Town of Duxbury, VT
Local Hazard Mitigation Plan Update
March 28, 2012
Adopted September 24, 2012
Prepared by the Town of Duxbury and CVRPC

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1. Introduction

The impact of expected, but unpredictable natural and human-caused events can be reduced through community planning. The goal of this Plan is to provide an all-hazards local mitigation strategy that makes the community of Duxbury more disaster resistant.

Hazard mitigation is any sustained action that reduces or eliminates long-term risk to people and property from natural and human-caused hazards and their effects. Based on the results of previous Project Impact efforts, FEMA and State agencies have come to recognize that it is less expensive to prevent disasters than to repeatedly repair damage after a disaster has struck. This Plan recognizes that communities have opportunities to identify mitigation strategies and measures during all of the other phases of emergency management – preparedness, response, and recovery. Hazards cannot be eliminated, but it is possible to determine what the hazards are, where the hazards are most severe and identify local actions that can be taken to reduce the severity of the hazard.

Hazard mitigation strategies and measures alter the hazard by eliminating or reducing the frequency of occurrence, avert the hazard by redirecting the impact by means of a structure or land treatment, adapt to the hazard by modifying structures or standards, or avoid the hazard by preventing or limiting development.

2. Purpose

The purpose of this Local Hazard Mitigation Plan is to assist the Town of Duxbury in recognizing hazards facing the region and their community and identify strategies to begin reducing risks from acknowledged hazards.

Duxbury strives to be in accordance with the strategies, goals and objectives of the State Hazard Mitigation Plan, including an emphasis on proactive pre-disaster flood mitigation for public infrastructure, good floodplain and river management practices, and fluvial erosion risk assessment initiatives.

The 2011 Duxbury Local Hazard Mitigation Plan is an update of the 2005 plan. The plan has been reorganized and new sections have been added regarding:

- Plan Update Process
- Plan Maintenance
- Update of Flood and Severe Storm Hazards
- Updates of Local Areas of Concern Map
- Status update of 2005 mitigation strategies
- Identification of new mitigation strategies

3. Community Profile

The Town of Duxbury is located on the western edge of Washington County and is bounded by the towns of Moretown to the east, Fayston to the south, Huntington to the west, and Waterbury and Bolton to the north. Duxbury's northern border is set by the Winooski River, while its western edge is marked by the principal ridge of the Green Mountains. These elements give Duxbury one of the most rugged physical reliefs in Vermont; with an elevation change from about 360 feet above sea level along the Winooski River to 4,083 feet at the summit of Camels Hump only four and a half miles away. These elevations are the lowest and highest, respectively, in Central Vermont (Town Plan).

Principal rivers and streams include Ridley Brook, which drains the northwestern portion of the Town into the Winooski, Crossett and Dowsville Brooks draining the eastern section of Town, and Shepard Brook, which provides drainage to a small area in the southwestern portion of Town.

According to the 2010 US Census, Duxbury has a total population of 1,337 people living in 639 housing units. Duxbury has seen its population increase by 3% from the 2000 Census, while its number of housing units has increased by 28%. Approximately 90% of Duxbury's workforce is employed outside of the community, while the remaining 10% are employed within the Town.

Development within the Town is primarily concentrated along Route 100, the single paved highway that transects the town in a north-south direction along its eastern boundary. Residential development has traditionally been focused along the Route 100 corridor and within a few compact settlements (e.g. Duxbury Corner). More recently, it has been augmented by development at higher elevations and in more remote areas, such as along Dowsville Road, Crossett Hill Road, and Camels Hump Road. Despite this trend, the Town Plan limits land uses and densities in outlying areas and high elevations and instead encourages appropriate clustered or concentrated patterns of development.

The Washington Electric Cooperative provides electricity to approximately 275 residences in the southern portion of the Town. Green Mountain Power serves the remaining north sections of Duxbury.

Natural springs and drilled wells provide water to most sections of Town; however, residences in Duxbury Corner, students at Crossett Brook Middle School, and the Town Offices are served by the Waterbury municipal system. Wastewater treatment within the town is treated by individual subsurface disposal facilities. These facilities are regulated by the State's wastewater regulations.

