. Incorporate hazard mitigation planning into other community planning projects, such as Town Plan, Capital Improvement Plan, and Town Local Emergency Operation Plan
7. Ensure that members of the general public continue to be part of the hazard mitigation planning process.

B. 2014 Sunderland Hazard Mitigation Plan

Sunderland completed a town hazard mitigation plan in 2015, which was approved by FEMA in 2015. Appendix I lists the actions from the 2014 plan and includes a column of which actions were completed, which carried over to this 2021 plan and which deleted. The priorities of the town for hazard mitigation have not changed since the 2014 plan except that earthquakes and hazardous materials spills were categorized as low priority, so actions for those are not included in this plan . Otherwise, many actions have been carried over to this plan. Since that time, the town has continued to upgrade culverts, engaged with the U.S. Forest Service on rebuilding the Kelly Stand, damaged during Tropical Storm Irene, and adopted updated special flood hazard and river corridor regulations as part of the Town Zoning Bylaws.

C. 2018 Sunderland Town Plan

The town plan was substantially revised and adopted in 2018. Actions listed in the plan relevant to mitigation include (Town of Sunderland 2018):

- Limiting development on slopes greater than 10% and prohibiting it on slopes greater than 20%
- Protecting the Batten Kill and tributaries

- Prohibiting development that would adversely affect surface waters
- Protecting shorelines and wetlands
- Encouraging protection of forest lands that provide for moderation of flood events, protect surface and groundwaters, and provide habitat for native species. Approximately 86% of Sunderland is within the boundaries of Green Mountain National Forest.
- Protection of surface and groundwater sources.

D. Sunderland Zoning Bylaws

The town bylaws were revised and adopted in 2020 (Town of Sunderland 2020). They the following provisions relevant to mitigation:

- Creation of an Inundation Hazard Overlay (IHO) District consisting of the floodway and flood fringe in which some types of development are minimized or prohibited, and others allowed following permit reviews.
- Creation of a River Corridor Overlay (RCO) district permitting new structures in that district and requiring permits for expansion of existing structures.
- Limitation of development within the Forest (F) District
- Provisions to protect or limit development in wetlands, streams, and other natural features.

Sunderland joined the National Flood Insurance Program in 1985. There are no active flood insurance policies nor any repetitive loss properties. The Zoning Administrator reviews building permits within the Inundation Overlay District and the River Corridor Overlay District for compliance with standards of the Flood Hazard Area Regulations as described in the Sunderland Land Use and Development Bylaw adopted in August 2020.

No new developments have been approved in either the Inundation Hazard Overlay District or the River Corridor Overlay District since 2015 (Source: Town Zoning Administrator).

E. Stormwater Management

The Vermont Clean Water Act, Vermont Act 64/H.35 and the Lake Champlain Phase 1 total maximum daily load (TMDL)[2] require that municipalities reduce sedimentation runoff from their road systems over a twenty-year period following attainment of stormwater permits between 2018 to 2021 (Vermont Agency of Natural Resources, 2017b). Towns are required to develop road stormwater management plans in the following steps:

1. Identify sections of roads connected to surface waters through ditches, culverts, or other

[2] This is a regulatory term under the Clean Water Act identifying the maximum amount of a pollutant that a body of water can receive and still meet water quality standards.

drainage structures.

2. Inventory connected portions of the road network to determine if these sections meet the standards being developed by the Vermont Agency of Natural Resources.
3. Develop a long-term plan to bring all connected sections up to statewide design standards.

The road erosion survey identified the following categories of road condition:

Table 22. Road erosion survey results
Source: Vermont Agency of Natural Resources Municipal Roads Program 2020; Available via: https://dec.vermont.gov/watershed/stormwater/permit-information-applications-fees/municipal-roads-program

Category	# Segments
Does Not Meet	**36**
Very High	2
High	12
Moderate	22
Partially Meets	**108**
Moderate	43
Low	65
Fully Meets	**127**
Not Connected	**146**
Incomplete Data	**88**
Grand Total	***505***

Roads that do not meet standards generally lacked drainage ditches, had eroded ditches, or had unstable conveyances. Those segments categorized as “Very High” priority will need to be brought up to standards by 2025 to meet the municipal general permit requirements. All segments should be brought up to standard by 2036.

Culvert surveys completed by BCRC indicate the following culvert conditions:

Table 23. Culvert condition for Sunderland culverts
Source: Source: VT AOT VTCULVERTS; available via: https://vtculverts.org/

Culvert Condition	Number
Excellent	77
Good	117
Fair	39
Poor	54

Table 23. Culvert condition for Sunderland culverts Source: Source: VT AOT VTCULVERTS; available via: https://vtculverts.org/	
Culvert Condition	Number
Critical	16
Urgent	3
Unknown	270
Total	576

Bridge condition was not specified.

Along with addressing road erosion, the Town will need to address culverts that are undersized or in poor condition.

BCRC hired Fitzgerald Environmental Associates to complete a stormwater master plan (Fitzgerald Environmental Associates 2017). That plan identified:

- Seven (7) culverts, mainly draining first order and intermittent streams, were analyzed for hydraulic capacity.
- Drainage culvert projects were identified in two locations where maintenance practices or stormwater runoff and associated sediment loads at cross-culverts located under Town maintained roads were deemed problematic.
- Twelve (12) roadside ditch projects were identified, typically along steep sections of Town maintained gravel roads. Ditches may convey large volumes of sediment to receiving surface waters, especially if the ditch is eroding, or filling in causing water to run across the road surface.
- Three (3) stream crossing projects were identified where a perennial stream crosses under a Town maintained road. These sites were assessed for culvert capacity and for the ease of Aquatic Organism Passage (AOP).
- Four (4) stormwater BMP projects were identified in areas where improved maintenance practices and/or the construction of stormwater treatment infrastructure could significantly reduce sediment and nutrient loading to receiving waters.

Based on these analyses, the following were identified as priority projects. Those marked with an * have been completed:

- C-3: A small stream crosses under Dunham Road through an undersized culvert. The road washed out in T.S. Irene and severed an important transportation link within the town.

- RD-1: A roadside ditch along Bentley Hill Road empties on to the road where a driveway connects to the road without a culvert, significant gully erosion along the road embankment draining directly into a small stream.
- *RD-8: Extreme ditch erosion along a steep section of Barney Orchard Road is causing significant sediment loading to a small stream.
- *RD-9: The roadway drainage network along lower Prouty Hill Road is complicated due to a missing driveway culvert, and severe ditch erosion and runoff across the road is causing significant sediment loading to the Fayville Branch.
- *SC-1: The Cole Brook culvert under North Road is undersized and was the location of significant flooding and roadway damage during Tropical Storm. Irene

The recommendations the road erosion inventory and from the Fitzgerald (2017) plan have been incorporated into Table 27 Mitigation Actions

F. State and Regional Plans and Programs

1. Vermont Hazard Mitigation Plan (2018)

The Vermont Hazard Mitigation Plan (2018) identified a series of hazards shown in Table 24 below along with those we considered in this plan. The planning team used the state plan as a starting point and local knowledge to create a more specific set of hazards that they addressed. Table 24 shows how the Sunderland plan tracks the state plan.

Table 24. Comparison of hazards considered in the 2018 Vermont Hazard Mitigation Plan vs. the Sunderland Hazard Mitigation Plan

2018 VT Hazard Mitigation Plan	Sunderland Hazard Mitigation Plan
Hazards	**Natural Hazards**
Drought	Drought
Earthquake	Earthquake
Inundation Flooding and Fluvial Erosion	Flooding and Fluvial Erosion
Hail	Hail
Wind	High Winds
Hurricane/Tropical Storm	High Winds and Flooding and Fluvial Erosion
Infectious Disease	Infectious Disease Outbreak
Invasive Species	Invasive Species
Landslides	Landslide/Debris Flow
Severe Thunderstorm	See High Winds and See Flooding and Fluvial Erosion

Table 24. Comparison of hazards considered in the 2018 Vermont Hazard Mitigation Plan vs. the Sunderland Hazard Mitigation Plan	
2018 VT Hazard Mitigation Plan	Sunderland Hazard Mitigation Plan
Snowstorm and Ice Storm	Winter Storms
Extreme Heat	Temperature Extremes
Extreme Cold	Temperature Extremes
Wildfire	Wildfire

2. Bennington County Regional Plan Policies and Actions (adopted March 19, 2015)

The Bennington County Regional Plan (Bennington County Regional Commission 2015) lists the following policies and actions supporting hazard mitigation including several policy recommendations emphasizing protecting natural resources, maintaining village and urban centers, and avoiding development on sensitive lands including areas of steep slope and wetlands along with the protection of surface and groundwater resources and forested lands (Sections VII and VIII). The regional plan also includes a flood resilience section (IX), which is required by Vermont statutes describing potential hazards from flooding and fluvial erosion. The section encourages avoiding development in flood hazard areas, reconstruction of bridges and culverts that impede flows, undisturbed buffer areas along streams to provide for lateral movement and attenuation of overland flow, participation in the National Flood Insurance Program, updating of flood bylaws, adoption of up-to-date road and bridge standards and participation in the community rating system.

3. Community Wildfire Protection Plan for the Towns of Arlington, Glastenbury, Sandgate, Shaftsbury, and Sunderland

A community wildfire protection plan (Batcher and Henderson 2013) was completed by the Bennington County Regional Commission for the towns of Arlington, Glastenbury Sandgate, Shaftsbury and Sunderland in 2013. The plan was developed in cooperation with the Arlington and Shaftsbury Fire Departments, the Vermont Department of Forests, Parks and Recreation, the fire wardens from each town, Bennington County Mutual Aid and Green Mountain National Forest. Presentations were made to the planning commissions of each town to gather their input as well.

The plan includes actions for education and outreach, improvements to water resources for wildland and structural fire protection, and fuel reduction projects. These have been incorporated in this plan as well. Fire hazard was mapped based on fuel types, slope, aspect, and topographic characteristics that affect fuel moisture. The Community Wildfire Protection Plan for the Towns of Arlington, Glastenbury, Sandgate, Shaftsbury, and Sunderland (Batcher and Henderson 2013 contains information on the locations of potential fuel treatments and areas where water resources need to be enhanced. Fuel treatments should be focused on areas

along the Kelly Stand where residences abut lands of Green Mountain National Forest and fields where structures are often proximate to grass and shrub dominated fields which can carry high intensity, fast moving fires.

4. Vermont Agency of Natural Resources

The Vermont Agency of Natural Resources (VT ANR) has worked with Sunderland and other communities to adopt updated flood and river corridor regulations. VT ANR also has mapped river corridors and can regulate activities within those that are not subject to review by municipalities. VT ANR also reviews municipal permit applications for development within the special flood hazard area, permit applications for stream alterations, regulated activities within wetlands, and permits for transporting hazardous materials.