The Waterbury Fire Department provides fire coverage in the northern section of Duxbury, while the Moretown Fire Department provides protection for residents in the southern section. Both Waterbury and Moretown Fire Departments are members of the Capital Fire Mutual Aid System, which is composed of approximately 45 departments in Washington, Orange and Caledonia Counties. The Departments responded to a combined 32 calls in 2004, which includes grass fires, propane leaks, automobile accidents and structural fires. Waterbury Ambulance

Service responds to emergencies throughout the Town, with back up support provided by The Mad River Valley Ambulance Service. The Ambulance departments report they responded to a total of 45 calls in 2004.

Police services are provided by the Vermont State Police stationed at the Middlesex Barracks. The Town of Duxbury has an approved Rapid Response Plan that was adopted in 2005. The State Complex in Waterbury until Irene, served as the Town's primary emergency shelter, with additional shelters being Crossett Brook Middle School, Thatcher Brook Primary School building and Harwood Union High School.

Comment [BTF1]: What do we do now that the complex is mostly shut down?

The Town Plan was adopted in 2008 and includes goals, policies, and tasks in regards to natural resources, future land use, wastewater treatment, transportation, and public services. The 2011 Zoning Ordinance greatly limits development within the Ecological Reserve Lands District, any land above 2,500 feet. Only low-impact uses are permitted within this District and special consideration must be made in regards to erosion control. In addition, the Ordinance prescribes a Flood Hazard Overlay District that limits the construction of structures within the National Flood Insurance Program's 100-year floodplain. The Town is in the process of updating their flood hazard bylaws and investigating a fluvial erosion hazard zone overlay as well.

4. Planning Process and Maintenance

4.1 Planning Process

The Central Vermont Regional Planning Commission (CVRPC) coordinated the Duxbury Local Hazard Mitigation Plan process. Richard Charland, Select Board Vice Chair, contacted CVRPC to set up a hazard mitigation meeting. CVRPC sent Town-Specific hazard mitigation material for review. After assessing the material, Richard and CVRPC staff held a meeting along with members of the community on November 30, 2011 at the Town Garage. The Duxbury Hazard Mitigation Meeting focused on assessing past mitigation projects and compiling information on its current and future hazard mitigation programs, projects and activities. The committee for the 11/30/2011 was formed in an ad hoc manner to update the plan. For the next update, a committee will be formed in a similar manner with members from the planning commission, select board, road crew, and emergency services.

Attendees included:

- Brian T. Fitzgerald – Planning Commission
- Bob Magee – Emergency Coordinator
- Michael Marshall – Select Board
- Steve Manosh – Road Foreman
- Richard Charland – Select Board
- Garett MacCurtain – Planning Commission

The meeting indicated that the Town is most vulnerable to flash flood/flood/fluvial erosion, hurricanes/severe storms/tropical storms, and wildfire/forest fire. Previously identified hazards include flooding, power shortage/failure, and forest fires. Duxbury feels power shortage/failure are no longer significant hazards because of Town wide changes that have been made over the course of the past 5 years and improved communications with the power utilities(see appendix A for description of previous hazards) The Town is now focusing on flooding hazards as these events are the most common.

Once the draft was updated, CVRPC placed a notice for public comments of the draft update on the CVRPC blog and newsletter, Crossett Brook School, Duxbury Store, Front Porch Forum, and bulletin board at the bottom of Camel's Hump Rd. The draft update was also available at the Duxbury Municipal offices and by request from CVRPC for public review and comments from 12/19/2011 to 12/31/2011. The announcement of the draft update in the CVRPC newsletter reached over 150 people and businesses in the Region's 23 towns, including the adjacent towns of Moretown, Waterbury, Fayston and Waitsfield. No comments were received. Public comments submitted in the future will be reviewed by the Select Board (and CVRPC Staff dependant on funding) and attached as an appendix. In the future, the draft plan will be made available during Town Meeting Day and local meetings with State and local officials to allow for more public comment and review. After Approval Pending Adoption, the plan will go before the Select Board for adoption.

4.2 Plan Update Process

The Duxbury Local Mitigation Plan was originally adopted by the Town as an Annex to the Central Vermont Regional Pre Disaster Mitigation Plan in December 2005 and received FEMA final approval in 2006. The 2011 update is intended to be submitted as a single jurisdiction local mitigation plan.

The current plan is an extensive update of the 2005 plan. Below is a list of the revisions that have been made from the past plan and the appropriate sections for reference. New hazards identified include severe storms, dam failure and winter storms.