5. Act 250 Review

The Act 250 program provides a public, quasi-judicial process for reviewing and managing the environmental, social, and fiscal consequences of major subdivisions and developments in Vermont. During Act 250 proceedings, agencies and the public can offer comments on such proposed developments.

6. Other Organizations

There are numerous organizations within Bennington County that provide assistance in health care, food, and services to seniors and other vulnerable populations.

G. Town Capabilities

The Town has an active program to maintain roads and bridges and has upgraded all of the bridges and culverts based on hydraulic studies completed by the Agency of Transportation. The Town has investigated using Sunderland Elementary as a shelter but has an agreement with Arlington to use their shelter. The Town Hall will have utilities placed underground and will be constructed to conform to the latest Vermont building requirements. The locations of critical facilities are shown on Map 3. Table 25 below summarizes town capabilities and areas needing improvement to enhance those capabilities.

Table 25. Capabilities of the Town of Sunderland			
Plans, Policies, Ordinances	Description/Responsible Agent	Effectiveness	Improvements Needed
Town Plan	Planning Commission; Select Board (adoption of Town Plan)	The town plan was last revised and adopted in 2018	The town plan should be the primary document used to guide policies and actions by the town. This should be reviewed after the results of the 2020 Census are complete.
LEMP	Town Emergency Management Coordinator; Select Board (adoption of plan)	Annual updates required	Update and improve LEMP and replace with annually and as needed
Flood hazard bylaws	Planning Commission; Development Review Board; Zoning Administrator (permitting); Select Board (approval of bylaws)	The Sunderland Land Use Bylaws (updated Aug 2020) reflect policies recommended by VT ANR following the publication of updates flood hazard maps	The town should continue to enforce the bylaws to limit and, in some cases, prohibit development in the special flood hazard area and in river corridors as recommended in the town plan. The Zoning Administrator should provide outreach to property owners and applicants for development on the requirements of the town bylaws on flooding and fluvial erosion.
Mutual Aid for Emergency Services	Town Emergency Management Coordinator; Select Board (approval of agreements); LEPC (coordination)	Needs some improvements and updates	Update mutual aid fire agreements with neighboring communities.
Mutual Aid for Public Works	Town Emergency Management Coordinator; Road Foreman; Select Board (approval of agreements); LEPC (coordination)	Needs some improvements and updates	Although the Town of Sunderland is quite self-sufficient in caring for our roads, the town should consider developing mutual aid agreements for emergency road repairs.
Zoning/Subdivision Regulations	Development Review Board and Zoning Administrator (permitting); Select Board (approval of bylaws)	Generally effective, The Sunderland Land Use and Development Bylaws were updated Aug 2020	Annual Review would be recommended

Table 25. Capabilities of the Town of Sunderland			
Plans, Policies, Ordinances	Description/Responsible Agent	Effectiveness	Improvements Needed
Wetlands/Rivers and Streams/Waterbodies/Steep Slopes/Groundwater Protection Regulations	Wetlands are primarily protected by VT ANR and ACT 250. The town bylaws do not address wetlands or groundwater resources but do address flood hazard areas (see above)	Provide some mitigation	Further assessment of natural resources could benefit improved development review.
Building Codes	State of Vermont (commercial only); Zoning Administrator (certain building codes in flood hazard zones)	Commercial building codes overseen by State of Vermont (Department of Public Safety)	The Town should encourage energy efficiencies in new construction for residential, commercial, and industrial structures.
Water	Sunderland has no public water supply, but residents of Chiselville are supplied water from Arlington's public water system	Majority of residents have private wells for their water supply	Work with Arlington for the supply to the Chiselville Residents.
Road Maintenance Programs and Standards	Road Foreman; Select Board	Effective; Town adopted most recent State of Vermont (AOT) road and bridge standards	On-going upgrades to culverts and storm water management grading and paving have kept Sunderland roads in compliance with AOT.
Events Management	Select Board Vendor permit	For private events	There have been few significant events in the Town of Sunderland
School Emergency Response	School administrators; Town Emergency Management Coordinator	Needs some review	Update and review school emergency plans; LEPC should conduct onsite training.
Vulnerable Populations	Town Emergency Management Coordinator and Health Officer	Needs improvements and updates	Need means to identify and communicate with vulnerable populations.
Mobile Homes	Town Emergency Management Coordinator and Health Officer and the Zoning Administrator	State of Vermont regulates mobile homes and mobile home parks	There are few mobile homes in Sunderland and no mobile home parks

H. Mitigation Projects

Table 27 below lists mitigation actions for each of those hazards. Some will be implemented by the Town of Sunderland and others by agencies such as the Vermont Agency of Transportation. Mitigation actions are listed by the type of hazard. Table 26 shows how these actions were prioritized.

Table 26. Criteria for prioritizing mitigation actions.
Source: Vermont Hazard Mitigation Plan 2018

	Impact	Feasibility
High	• Significantly benefit the environment, OR • Significantly benefit people/vulnerable populations, OR • Significantly reduce risk in our built environment, OR • Significantly benefit the economy, OR • Create the opportunity to do one of the above (e.g., filling a data gap), AND Significantly reduce vulnerability to a high priority hazard (erosion, inundation, ice, snow)	• Have political and community support, AND • Are consistent with current state laws/policies, AND • Have funding/other required resources available or identified, AND • Are technically/logistically feasible
Medium	• Moderately benefit the environment, OR • Moderately benefit people/vulnerable populations, OR • Moderately reduce risk in our built environment, OR • Moderately benefit the economy, OR • Create the opportunity to do one of the above (e.g., filling a data gap), AND • Moderately reduce vulnerability to a profiled hazard	• Have political and community support, OR • Are consistent with current state laws/policies, OR • Have funding/other required resources available or identified, AND • Are technically/logistically feasible
Low	• Minorly benefit the environment, OR • Minorly benefit people/vulnerable populations, OR • Minorly reduce risk in our built environment, OR • Minorly benefit the economy, OR • Create the opportunity to do one of the above (e.g., filling a data gap), AND • Minorly reduce vulnerability to a profiled hazard	• Have political and community support, OR • Are consistent with current state laws/policies, OR • Have funding/other required resources available or identified, OR • Are technically/logistically feasible

Prior to the implementation of any action, a benefit-cost analysis would be completed to assure the action would be feasible and cost-effective. Funding sources listed in Table 26 include:

Town of Sunderland General Fund

VT Agency of Transportation funding for road projects and stormwater management

FEMA Flood Management Assistance Grants

Hazard Mitigation Grants (HMGP)

Building Resilient Infrastructure and Communities (BRIC) grants

Vermont Division of Parks, Forests and Recreation grants

Vermont Ecosystem Restoration Program Grants from VT ANR

Table 27. Mitigation actions [3]							
Hazard	Type	Actions	Responsible Parties	Time Frame	Funding Source(s)	Impact	Feasibility
All Hazards	Education and Outreach	Provide information on the Town website with links to information for residents on preparing for hazards.	Town Select Board	2021-2022	Town general fund	High	High
All Hazards	Local Planning and Regulations	Initiate encouraging proper construction techniques and use of appropriate materials to address hazards, particularly flooding, winter storms, wind events, earthquakes, landslides, and wildfire during the review of proposed developments, encourage	Town Planning Commission; Zoning Administrator	2022	Town general fund	High	High
All Hazards	Education and Awareness	Encourage residents to sign up with the Citizens Assistance Registry for Emergencies to provide first responders with contacts of populations vulnerable to potential hazards, particularly drought, extreme temperatures, and infectious diseases, but also those in need of assistance for evacuation and/or sheltering	Town Emergency Management Director	2022	Town general fund	High	Medium
All Hazards	Local Planning and Regulations	Assess need for driveway standards to assure adequate emergency access particularly to assure adequate access in winter storms, floods and for wildfire protection	Town Planning Commission	2021 to 2022	Town general fund	Medium	Medium
Floods and Flash Floods	Education and Awareness	Educate owners on importance of securing propane tanks and other items that could float or blow away in storms	Town Zoning Administrator	2022	Town general fund	High	High
Floods and Flash Floods	Local Planning and Regulations	Enforce updated flood hazard and fluvial erosion hazard zone bylaws	Town Planning Commission; Zoning Administrator	Ongoing	Town general fund	High	Medium
Floods and Flash Floods	Local Planning and Regulations	Participate in the Community Rating System to help reduce flood insurance premiums	Town Select Board	2023-2025	Town general fund	Low	Low

[3] Prior to the implementation of any action, a benefit-cost analysis would be completed to assure the action would be feasible and cost-effective.

Table 27. Mitigation actions [3]							
Hazard	Type	Actions	Responsible Parties	Time Frame	Funding Source(s)	Impact	Feasibility
Floods and Flash Floods	Local Planning and Regulations	Begin to encourage appropriate stormwater and erosion control measures in new developments as recommended in the Fitzgerald (2017) plan, and the Town Plan (2018)	Town Planning Commission	2022	Town general fund	High	High
Floods and flash floods	Local Planning and Regulations	Prepared draft contract for company to provide services if debris piles up under bridges or blocking culverts to prevent blockages and resulting flooding.	Town Select Board; Town Road Foreman	2022	Town highway fund	High	Medium
Floods and flash floods	Structure and Infrastructure Projects	Create a system for road crew to regularly survey culverts for blockages including photographs and records of damages and costs	Town Road Foreman	2022	Town highway fund	High	High
Floods and flash floods	Structure and Infrastructure Projects	Regularly adopt the latest and updates to the Vermont Town Road and Bridge Standards	Town Select Board	Annually	Town general fund	Medium	High
Floods and flash floods	Structure and infrastructure projects	Identify and replace culverts and bridges that do not meet current Vermont Town Road and Bridge Standards or are categorized as poor, urgent, or crucial.	Town Road Foreman	2021 to 2026	Town highway fund State of Vermont AOT FEMA HMGP, PDM, FMA	High	High
Floods and flash floods	Structure and Infrastructure Projects	Bring all road segments categorized as “very high” in the town road erosion inventory to AOT standards by 2025	DPW Supervisor	2021 to 2025	Town general fund VT AOT	High	High

Table 27. Mitigation actions [3]							
Hazard	Type	Actions	Responsible Parties	Time Frame	Funding Source(s)	Impact	Feasibility
Floods and flash floods	Structure and Infrastructure Projects	Complete the following road and culvert projects: C-3: A small stream crosses under Dunham Road through an undersized culvert. The road washed out in T.S. Irene and severed an important transportation link within the town. RD-1: A roadside ditch along Bentley Hill Road empties on to the road where a driveway connects to the road without a culvert, significant gully erosion along the road embankment draining directly into a small stream.	Road Foreman State of Vermont	2021 to 2026	Town general fund Town VT AOT	High	High
Floods and flash floods	Structure and Infrastructure Projects	Remediate the other 28 problem areas identified in the Fitzgerald (2017) study based on their impact and available funding.	Road Foreman	2022-2025	Town general fund VT AOT	Medium	Medium
Floods and flash floods	Structure and infrastructure protection	Develop materials to advise property owners in flood or fluvial erosion hazard zones to of the possibility of r selling their properties (buy out) or implementing flood proofing including elevating structures	Town Select Board	2022	FEMA HMGP, PDM, FMA	Medium	Low
Floods and flash floods	Structure and infrastructure protection	Implement corridor protection, buffer plantings, structure and berm removal and other projects listed in the 2016 Batten Kill Walloomsac Hoosic Tactical Basin Plan (Vermont Agency of Natural Resources 2016) and updates to that plan	Town Select Board; Batten Kill Watershed Alliance	2022-2024	FEMA HMGP, FMA, PDM Vermont Ecosystem Restoration Program, Vermont Watershed Grant	Medium	Low

Table 27. Mitigation actions [3]							
Hazard	Type	Actions	Responsible Parties	Time Frame	Funding Source(s)	Impact	Feasibility
Floods and flash floods	Natural Systems Protection	Encourage conservation organizations to acquire lands subject to frequent flooding or wetlands within or adjacent to flood prone areas to provide flood storage	Town Select Board; Batten Kill Watershed Alliance: Vermont Land Trust	2022-2024	State of Vermont Watershed Grants, Vermont Ecosystem Restoration Program, Nonprofit organizations	Low	Low
Winter storms	Education and Outreach	Provide educational materials on sheltering in place and preparation for winter storms, including long-term power outages	Town Emergency Management Director	2022	Town general fund	High	High
Winter storms	Education and Awareness	Provide materials for residents on methods to protect property from wind events through the town website and written material displayed in the town office	Town Emergency Management Director; Zoning Administrator	2022	Town general fund FEMA HMGP, PDM, FMA	Medium	High
All Hazards	Local Planning and Regulations	Develop agreements with adjacent towns for sharing resources for ongoing maintenance as well as for disaster management	Town Select Board; Town Road Foreman	2021 to 2022	Town general fund	High	High Low
Winter storms	Structure and Infrastructure Projects	Place utilities underground for critical facilities	Town Select Board	2024-2025	FEMA HMGP, PDM, FMA	High	Low

Table 27. Mitigation actions [3]							
Hazard	Type	Actions	Responsible Parties	Time Frame	Funding Source(s)	Impact	Feasibility
High wind events	Education and Outreach	Provide educational materials on sheltering in place and preparation for windstorms, including long-term power outages	Town Emergency Management Director	2022	Town general fund	High	High
High wind events	Local Planning and Regulation	Begin to require boats, propane tanks and other items stored outdoors to be secured, and adopt appropriate regulations if necessary	Town Planning Commission; Zoning Administrator	2023	Town general fund	Medium	Medium
High wind events	Local Planning and Regulation	Encourage appropriate plantings to avoid future damage from downed trees	Town Emergency Management Director	2022	Town general fund	Low	Low
High wind events	Local Planning and Regulation	Encourage protection and planting of wind breaks in new developments	Town Emergency Management Director; Zoning Administrator	2022	Town general fund	Low	High Low
High wind events	Structure and Infrastructure Projects	Retrofit existing buildings to withstand high winds including protection of power lines and other utilities	Town Select Board Private Owners	2023-2024	FEMA HMGP, PDM	Low	Low
High wind events	Structure and Infrastructure Projects	Place utilities underground for critical facilities	Town Select Board; Private Owners	2023-2024	FEMA HMGP, PDM	High	Low

Table 27. Mitigation actions [3]							
Hazard	Type	Actions	Responsible Parties	Time Frame	Funding Source(s)	Impact	Feasibility
Temperature extremes	Education and Awareness	Encourage residents to sign up with the Citizens Assistance Registry for Emergencies to provide first responders with contacts of populations vulnerable to potential hazards, particularly drought, extreme temperatures, and infectious diseases, but also those in need of assistance for evacuation and/or sheltering	Town Emergency Management Director	2022	Town general fund FEMA HMGP, PDM	High	Medium
Drought	Local Planning and Regulation	Begin to monitor drought conditions and report on the town website when droughts are occurring.	Town Emergency Management Director	2022	Town general fund	Medium	High
Drought	Education and Awareness	Provide educational materials on dealing with drought.	Town Emergency Management Director	2021 to 2022	Town general fund FEMA HMGP, PDM	Medium	High
Drought	Natural System Protection	Develop improved assessment of groundwater sources and amend bylaws to assure their protection	Vermont Geological Survey Town Planning Commission	2022 to 2026	FEMA HMGP, PDM State of VT	Medium	Medium
Drought	Local Planning and Regulation	Incorporate planning for droughts in the emergency management plan	Town Emergency Management Director	Annually	Town general fund	High	High
Wildfire	Education and Outreach	Acquire materials from Firewise for homeowners and provide to Sunderland to make available for landowners	BCRC	2022	BCRC	High	High
Wildfire	Education and Outreach	Provide information on outdoor burning safety prior to the spring and fall fire seasons	Fire wardens	2022	Fire wardens	Medium	High

Table 27. Mitigation actions [3]							
Hazard	Type	Actions	Responsible Parties	Time Frame	Funding Source(s)	Impact	Feasibility
Wildfire	Education and Outreach	Provide a review of properties where owners request assessment of their properties for wildfire safety and adequate defensible space	BCRC, Arlington Fire Department	2024	BCRC, Arlington FD	Medium	High
Wildfire	Education and Outreach	Encourage owners to maintain defensible space around structures and to mow fields along road edges to prevent wildfire	Town Emergency Management Director; Arlington Fire Department	2022	Town general fund	Medium	Medium
Wildfire	Local Planning and Regulations	During reviews of development projects, encourage defensible space around structures	Town Planning Commission Zoning Administrator	2022	Town general fund	Medium	Medium
Wildfire	Structure and Infrastructure Projects	Assure adequate water supplies are available including areas identified as gaps in the 2013 Community Wildfire Protection Plan	Town Select Board; Emergency Management Director, Arlington Fire Department	2022-2023	Town general fund /State of Vermont grants for dry hydrants/ Vermont Department of Parks, Forestry and Recreation	High	Medium
Wildfire	Natural Systems Protection	Implement fuel reduction, particularly in grass fields and in areas of Green Mountain National Forest	Arlington Fire Department/Green Mountain National Forest	2023-2024	Arlington FD/Green Mountain NF	Medium	Low

Table 27. Mitigation actions [3]							
Hazard	Type	Actions	Responsible Parties	Time Frame	Funding Source(s)	Impact	Feasibility
Landslide and debris flow	Local Planning and Regulations	Map known landslides and identify potential landslide areas	Town/BCRC/State of Vermont	2021 to 2023	FEMA HMGP, PDM	Medium	High
Landslide and debris flow	Local Planning and Regulations	Enforce fluvial erosion hazard bylaws	Town Select Board; Town Planning Commission	2022	Town general fund	High	High
Landslide and debris flow	Structure and Infrastructure Projects	Implement visual monitoring in potential landslide areas	Town Emergency Management Director	2023	Town general fund	Low	Medium
Landslide and debris flow	Structure and Infrastructure Projects	Stabilize and replant stream corridor areas subject to landslides including those along the Kelly Stand	Batten Kill Alliance	2022-2023	State of VT Watershed grants	Medium	Low
Hazardous materials spill	Local Planning and Regulation	Complete an assessment of hazardous materials and potential accident locations	LEPC 7 BCRC	2022 to 2024	Town general fund	Medium	Medium
Hazardous materials spill	Structure and Infrastructure Projects	Work with VT AOT to create adequate crossing warnings at all RR crossings One Road Crossing is Protected One Driveway crossing Not protected	VT AOT	2022 to 2024	State AOT funds	Low	Low
Hazardous materials spill	Natural Systems Protection	Identify groundwater source areas and develop ordinances to protect those areas	Vermont Geological Survey	2022 to 2025	VT Geological Survey funds	High	Low
Infectious disease outbreak	Local Planning and Regulations	Begin to monitor disease occurrences and potential outbreaks	Town Health Officer	2022	Town general fund	High	Medium

Table 27. Mitigation actions [3]							
Hazard	Type	Actions	Responsible Parties	Time Frame	Funding Source(s)	Impact	Feasibility
Infectious disease outbreak	Education and Outreach	Provide educational materials in printed form and on the town web site on potential infectious diseases at Town Hall and on the Website	Town Health Officer	2022	Town general fund /State of Vermont Health Departmen t	High	High
Invasive species	Local Planning and Regulations	Begin to monitor extent of invasive species, particularly forest invasive species such as Emerald Ash Borer	Town Select Board	2023	Town general fund	High	Medium
Invasive species	Local Planning and Regulations	Complete surveys for ash trees vulnerable to Emerald Ash Borer	BCRC; Bennington County Conservation District	2022 to 2024	FEMA HMGP, PDM VT Departmen t of Forests, Parks and Recreation	High	Medium
Invasive species	Local Planning and Regulations	Survey for invasive species (e.g., Japanese knotweed)s along streams to identify potential erosion areas	Batten Kill Watershed Alliance	2022-2024	State of Vermont Departmen t of Parks, Forestry and Recreation	Medium	Low
Invasive species	Local Planning and Regulations	During the review of development proposals begin to encourage use of native species in plantings for commercial and residential development	Town Planning Commission	2022	Town general fund	High	High

Table 27. Mitigation actions [3]							
Hazard	Type	Actions	Responsible Parties	Time Frame	Funding Source(s)	Impact	Feasibility
Invasive species	Education and Awareness	Provide outreach materials for landowners on using native plants and controlling invasive species	Bennington County Conservation District	2022	Town general fund /State of Vermont Department of Parks, Forestry and Recreation	High	High

VII. Plan Maintenance

A. Annual Monitoring and Continued Public Involvement

Copies of this plan will be kept at the town office and made available via the town and BCRC website. The Select Board intends to involve the public in the implementation, review, and update of this plan. Tracking of actions will take place during the annual budgeting process, when funds are allocated for various programs to operate the town, including capital improvements. The Select Board is responsible for developing a town budget, which is approved during Town Meeting Day in March.

During future updates to the Town Plan, the planning commission will review this plan and incorporate relevant mitigation actions and goals into the Town Plan. This plan will also be integrated into annual updates to the Town Local Emergency Operations Plan. New data from a variety of studies completed by the Bennington County Regional Commission, the State of Vermont, the U.S. Forest Service, and others will be used in updating the town plan, as they were used to develop this hazard mitigation plan. The process of updating the town plan will incorporate the public involvement, agency review and adjacent town review requirements of Vermont statutes.

B. Plan Evaluation and Update

The Sunderland Select Board will be responsible for serving as or appointing a planning team for evaluating and updating the plan.