General Updates

- General reorganization/restructuring of the plan according to future FEMA/VEM checklist
    - New sections added – 4.2 Plan Update Process, 4.3 Plan Maintenance, 5.2 Worst Threat Hazards 5.3 Non Worst Threat Hazards
- Update of all data and statistics using 2010 Town Report and US Census Data (Section 3)
- Revaluation, identification and analysis of all significant hazards (Section 5)
- Acknowledgment of implemented mitigation strategies since 2007 -- see matrix below (section 4.2)
- Identification of on-going mitigation projects and strategies – see Existing Mitigation Programs, Projects and Activities section (section 4.2)

Hazard Analysis Updates (Sections 5 and 6)

- New hazards added – severe storms, winter storms, dam failures
- Added location/vulnerability/extent/impact/likelihood table for each hazard to summarize hazard description (Section 5.1-5.3 – after each hazard)
- Review of Vermont Hazard Mitigation Plan (Section 5 – hazard analysis table)

Maps

- Review of 2005 Areas of Concern map – updated flood prone areas, added forest layer

Preparation for the meeting included a review of Duxbury's planning documents, including the Duxbury Municipal Plan (2008), and the Duxbury Rapid Response Plan (2006), VT State Forest Management Plan (2010), Duxbury Flood Zoning Regulations (2011), and Mid Winooski Phase I assessment (2007). Information from these documents is incorporated throughout the plan.

The following chart provides an overview of Duxbury's proposed 2005 local hazard mitigation actions along with their current status. Additionally since the 2005 plan, the Town is in the process of updating their flood regulations post TS Irene to maintain NFIP compliance.

2005 Mitigation Action	2011 Status
Update homebound persons phone tree	Developed phone tree for police and town officers; would like to perform a sensitive populations survey again
Update rapid response plan	Working on – EMC resigned and looking for replacement
Provide backup power to town shelters	Looking for funding for town garage and town office back up power supplies
Participate in a Stream Geomorphic assessment	Still interested in – no funding; enrolling in CVRPC post Irene debris assessment
Institute a fire notification system	Low priority

Existing Mitigation, Maintenance, and Preparedness Programs, Projects & Activities

The ongoing or recently completed programs, projects and activities are listed by strategy have occurred since the development of the previous plan.

Community Preparedness Activities

- Rapid Response Plan 2006
- Capital Equipment Plan
- Water Supply Contamination Plan
- Homebound Persons Phone Tree

Hazard Control & Protective Works

- Maintenance Programs (Culvert Survey & Replacement) – CVRPC Survey 2010
- Informal Winooski River dam release agreement with Green Mountain Power
- Adoption of new VTrans bridge and culvert standards –2011

Insurance Programs

- Participation in NFIP

Land use Planning/Management

- Ecological Reserve Lands District
  - Section 1 – Above 2,500 feet, all structures prohibited except Conditional Uses for structures associated with low intensity non-commercial recreation.
    Development in this area must make special consideration for impact on wildlife habitat and natural vegetative cover, along with erosion control
- Timber Management & Wildlife District
  - Section 2 – Between 1,500 feet and 2,500 feet only low impact, nonstructural development is a Permitted Use and minimum lot sizes are 25 acres. Low impact structures are a Conditional Use.
- Flood Hazard Overlay District
  - Section 7 – Limits construction of structures in floodplain areas designated within the Flood Insurance Rate Map for Duxbury.

Protection/Retrofit of Infrastructure and Critical Facilities

- Fire Hydrants at Crossett Brook Middle School and along Main Street
- Dry hydrants – 1

Public Awareness, Training & Education

- CPR Trainings
- School Fire Safety Program

4.3 Plan Maintenance Process

The Duxbury Local Hazard Mitigation Plan will be updated and evaluated annually at an April Select Board and Planning Commission meeting along with the review of the Basic Emergency Operations Plan. Updates and evaluation by the Select Board will also occur within three months after every federal disaster declaration and as updates to town plan/zoning and river corridor plans come into effect. The plan will be reviewed by the Select Board, Planning Commission and public at the abovementioned April Select Board meeting. CVRPC will help with updates or if no funding is available, the Select Board Chair will update the plan.

The process of evaluating and updating the plan will include continued public participation through public notices posted on the municipal website, notice in the municipal building, Valley Reporter, Front Porch Forum, Duxbury Store, Crossett School, bottom of Camel's Hump Rd., and CVRPC newsletter and blog inviting the public to the scheduled Select Board (or specially scheduled) meeting. Additional stakeholders invited to the meeting will be the School. Also invited in the future will be the VT Agency of Natural Resources (VT ANR), as they are able to provide assistance with NFIP outreach activities, models for stricter floodplain zoning regulations, delineation of fluvial erosion hazard areas, and other applicable initiatives. These efforts will be coordinated by the Select Board.