1. Plan Evaluation

The effectiveness of the plan will be determined by whether or not actions listed in Table 27 are implemented and whether or not the goals listed in VI. A. have been achieved.

a) Prior to town meeting in March, the Select Board, and the Emergency Management Director, will review each of the actions in Table 27 to determine their status. Status categories will include completed, in progress, scheduled, no progress.
b) The evaluation will be presented at a public meeting to allow for a discussion on progress in implementing the plan and the need for applying for funding or to address program and budgeting priorities.
c) The evaluation will be used to update the Local Emergency Operations Plan, which is required annually, and to identify potential changes to other town plans, programs, and policies.

If requested, the Bennington County Regional Commission will provide advice and assistance on the plan evaluation.

2. Plan Update

At least one year before the five-year period covered by this plan, the planning team will initiate a review of the plan by:

a. Updating the descriptions and analyses of events using new information since completion of this 2017 hazard mitigation plan.
b. Identification of any new buildings or infrastructure or changes in critical facilities.
c. Estimation of potential probability and extent of hazards based on any new information since completion of this plan.
d. Review of completed hazard mitigation projects.
e. Identification of new projects given the revised hazard evaluation.
f. Review of any changes in priorities since adoption of this plan.
g. Revision of the assessment of risks and vulnerability from identified hazards.
h. Development and use of criteria to assess the potential benefits and costs of identified actions for use in prioritizing those actions.
i. Integration of the updated plan into the any updates to the Sunderland Town Plan and other plans and programs.

The planning team will hold open meetings to solicit opinions and to identify issues and concerns from members of the public and stakeholders. The planning team and the Town of Sunderland Select Board will work with the Bennington County Regional Commission and the State Hazard Mitigation Officer (SHMO) to review and update programs, initiatives and projects based on changing local needs and priorities. BCRC will assist in any necessary coordination and communication with neighboring towns to assure that mitigation actions address regional issues of concern. The revised plan will be submitted for review by the State Hazard Mitigation Officer and FEMA and revised based on their comments. Following approval by FEMA, the Select Board will adopt the completed plan.

C. Post Disaster Review and Revision

Should a declared disaster occur, Sunderland may undertake special review of this plan and the appropriate updates made. After Action Reports, reviews, and debriefings should be integrated into the update process. The plan should also be updated to reflect completion of projects listed in the basin plan, river corridor plan, culvert surveys and other studies.

VIII. References

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B. Map Data Sources

The Vermont Open Geodata Portal (http://geodata.vermont.gov/)provides data on transportation systems, the location of structures (E911), critical facilities, jurisdictional boundaries, and other information. The base map was from ArcGIS Online (ESRI). Data from other sources specific maps (if any) is noted listed.

Map 1. Town of Sunderland

Map 2. Town of Sunderland Land Cover: National Oceanographic and Atmospheric Administration, https://coast.noaa.gov/digitalcoast/data/nlcd.html

Map 3. Town of Sunderland Critical Facilities: Vermont Agency of Transportation provided to BCRC for Batten Kill Resilience Study and Town Planning Committee

Map 4. Town of Sunderland Special Flood Hazard Areas and River Corridors: Vermont Agency of Natural Resources Natural Resources Atlas, http://anrmaps.vermont.gov/websites/anra/
FEMA Flood Map Service Center: https://msc.fema.gov/portal/

Map 5. Town of Sunderland Past Damages: data collected by BCRC with assistance from Marc Johnson, Sunderland Road Foreman.

Map 6. Town of Sunderland Water Resources

Map 7. Town of Sunderland Wildfire Potential: LANDFIRE Program, www.landfire.gov
Vermont Forest Resources Plan, http://anrmaps.vermont.gov/websites/sars_data/; BCRC data.

Map 8. Town of Sunderland Landslide Potential: LANDFIRE Program, www.landfire.gov
Vermont Forest Resources Plan, http://anrmaps.vermont.gov/websites/sars_data/; BCRC data.

Map 9. Town of Sunderland Invasive Species: Early Detection and Distribution Mapping System 2021; Mary Beth Deller, personal communication; Michael S. Batcher observations.

Map 10. Town of Sunderland Water Resources and Transportation

C. Personal Communication Sources

Mary Beth Deller, Botany Program Coordinator, Green Mountain and Finger Lakes National Forest, Rochester, VT

Veronica Fialkowski, MPH., Infectious Disease Epidemiologist, Vermont Department of Health, Veronica.Fialkowski@vermont.gov

Richard Heims, NOAA regarding drought indices, richard.heim@noaa.gov

Stuart Hinson, NOAA regarding NOAA data, stuart.hinson@noaa.gov

Appendix I. Mitigation actions from 2014 Sunderland HMP

Hazard	Type[4]	Actions	Responsible Parties	Time Frame	Status (complete, carried to 2021 plan/ongoing, or deleted)	Priority
All Hazards	Education and Outreach	Provide a "be prepared" section of the Town website with links to information for residents	Town Select Board	6-12 months	Completed and ongoing	High
All Hazards	Local Planning and Regulations	Encourage proper construction techniques and use of appropriate materials to address hazards, particularly flooding, winter storms, wind events, earthquakes, landslides, and wildfire	Town Planning Commission; Zoning Administrator	6-12 months	2021	High
All Hazards	Education and Awareness	Identify and develop methods to communicate with populations vulnerable to potential hazards, particularly drought, extreme temperatures, and infectious diseases, but also those in need of assistance for evacuation and/or sheltering	Town Emergency Management Director	6-18 months	2021	High
All Hazards	Local Planning and Regulations	Assess need for driveway standards to assure adequate emergency access particularly to assure adequate access in winter storms, floods and for wildfire protection	Town Planning Commission	6-18 months	2021	High
Floods and Flash Floods	Education and Awareness	Educate owners on importance of securing propane tanks and other items that could float or blow away in storms	Town Zoning Administrator	6-18 months	2021	Medium
Floods and Flash Floods	Local Planning and Regulations	Adopt and enforce updated flood hazard and fluvial erosion hazard zone bylaws	Town Planning Commission; Zoning Administrator	6-12 months	2021; Completed and ongoing	High
Floods and Flash Floods	Local Planning and Regulations	Participate in the Community Rating System to help reduce flood insurance premiums	Town Select Board	12-24 months	2021	High
Floods and Flash Floods	Local Planning and Regulations	Encourage appropriate stormwater and erosion control measures in new developments	Town Planning Commission	1-5 years	2021/ongoing	High

[4] Follows FEMA 2013 Mitigation ideas; a resource for reducing. Federal Emergency Management Agency, U.S. Department of Homeland Security, Washington, DC

Appendix I. Mitigation actions from 2014 Sunderland HMP

Hazard	Type[4]	Actions	Responsible Parties	Time Frame	Status (complete, carried to 2021 plan/ongoing, or deleted)	Priority
Floods and flash floods	Local Planning and Regulations	Prepared draft contract for company to provide services if debris pile up bridges and culverts to prevent blockages and resulting flooding.	Town Select Board; Town Road Foreman	6-12 months	2021	High
Floods and flash floods	Structure and Infrastructure Projects	Road crew should regularly survey culverts for blockages including photographs and records of damages and costs	Town Road Foreman	1-5 years	2021	High
Floods and flash floods	Structure and Infrastructure Projects	Adopt the 2013 and updates to the Vermont Town Road and Bridge Standards	Town Select Board	6-12 months and as updated	Completed	High
Floods and flash floods	Structure and infrastructure projects	Identify and replace culverts and bridges that do not meet current Vermont Town Road and Bridge Standards	Town Road Foreman	1-5 years	Completed and ongoing	High
Floods and flash floods	Structure and infrastructure protection	Encourage property owners in flood or fluvial erosion hazard zones to consider selling their properties (buy out) or implementing flood proofing including elevating structures	Town Select Board	1-5 years	2021	High
Floods and flash floods	Structure and infrastructure protection	Implement corridor protection, buffer plantings, structure and berm removal and other projects listed in the 2007 Batten Kill corridor plan (Field 2007)	Town Select Board; Batten Kill Watershed Alliance	1-5 Years	2021	Medium to High
Floods and flash floods	Natural Systems Protection	Acquire lands or work with conservation organizations to acquire lands subject to frequent flooding or wetlands within or adjacent to flood prone areas to provide flood storage	Town Select Board; Batten Kill Watershed Alliance: Vermont Land Trust	1-5 years	2021	Medium
Winter storms	Education and Outreach	Provide educational materials on sheltering in place and preparation for winter storms, including long-term power outages	Town Emergency Management Director	6-12 months	2021/ongoing	High

Appendix I. Mitigation actions from 2014 Sunderland HMP

Hazard	Type[4]	Actions	Responsible Parties	Time Frame	Status (complete, carried to 2021 plan/ongoing, or deleted)	Priority
Winter storms	Education and Awareness	Provide materials for residents on methods to protect property from wind events	Town Emergency Management Director; Zoning Administrator	12-24 months	2021/ongoing	High
Winter storms	Local Planning and Regulations	Develop agreements with adjacent towns for sharing of highway equipment	Town Select Board; Town Road Foreman	6-12 months	2021 (informal agreements exist)	High
Winter storms	Structure and Infrastructure Projects	Place utilities underground for critical facilities	Town Select Board	6-24 months	2021	Medium
High wind events	Education and Outreach	Provide educational materials on sheltering in place and preparation for winter storms, including long-term power outages	Town Emergency Management Director	6-12 months	2021	High
High wind events	Local Planning and Regulation	Require boats, propane tanks and other items stored outdoors to be secured	Town Planning Commission; Zoning Administrator	6-18 months	2021	High
High wind events	Local Planning and Regulation	Encourage appropriate plantings to avoid future damage from downed trees	Town Emergency Management Director	6-18 months	2021	Medium
High wind events	Local Planning and Regulation	Encourage protection and planting of wind breaks in new developments	Town Emergency Management Director; Zoning Administrator	6-24 months	2021/ongoing	Medium
High wind events	Structure and Infrastructure Projects	Retrofit existing buildings to withstand high winds including protection of power lines and other utilities	Town Select Board Private Owners	12 to 24 months	2021	Medium

Appendix I. Mitigation actions from 2014 Sunderland HMP

Hazard	Type[4]	Actions	Responsible Parties	Time Frame	Status (complete, carried to 2021 plan/ongoing, or deleted)	Priority
High wind events	Structure and Infrastructure Projects	Place utilities underground for critical facilities	Town Select Board; Private Owners	12-24 months	2021	Medium
Hail	Structure and Infrastructure Projects	Retrofit existing buildings to minimize hail damage	Town Select Board; Private Owners	24-48 months	Deleted	Low
Temperature extremes	Education and Awareness	Identify vulnerable community members through a survey and outreach	Town Emergency Management Director	6-18 months	2021/ongoing	High
Temperature extremes	Local Planning and Regulation	Develop cooperative agreement with Arlington for sheltering of vulnerable populations	Town Select Board; Emergency Management Director	6-12 months	Completed	High
Drought	Local Planning and Regulation	Monitor drought conditions	Town Emergency Management Director	1-5 years	2021/ongoing	High
Drought	Education and Awareness	Provide educational materials on dealing with drought	Town Emergency Management Director	12-24 months	2021/ongoing	Medium
Drought	Natural System Protection	Develop improved assessment of groundwater sources and amend bylaws to assure their protection	Vermont Geological Survey Town Planning Commission	24-36 months	2021	Medium
Drought	Local Planning and Regulation	Incorporate planning for droughts in the emergency management plan	Town Emergency Management Director	6-18 months	2021	High