Monitoring of plan progress, implementation, and the 5 year update process will be undertaken by the Select Board Chair. Monitoring updates may include changes in community mitigation strategies; new town bylaws, zoning and planning strategies; progress of implementation of initiatives and projects; effectiveness of implemented projects or initiatives; and evaluation of challenges and opportunities. If new actions are identified in the five year interim period, the plan can be amended without formal re-adoption during regularly scheduled Select Board meetings. After a five year period, the plan will be submitted for re-adoption following the process outlined the schematic found in the Attachments section.

Duxbury shall also consider incorporation of mitigation planning into their long term land use and development planning documents. It is recommended the Town review and incorporate elements of the Local Hazard Mitigation Plan when updating the municipal plan, zoning regulations, and flood hazard/FEH bylaws. The incorporation of the Local Hazard Mitigation Plan into the municipal plan, zoning regulations and flood hazard/FEH bylaws will also be considered after declared or local disasters. The Town shall also consider reviewing future Winooski River planning documents for ideas on future mitigation projects and hazard areas.

5. Risk Assessment

5.1 Hazard Identification and Analysis

The following natural disasters were discussed and the worst threat hazards were identified based upon the likelihood of the event and the community's vulnerability to the event. Hazards not identified as a "worst threat" may still occur. Greater explanations and mitigation strategies of moderate hazards can be found in the State of Vermont's Hazard Mitigation Plan.

Hazard	Likelihood [1]	Community Vulnerability [2]	Worst Threat
Avalanche/ Landslide	Low	No	
Dam Failures (beaver)	Med	No	
Drought	Low	No	
Earthquake	Low	No	
Extreme Cold/Winter Storm/Ice Storm/Power Failure	High	No	
Flash Flood/Flood/Fluvial Erosion	Med	Yes	X
High Wind	Low	No	
Hurricane/Tropical Storm/Severe Storms	Med	Yes	X
Structure Fire	Low	No	
Tornado	Low	No	
Water Supply Contamination	Low	No	
Wildfire/Forest Fire	Med	Yes	X

The following hazards were found to be most significant in the Town of Duxbury:

- Flash Flood/Flood/Fluvial Erosion
- Hurricane/Severe Storms/Tropical Storms
- Wildfire/Forest Fire

Due to the frequent and severe nature of flooding events, Duxbury feels flooding is the worst natural hazard within the Town and will focus on mitigation efforts to reduce the impacts from flooding events.

Non worst threat hazards include
- Dam Failures (beaver)
- Extreme Cold/Winter Storm/Ice Storm/Power Failure

[1] High likelihood of happening: Near 100% probability in the next year.
Medium likelihood of happening: 10% to 100% probability in the next year or at least once in the next 10 years.
Low likelihood of happening: 1% to 10% probability in the next year or at least once in the next 100 years.
[2] Does the hazard present the threat of disaster (Yes)? Or is it just a routine emergency (No)?

A discussion of each significant hazard is included in the proceeding subsections and a map identifying the location of each hazard is attached (See map titled *Areas of Local Concern.*) Each subsection includes a list of past occurrences based upon County-wide FEMA Disaster Declarations (DR-#) plus information from local records, a narrative description of the hazard and a hazard matrix containing the following overview information:

Hazard	Location	Vulnerability	Extent	Impact	Probability
Type of hazard	General areas within municipality which are vulnerable to the Identified hazard.	Types of structures impacted	Magnitude of hazard: Scale dependent on hazard	Dollar value or percentage of damages	Likelihood of hazard occurring based upon past events: HIGH = 10% to 100% probability within the next year or at least once in the next 10 years. MED = less than 10% to 100% probability within the next year or less than once in the next 10 years.

5.2 Worst Threat Hazards

Flash Flood/Flood/Fluvial Erosion

History of Occurrences: Local and County Wide Data – nearest flood gauges are Winooski Gauge, Waterbury and Mad River Gauge, Moretown (from NCDC website and FEMA DR List)

Date	Event	Location	Extent
8/28/2011	Flood/Tropical Storm	Statewide, Duxbury	Winooski Flood gauge knocked out – above 423.3 feet (flood stage is 419 feet) – DR 4022
5/27/2011	Flood	Duxbury	Winooski flood gauge at 423.3 feet DR 4001
4/11/2011	Flood	Duxbury	Winooski flood gauge at 421.0 feet
10/01/2010	Flood	Duxbury	Winooski flood gauge at 421.8 feet
1/19/2006	Flood, Ice jam	Duxbury	Winooski flood gauge at 421.9 feet
12/17/2000	Flood	County Wide	3" of rain, $1 M in damages
6/27/1998	Flash Flood	County Wide	3-6" of rain over 2 day period – Mad River flood gauge at 14.13 feet (flood stage is 9 feet) DR 1228
1/19/1996	Flood; ice jam	County Wide	3-5" of rain, not historical crest
8/4/1995	Flood	County wide	$1.5 M damages; Mad River gauge at 8.12 ft
8/10/1976	Flood	County Wide	Mad River flood gauge at 13.47

			feet DR 518
9/22/1938	Flood	County Wide	Mad River flood gauge at 16.34 feet
11/03/1927	Flood	County Wide	Mad River flood gauge at 19.40 feet

Flooding/flash flooding/fluvial erosion is Duxbury's most commonly recurring hazard. Flooding is the overflowing of rivers, streams, drains and lakes due to excessive rain, rapid snow melt or ice. Flash flooding is a rapidly occurring flood event usually from excessive rain. Fluvial erosion is the process of natural stream channel adjustments. Fluvial erosion causes erosion of sediment in some areas, while causing aggradation of sediment in other. Fluvial erosion processes occur more quickly and severely during flood events.

The major water bodies within the Town of Duxbury are: Ridley Brook, which drains the northwestern portion of the Town into the Winooski; Crossett and Dowsville Brooks draining the eastern section of Town; and Shepard Brook, which provides drainage to a small area in the southwestern portion of Town. The Winooski River, which serves as the Town's northern border, drains into Lake Champlain. These waterways drain the Green Mountain's principle eastern ridge, resulting in a vertical drop of over 3,700 feet within the Town. As a result, there exists great variability in the streams' water levels, which makes them prone to flooding and erosion during snowmelt and after heavy rains.

The majority of the Town's National Flood Insurance Program (NFIP) designated 100-year floodplain is located along the Winooski and out of reach of most of the Town's built environment. However, based on the results of overlaying the FIRM flood maps with the location of the E911 points, there exist 35 buildings and 70 properties in the Town that are vulnerable to potential flooding. The estimated loss for a severe flooding event for all properties located within the Town's 100-year floodplain is approximately $32,468,400. There are no repetitive loss structures in Duxbury.

As previous events have made clear, even areas beyond the NFIP designated 100-year floodplain may be vulnerable to flood related hazards. Channel adjustments with devastating consequences have frequently been documented wherein such adjustments are linked to historical channel management activities, floodplain encroachments, adjacent land use practices and/or changes in watershed hydrology associated with conversion of land cover and drainage activities, within and beyond the NFIP floodplain. The attached Local Areas of Concern Map identifies the Crossett Brook Middle School and Town Offices, as well as other buildings, as outside the designated floodplain, but nearest major waterways.

In order to maintain NFIP compliance, Duxbury adopted a flood hazard overlay district to limit new development in flood prone areas. The Development Review Board is charged with reviewing development applications in the overlay areas. The Zoning Administrator is charged with enforcement of the regulations. The overlay is based on the NFIP 100 year floodplain data. Duxbury's current FIRM date is 11/19/1997. New digital flood maps for Washington County are in

the preliminary approval stages as of writing this plan. The Town has 7 policies in force for a total coverage of $796,000. The Town has not reported any flood hazard regulation compliance issues.

The worst anticipated flooding varies throughout the Duxbury due to the terrain. Most flooding in the highlands is experienced as flash flooding. The worst flooding event in Duxbury's recorded history occurred in 1927, followed closely the 2011 events in April, May and August. Data from the Winooski flood gauge for the 1927 is not available. The Mad River gauge was 10 feet above flood stage. During Irene, the Winooski flood gauge was damaged and the Mad River flood gauge was 10 feet above flood stage. Lesser but more regular flooding occurs in Duxbury, with generally 1 -2 feet of flooding in low lying areas every two or three years. In the future, Duxbury can better gather data for flooding extent by having individuals call in local flood levels in areas around Duxbury.