Appendix I. Mitigation actions from 2014 Sunderland HMP

Hazard	Type[4]	Actions	Responsible Parties	Time Frame	Status (complete, carried to 2021 plan/ongoing, or deleted)	Priority
Wildfire[5]	Education and Outreach	Acquire materials from Firewise for homeowners and provide to Sunderland to make available for landowners	BCRC	6-12 months	2021/ongoing	High
Wildfire	Education and Outreach	Provide information on outdoor burning safety prior to the spring and fall fire seasons	Fire wardens	1-5 years	2021/ongoing	High
Wildfire	Education and Outreach	Provide a review of properties where owners request assessment of their properties for wildfire safety and adequate defensible space	BCRC, Arlington Fire Department	1-5 years	2021	Medium
Wildfire	Education and Outreach	Encourage owners to maintain defensible space around structures and to mow fields along road edges to prevent wildfire	Town Emergency Management Director; Arlington Fire Department	1-5 years	2021	High
Wildfire	Local Planning and Regulations	Encourage defensible space around structures	Town Planning Commission	1-5 years	2021	High
Wildfire	Structure and Infrastructure Projects	Assure adequate water supplies are available including areas identified as gaps in the 2013 Community Wildfire Protection Plan	Town Select Board; Emergency Management Director, Arlington Fire Department	1-5 years	2021	High
Wildfire	Natural Systems Protection	Implement fuel reduction, particularly in grass fields and in areas of Green Mountain National Forest	Arlington Fire Department/Green Mountain National Forest	1-5 years	2021/ongoing	Medium

[5] See Batcher, M., and J. Henderson 2013. Community wildfire protection plan for the towns of Arlington, Glastenbury, Sandgate, Shaftsbury and Sunderland. Prepared by the Bennington County Regional Commission, 111 South St., Suite 203, Bennington, VT

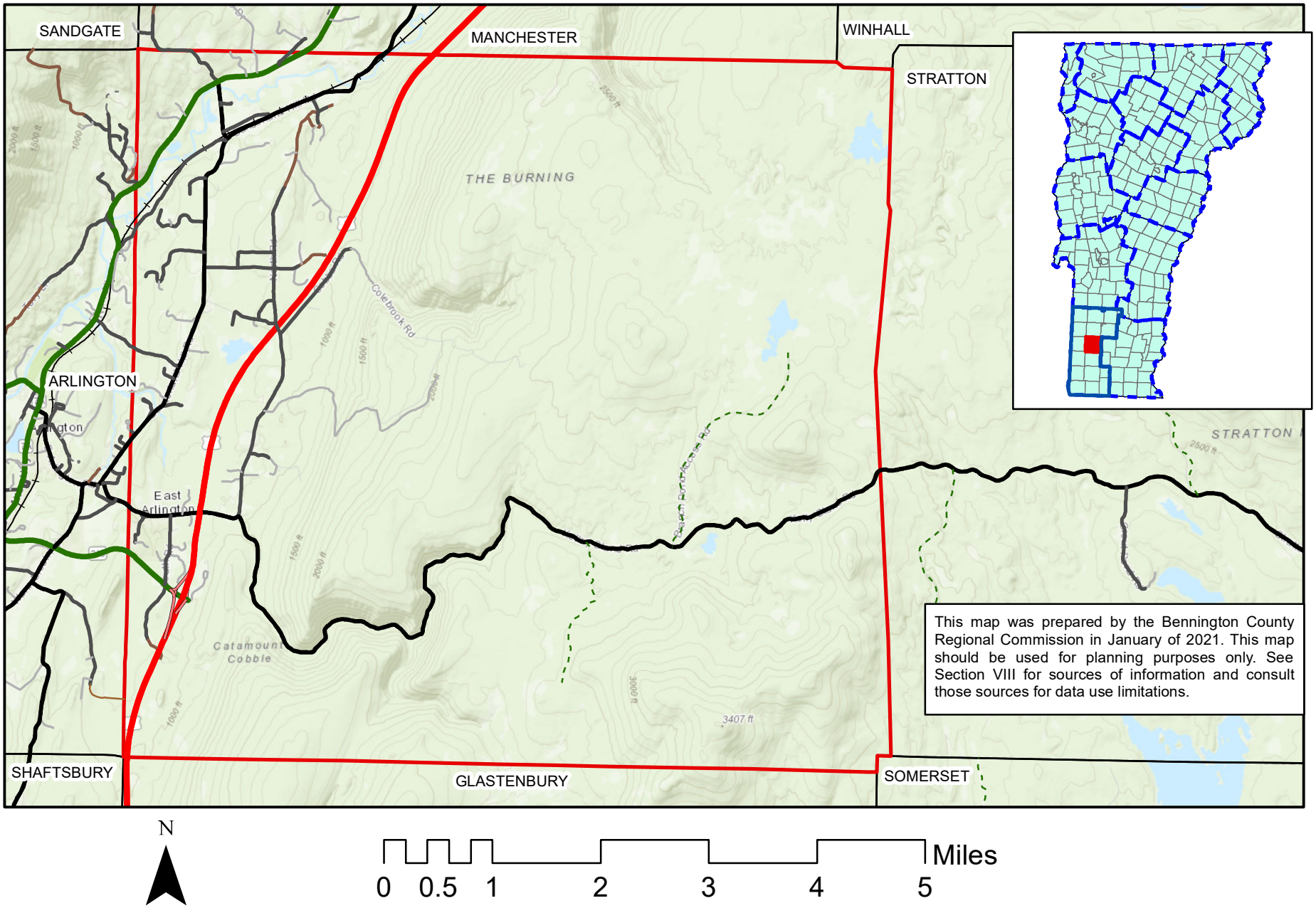
Appendix I. Mitigation actions from 2014 Sunderland HMP

Hazard	Type[4]	Actions	Responsible Parties	Time Frame	Status (complete, carried to 2021 plan/ongoing, or deleted)	Priority
Landslide and debris flow	Local Planning and Regulations	Map known landslides and identify potential landslide areas	Town/BCRC/State of Vermont	12-24 months	Completed and ongoing	High
Landslide and debris flow	Local Planning and Regulations	Adopt fluvial erosion hazard bylaws	Town Select Board; Town Planning Commission	6-12 months	Completed	High
Landslide and debris flow	Structure and Infrastructure Projects	Implement visual monitoring in potential landslide areas	Town Emergency Management Director	12-24 months	Completed and ongoing	High
Landslide and debris flow	Structure and Infrastructure Projects	Stabilize and replant stream corridor areas subject to landslides	Batten Kill Alliance	1-5 years	2021	High
Earthquake	Education and Awareness	Educate property owners on proper construction techniques to reduce potential damage from earthquakes	Town Zoning Administrator	6-24 months	Deleted	Medium
Hazardous materials spill	Local Planning and Regulation	Complete an assessment of hazardous materials and potential accident locations	LEPC 7	24-48 months	Deleted	Medium
Hazardous materials spill	Structure and Infrastructure Projects	Work with VT AOT to create adequate crossing warnings at all RR crossings	VT AOT	12-36 months	Deleted	Medium
Hazardous materials spill	Natural Systems Protection	Identify groundwater source areas and develop ordinances to protect those areas	Vermont Geological Survey	12-36 months	Deleted	Medium
Infectious disease outbreak	Local Planning and Regulations	Monitor disease occurrences and potential outbreaks	Town Health Officer	1-5 years	2021/ongoing	High
Infectious disease outbreak	Education and Outreach	Provide educational materials in printed form and on the town web site on potential infectious diseases	Town Health Officer	12-36 months	2021/ongoing	High
Invasive species	Local Planning and Regulations	Monitor extent of invasive species, particularly forest invasive species such as Emerald Ash Borer	Town Select Board	1-5 years	2021	High

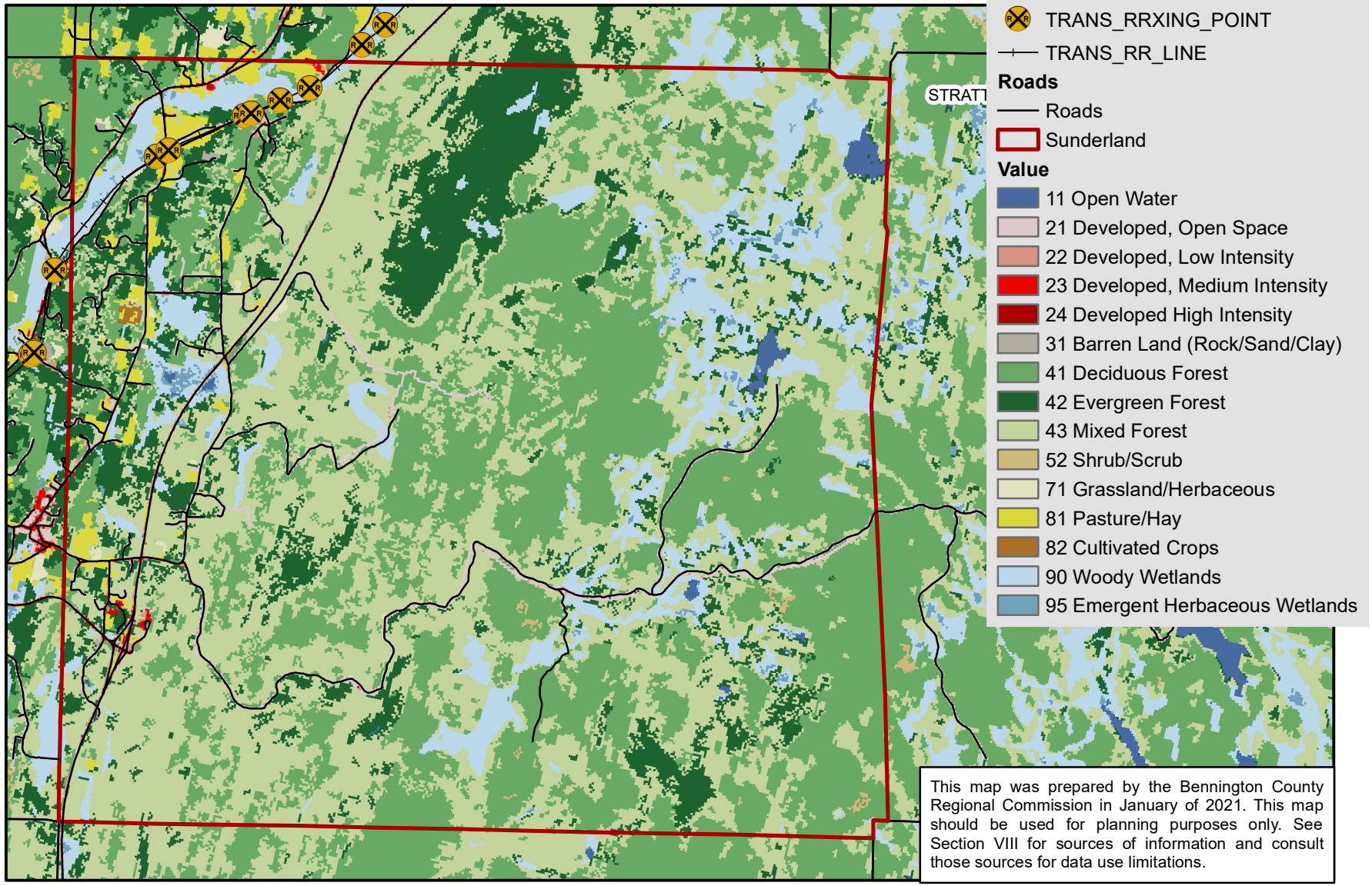
Appendix I. Mitigation actions from 2014 Sunderland HMP