In 2011, storms in April, May and August caused severe damage to Duxbury public and private infrastructure. Duxbury estimates that it cost close to $2 million to repair public infrastructure damages from the storms. Damage to road and culverts from the April storm occurred on:

- Camels Hump Rd – slide on lower road, bridge abutment severely damaged
- Dowsville Rd
- Scrabble Hill Rd
- Mountain View Rd
- Legal trails – Wescott Rd
- Ward Hill Rd
- Crossett Hill Rd – bridge and road damage
- River Rd
- Pollander Rd

On August 28, 2011, 4-5" of rain fell during Tropical Storm Irene. Damages from Irene cost the Town approximately $750,000. Tropical Irene storm damaged occurred in the following areas:

- Stevens Brook Rd – culvert
- Dowsville Rd – 6 ft culvert
- Camel's Hump Rd – lower portion again, bridge 41 at Marshall Rd
- Crossett Hill Rd
- River Rd

Camels Hump Road is partially closed for the winter and only open to local traffic due to damages to the bridge and road.

In addition to public infrastructure, there was extensive damage to private driveways on steep hills, and riverside properties in low lying areas, especially mobile home parks. Mobile home parks that were damaged were Crossett Hill and Duxbury Corner mobile home parks.

Comment [BTF2]: Is this list correct, or are Patterson and Duxbury Corner the same park?

Hazard	Location	Vulnerability	Extent	Impact	Probability
	Camel's Hump	Roads,	Winooski River	Over $2	medium

Flood/Flash Flood/Fluvial Erosion	Rd, Dowsville Rd, Scrabble Hill Rd, Mountain View Rd, Wescott Rd, Ward Rd, Crossett Hill Rd, flood plain	bridges, culverts, mobile home parks, properties in floodplain	gauge highest recorded historical crest at 423' on 5/28/11; gauge damaged during TS Irene event, but water was higher	million	

Hurricanes/Tropical Storms/Severe Storms

History of Occurrence (from NCDC website and FEMA DR List):

Date	Event	Location	Extent
8/28/2011	TS Irene	Statewide	~6" rain , Mad River flood gauge at 19.07 feet; 9 ft is flood stage (Winooski gauge damaged) DR 4022
5/27/2011	Severe Storm, flash flooding	Waterbury Center	1" hail, 3-5" of rain, 52 knot winds DR 4001
7/21/2008	Severe storms, flooding	County Wide	3-5" of rain
8/25/2007	Severe Storms	Waterbury Center	65 mph wind gusts, 1" hail
7/9/2007	Severe Storms, hail, flooding	Duxbury, Waterbury, Middlesex	1"-2.75" hail. $20k property damages, DR 1715
6/19/2006	Severe storms	Waterbury	55 knot winds, downed trees and power lines
8/1/2005	Severe Storm	Waterbury Center	1" hail
9/16/1999	Tropical Storm Floyd	Statewide	Tropical Storm, DR 1307, Mad River gauge 8.23 feet
6/17/1998	Severe Storms	County Wide	DR 1228, Mad River gauge 14.13 feet
5/29/1998	Severe Storms	Duxbury, Waterbury, Middlesex	50 knot winds, heavy rains, downed trees and power lines
7/15/1997	Severe Storms	County Wide	Data gap - gauge data not available
8/4-6/1995	Severe storms, flooding	County Wide	DR 1063 – 3-6" of rain – Mad River gauge at 8.12 ft
7/23/1990	Severe Storms, flash flooding	County Wide	DR 875 – not a historical crest

8/4/1989	Severe Storms, Flooding	County Wide	DR 840 – Mad River gauge at 10.23 feet
6/7/1982	Severe Storms	New England	14" of rain, $276 M damages
8/5/1976	Hurricane Belle	Statewide	Gale force winds, 2 deaths, DR 518 - gauge data not available
7/3/1964	Hail	County Wide	1.5" hail
9/22/1938	Hurricane	Statewide	Category 1 force winds - gauge data not available

Hurricanes and tropical storms are violent rain storms with strong winds that have large amounts of rainfall and can reach speeds up to 200 mph. Hurricane season is between the months of June and November. These types of storms originate in the warm waters of the Caribbean and move up the Eastern seaboard where they lose speed in the cooler waters of the North Atlantic. A severe thunderstorm is a thunderstorm that contains any one or more of the following three weather conditions: hail that is 3/4 of an inch or greater in diameter , winds 58 miles per hour or greater, and/or tornadoes. Severe storm events can occur in late spring and early summer as temperatures increase in the summer season. The frequency and intensity of hurricanes, tropical storms, and severe storms is expected to increase with climate change.

The impacts associated with hurricanes and severe storms are mainly associated with flooding impacts. Damage locations from April, TS Irene, and the May 28, 2011 storm events are outlined in the Flood/Flash Flood/Fluvial Erosion hazard section. There were no high wind impacts associated with these events.

Similar to flooding, the extent of severe storms is not well documented in the Town of Duxbury. The impact of storms is usually flood related. See flood extent description in flood section above. Wind extent from storms is not well documented as there is no monitoring station in Duxbury. Estimates for wind are gathered from county wide data off the NCDC website. To date, the worst wind extent in Duxbury were hurricane force winds from Hurricane Belle. In the future, Duxbury could consider installing a monitoring station on major brooks and training staff as spotters to better gather data for wind and flood events. The scales used by spotters to measure the extent of the severe storm events are:

Beaufort Scale

Beaufort number	Wind Speed (mph)	Seaman's term		Effects on Land
0	Under 1	Calm		Calm; smoke rises vertically.
1	1-3	Light Air		Smoke drift indicates wind direction; vanes do not move.
2	4-7	Light Breeze		Wind felt on face; leaves rustle; vanes begin to move.
3	8-12	Gentle Breeze		Leaves, small twigs in constant motion; light flags extended.
4	13-18	Moderate Breeze		Dust, leaves and loose paper raised up; small branches move.
5	19-24	Fresh Breeze		Small trees begin to sway.
6	25-31	Strong Breeze		Large branches of trees in motion; whistling heard in wires.
7	32-38	Moderate Gale		Whole trees in motion; resistance felt in walking against the wind.
8	39-46	Fresh Gale		Twigs and small branches broken off trees.
9	47-54	Strong Gale		Slight structural damage occurs; slate blown from roofs.
10	55-63	Whole Gale		Seldom experienced on land; trees broken; structural damage occurs.
11	64-72	Storm		Very rarely experienced on land; usually with widespread damage.
12	73 or higher	Hurricane Force		Violence and destruction.

Saffir-Simpson Scale for Hurricane Classification				
Strength	Wind Speed (Kts)	Wind Speed (MPH)	Pressure (Millibars)	Pressure
Category 1	64- 82 kts	74- 95 mph	>980 mb	28.94 "Hg
Category 2	83- 95 kts	96-110 mph	965-979 mb	28.50-28.91 "Hg
Category 3	96-113 kts	111-130 mph	945-964 mb	27.91-28.47 "Hg
Category 4	114-135 kts	131-155 mph	920-944 mb	27.17-27.88 "Hg
Category 5	>135 kts	>155 mph	919 mb	27.16 "Hg
Tropical Cyclone Classification				
Tropical Depression	20-34kts			
Tropical Storm	35-63kts			
Hurricane	64+kts or 74+mph			

Combined NOAA/TORRO Hailstorm Intensity Scales

Size Code	Intensity Category	Typical Hail Diameter (inches)	Approximate Size	Typical Damage Impacts
H0	Hard Hail	up to 0.33	Pea	No damage
H1	Potentially Damaging	0.33-0.60	Marble or Mothball	Slight damage to plants, crops
H2	Potentially Damaging	0.60-0.80	Dime or grape	Significant damage to fruit, crops, vegetation
H3	Severe	0.80-1.20	Nickel to Quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.2-1.6	Half Dollar to Ping Pong Ball	Widespread glass damage, vehicle bodywork damage
H5	Destructive	1.6-2.0	Silver dollar to Golf Ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0-2.4	Lime or Egg	Aircraft bodywork dented, brick walls pitted
H7	Very destructive	2.4-3.0	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very destructive	3.0-3.5	Baseball to Orange	Severe damage to aircraft bodywork
H9	Super Hailstorms	3.5-4.0	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	4+	Softball and up	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Hazard	Location	Vulnerability	Extent	Impact	Probability
Hurricane/ Severe Storms/Tropical Storms	Camel's Hump Rd, Dowsville Rd, Scrabble Hill Rd, Mountain View Rd, Wescott Rd,	Roads, bridges, culverts, mobile home parks, properties in floodplain	Winooski River historical crest at 423' on 5/28/11; gauge damaged during TS Irene event	Over $2 million	medium

	Ward Rd, Crossett Hill Rd, flood plain				

Wild Fire/Forest Fires

FEMA indicates there are three classes of wild land fires – surface fires, ground fires and crown fires, with the most common type indicated as a surface fire. Surface fires burn slowly along the forest floor, killing and damaging trees. Ground fires burn on or below the forest floor and are usually caused by lightning. Crown fires move quickly by jumping along the tops of trees. Crown fires can spread quickly during windy conditions.