Hazard	Type[4]	Actions	Responsible Parties	Time Frame	Status (complete, carried to 2021 plan/ongoing, or deleted)	Priority
Invasive species	Local Planning and Regulations	Complete surveys for ash trees vulnerable to Emerald Ash Borer	BCRC; Bennington County Conservation District	6-24 months	2021	Medium
Invasive species	Local Planning and Regulations	Survey for invasive species (e.g., Japanese knotweed)s along streams to identify potential erosion areas	Batten Kill Watershed Alliance	12-24 months	2021	Medium
Invasive species	Local Planning and Regulations	Encourage use of native species in plantings for commercial and residential development	Town Planning Commission	1-5 years	2021	Medium
Invasive species	Education and Awareness	Provide outreach materials for landowners on using native plants and controlling invasive species	Bennington County Conservation District	6-18 months	2021	High

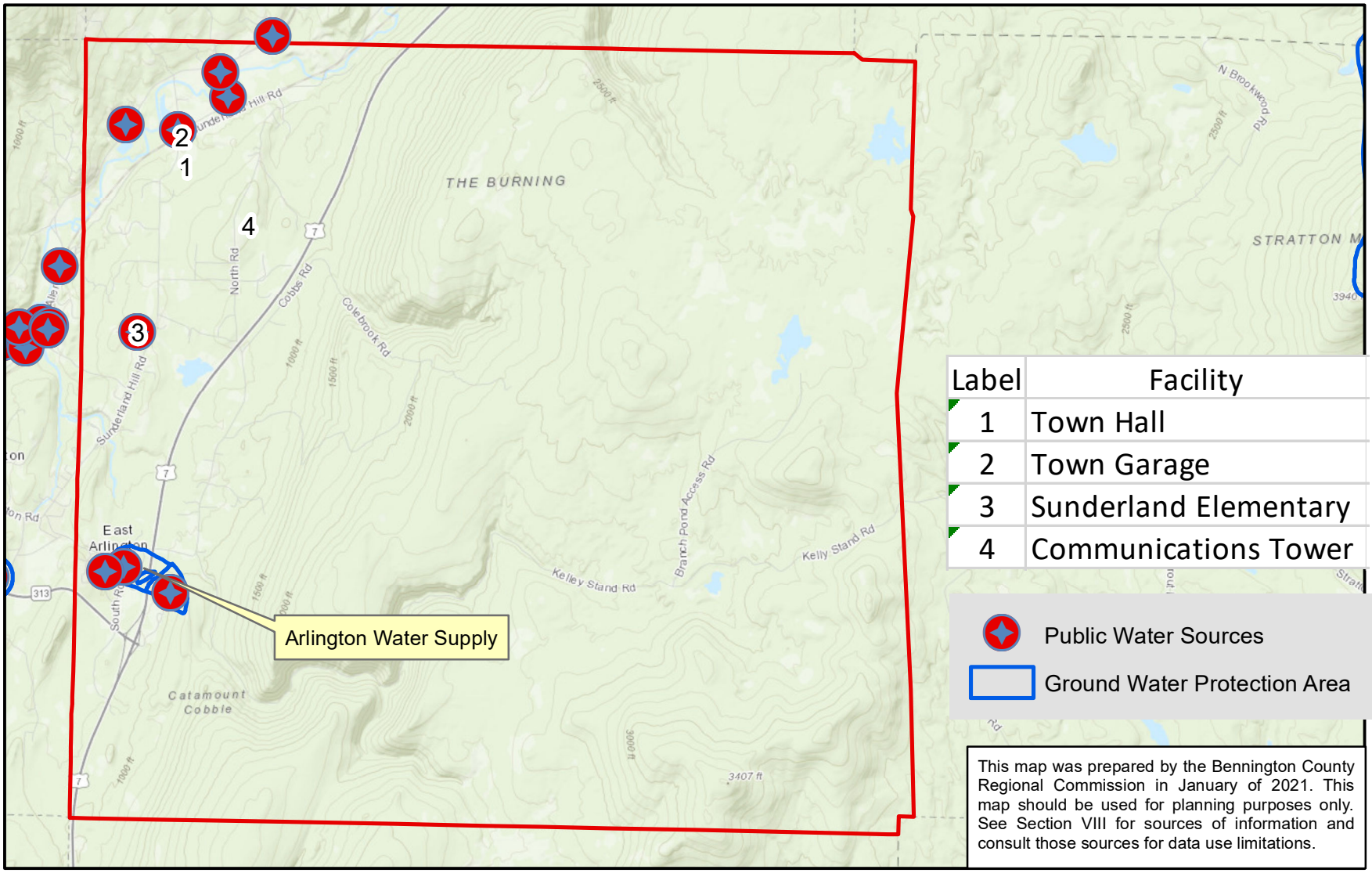
Map 1. Town of Sunderland



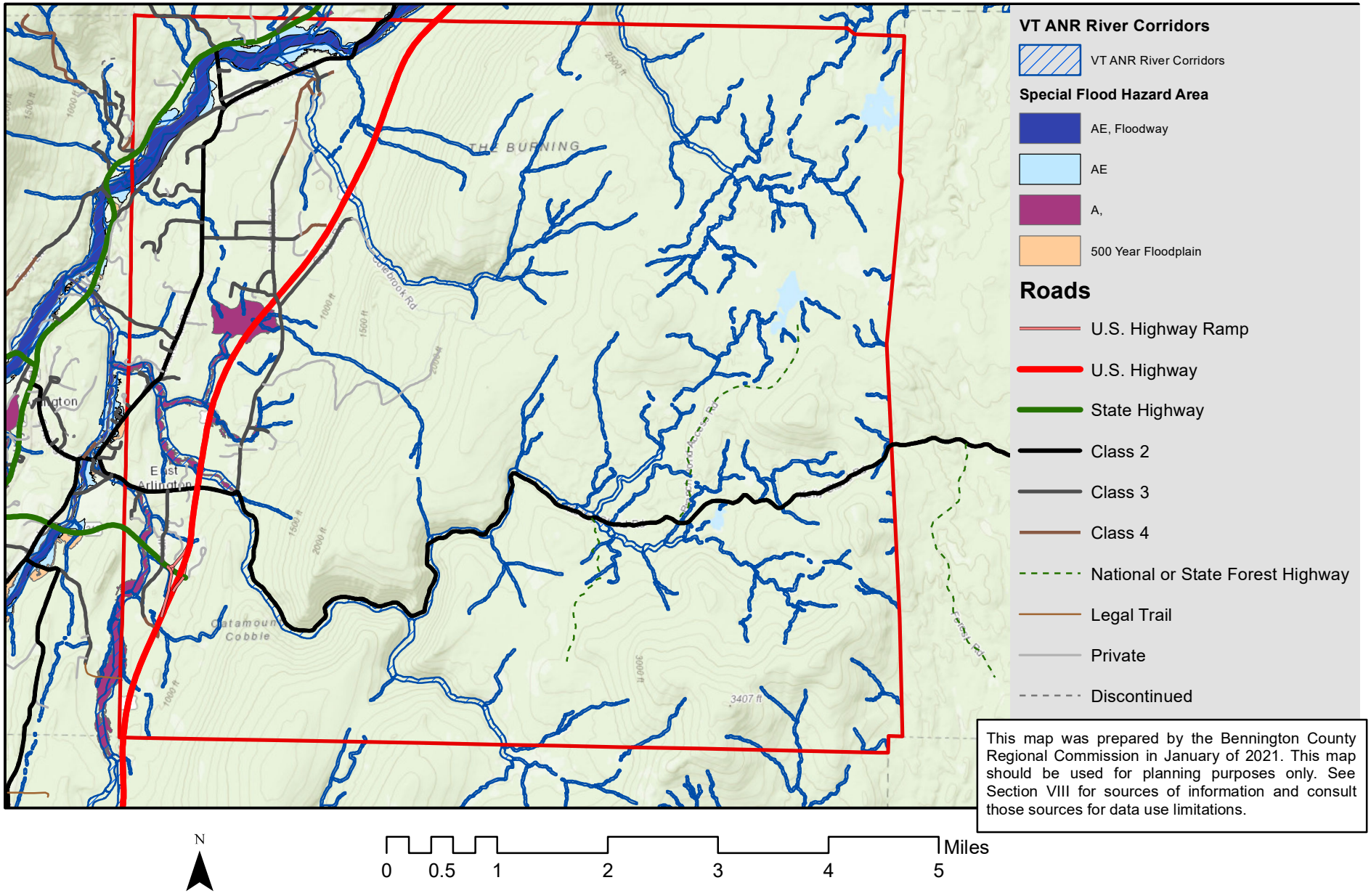
Map 2.Town of Sunderland Land Cover



Map 3. Sunderland Critical Facilities

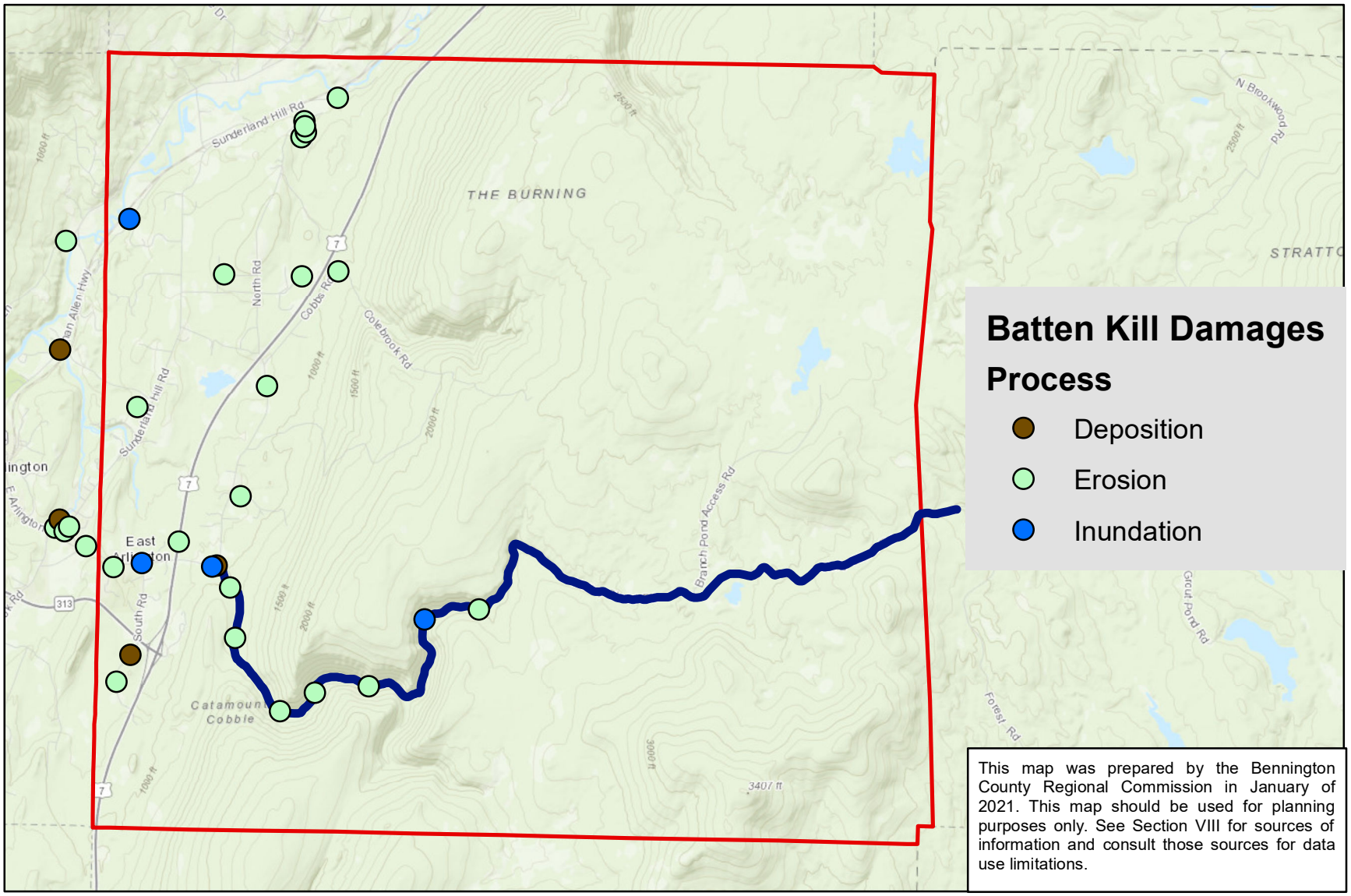


Map 4. Town of Sunderland
Special Flood Hazard Zones and River Corridors

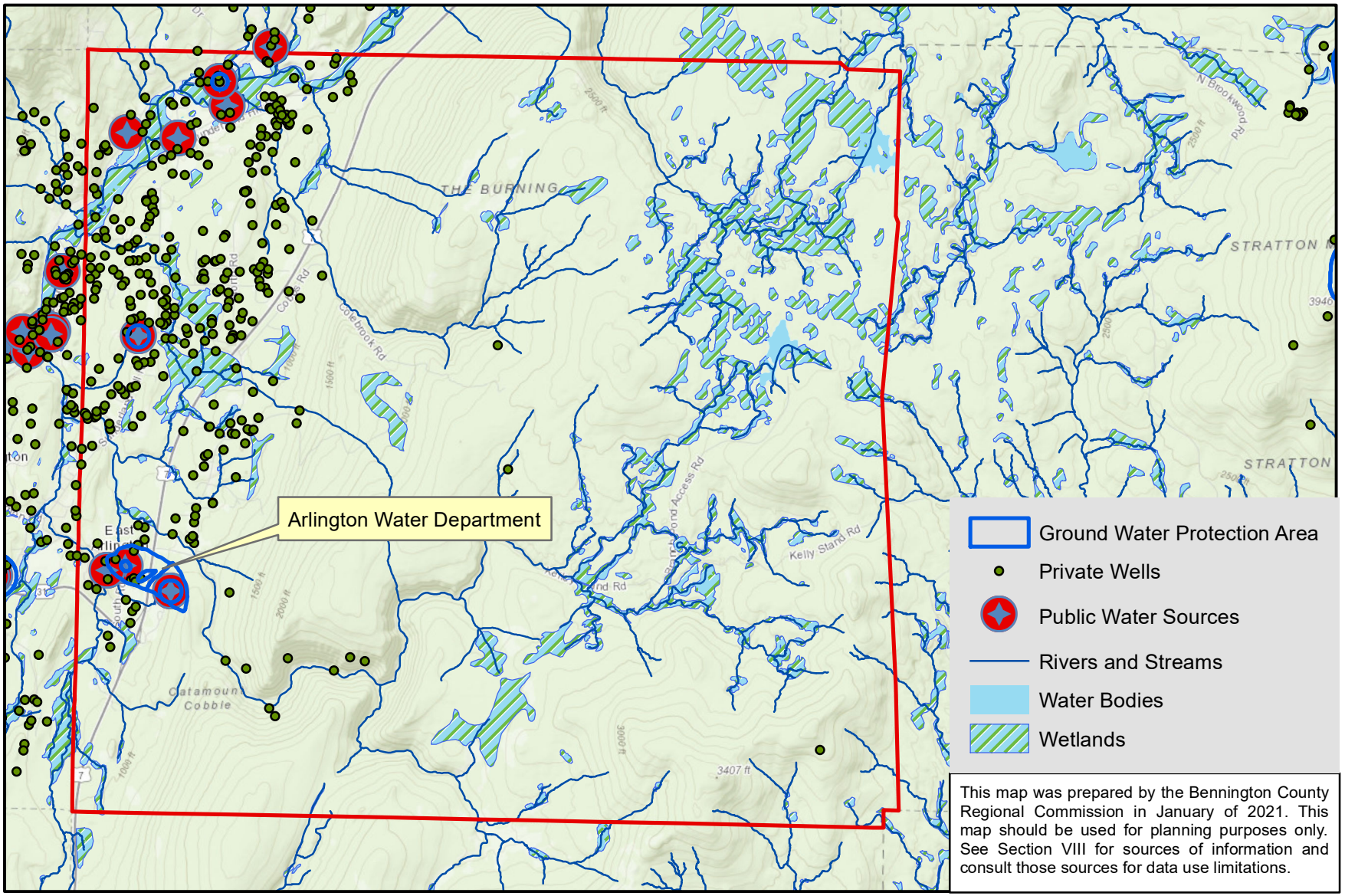


This map was prepared by the Bennington County Regional Commission in January of 2021. This map should be used for planning purposes only. See Section VIII for sources of information and consult those sources for data use limitations.

Map 5. Town of Sunderland Past Damages

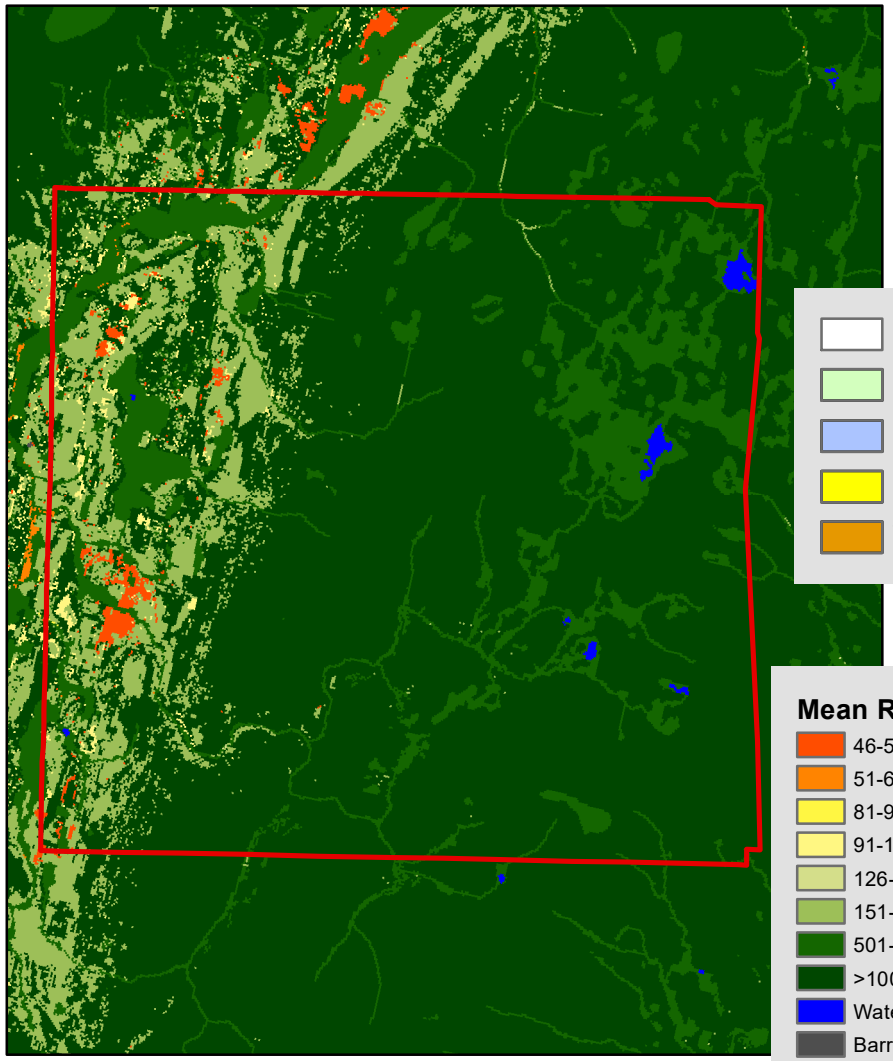


Map 6. Sunderland Water Resources

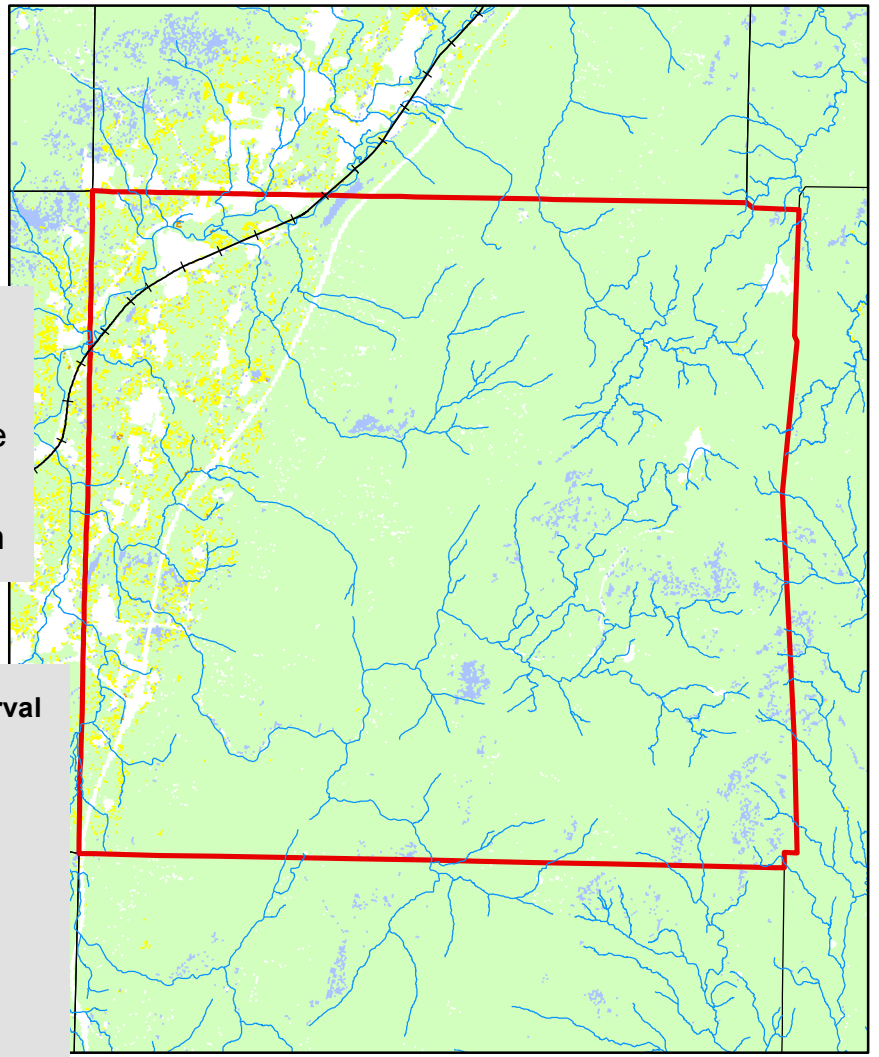


Map 7. Sunderland Wildfire Potential

Mean Fire Return Interval



Wildfire Risk



No risk
Low
Moderate
High
Very high

Mean Return Interval

- 46-50 Years
- 51-60 Years
- 81-90 Years
- 91-100 Years
- 126-150 Years
- 151-200 Years
- 501-1000 Years
- >1000 Years
- Water
- Barren

N

0 1.25 2.5 5 7.5 10 Miles

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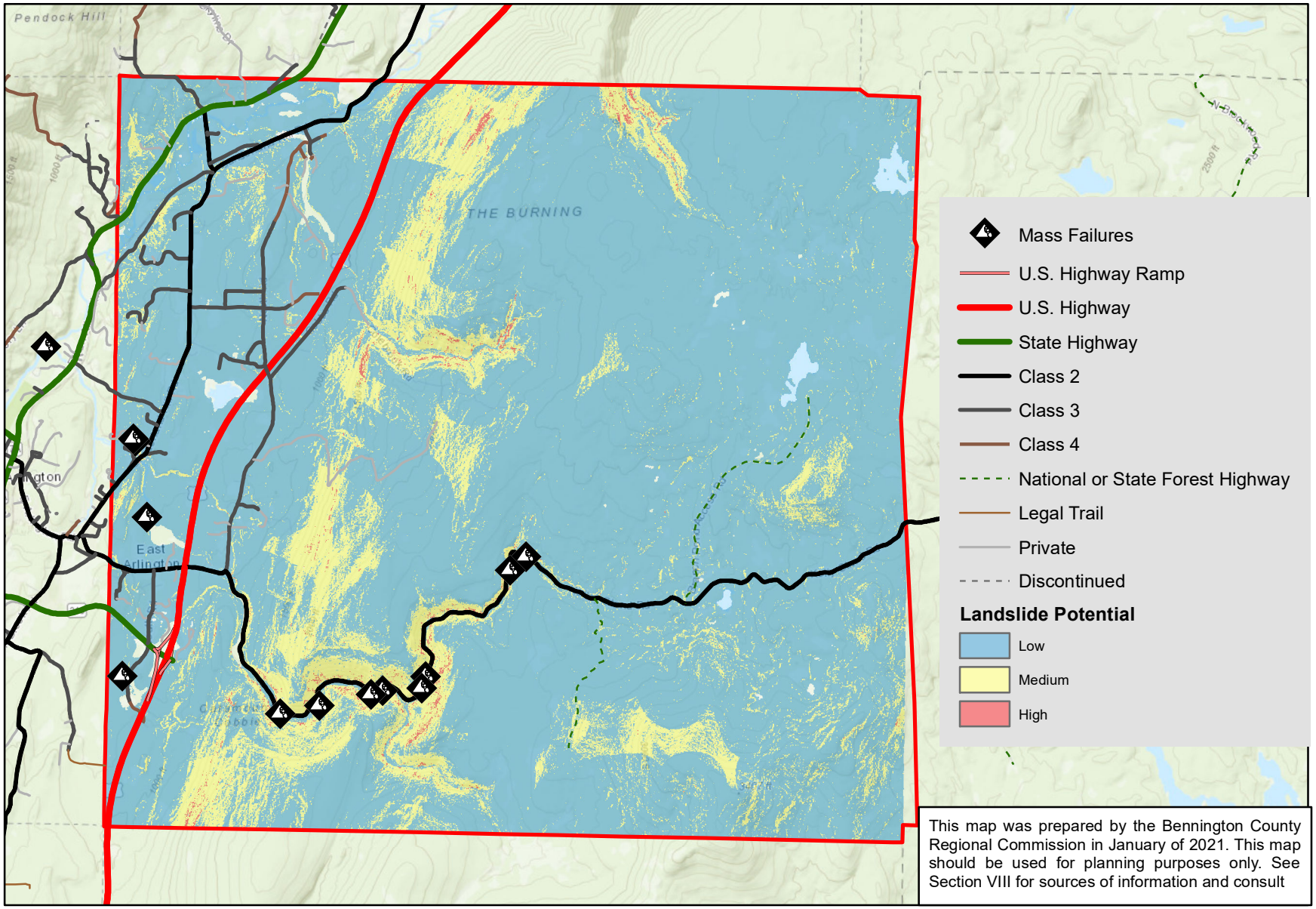
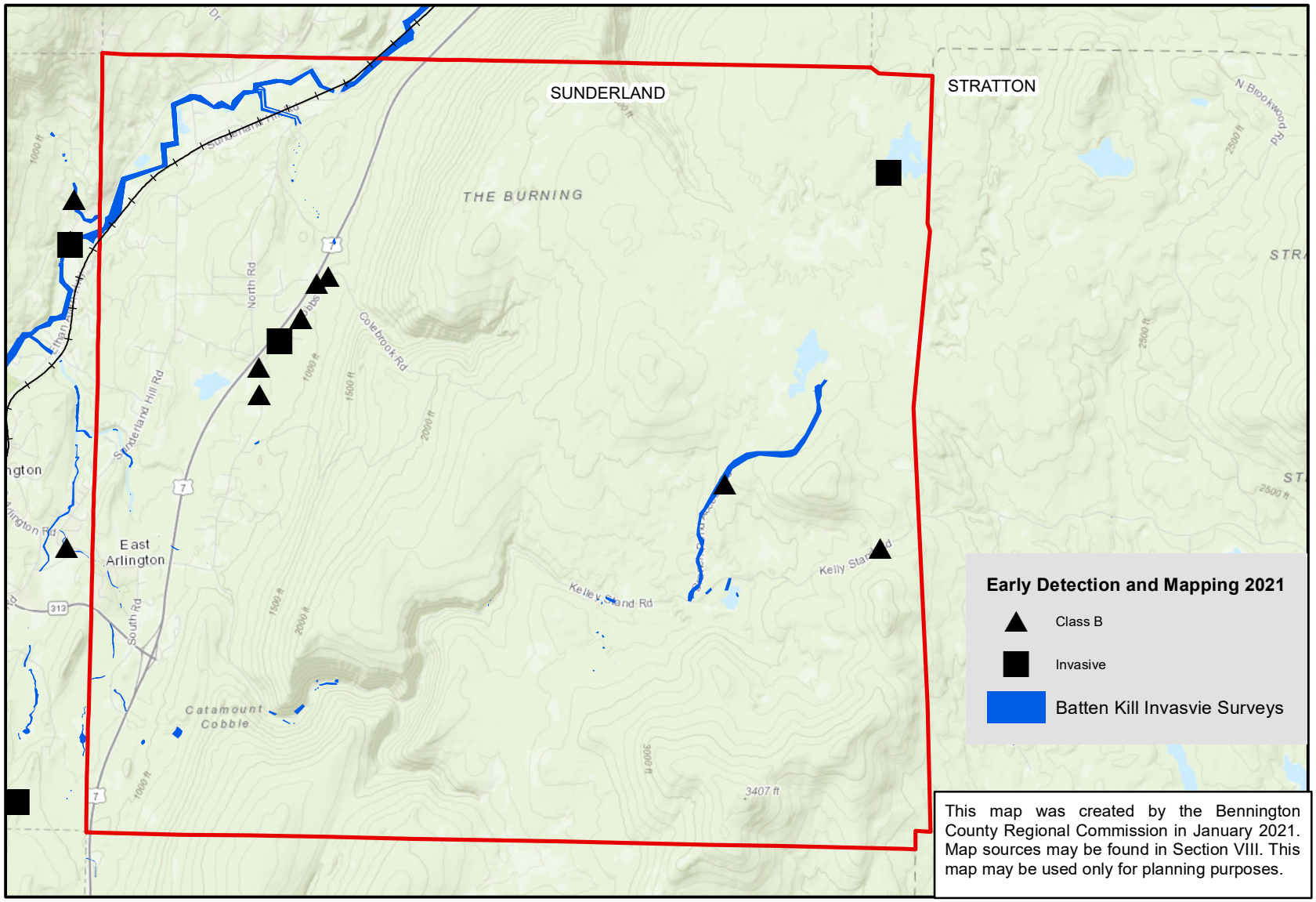
Map 8. Sunderland Landslide Potential



Map 9. Town of Sunderland Invasive Species



Map 10. Sunderland Water Resources and Transportation System