Approximately 90 percent, or 27,000 acres, of Duxbury is wooded. Despite the absence of recent forest fires of significant size, the volume of the Town's forested landscape in conjunction with dry and windy weather has the potential to rapidly spread fire and create a hazardous situation. Much of Duxbury is unreachable by road and an extensive dry hydrant system does not exist, limiting firefighting ability. Properties within the Town's interior are at greatest risk to forest fires; especially in the case where access is limited to a single road, such has Devlin Road, Richardson Road, and the properties off of Camels Hump Road. Approximately 122 residences are located within these three areas. Using Duxbury's average grand list property value, the approximate total value of properties with the greatest risk to forest fire is approximately $34 million.

Hazard	Location	Vulnerability	Extent	Impact	Probability
Wildfire/Forest Fire	Camel's Hump State Forest, Town Wide, Devlin Rd, Richardson Rd, Camels Hump Rd	Properties on urban/forest interface, private homes, road infrastructure	To date - 0 acres, total forested area - 27,000 acres	$34 million, plus firefighting costs	Medium

5.3 Moderate Threat Hazards

Dam Failures (beaver)

The dams of concern in Duxbury are beaver dams. The exact number and location of all the beaver dams is unknown; however, the majority of them are located in Camel's Hump State Park and the heavily wooded areas of Duxbury. Known locations of beaver dams include:

- Vigilante Rd
- VAST Trail in Camel's Hump State Park
- Dowsville Rd

- Atwood Rd

There have been several occurrences of beaver dams washing out and flooding downstream property. The most recent breech occurred in April 2011. The previous winter had been especially snowy, followed by a period of heavy rain. The dam on Dowsville Rd was washed out. The additional water from the dam in conjunction with the heavy rains and snowmelt damaged a 6 foot culvert downstream of the dam.

Hazard	Location	Vulnerability	Extent	Impact	Probability
Dam Failure (beaver)	Camel's Hump State Park, Vigilante Rd, VAST Trails, Dowsville Rd, Atwood Rd	Roads, culverts	Data gap – depends on severity of event	Depends on severity rain/ snowmelt events	Medium

Winter Storm/Ice Storm/Extreme Cold/Power Outage

History of Occurrence (from NCDC website and FEMA DR List.) Due to the area-wide nature of winter storms, snowfall depths vary in and around the Town of Duxbury:

Date	Event	Location	Extent
3/6/2011	Winter storm	Washington County, Duxbury	15-25" of snow, 10,000 customers lost power statewide
2/23/2010	Winter Storm	Washington County, Duxbury	20" of snow and 50,000 customers lost power statewide
2/22/2009	Winter Storm	Washington County, Duxbury	10-18" of snow, 30 mph wind gusts
2/1/2008	Winter storm	Washington County, Duxbury	3-7" of snow and ice ¼-1/2"thick, 50 mph wind gusts
2/14/2007	Winter storm	Washington County, Duxbury	18-22" of snow
1/4/2003	Winter storm	Washington County, Duxbury	12-20" of snow
3/5/2001	Winter storm	Washington County, Duxbury	15-30" of snow
12/31/2000	Winter storm	Washington County, Duxbury	15" of snow
12/29/1997	Winter storm	Washington County, Duxbury	8-21" of snow
12/7/1996	Winter Storm	Washington County, Duxbury	12" of snow
3/21/1994	Winter storm	Washington County,	5-11" of snow

		Duxbury	
11/1/1993	Winter storm	Washington County, Duxbury	10-20" of snow
1/3/1993	Freezing Rain	Statewide	

A winter storm is defined as a storm that generates sufficient quantities of snow, ice or sleet to result in hazardous conditions and/or property damage. Ice storms are sometimes incorrectly referred to as sleet storms. Sleet is similar to hail only smaller and can be easily identified as frozen rain drops (ice pellets) that bounce when hitting the ground or other objects. Sleet does not stick to wires or trees, but in sufficient depth, can cause hazardous driving conditions. Ice storms are the result of cold rain that freezes on contact with the surfaces coating the ground, tress, buildings, overhead wires and other exposed objects with ice, sometimes causing extensive damage. Periods of extreme cold tend to occur with these events.

Although winter storms and periods of cold temperatures are a frequent occurrence, the extent of winter storms within Duxbury is difficult to estimate as it is dependent on the size and path of the storm.

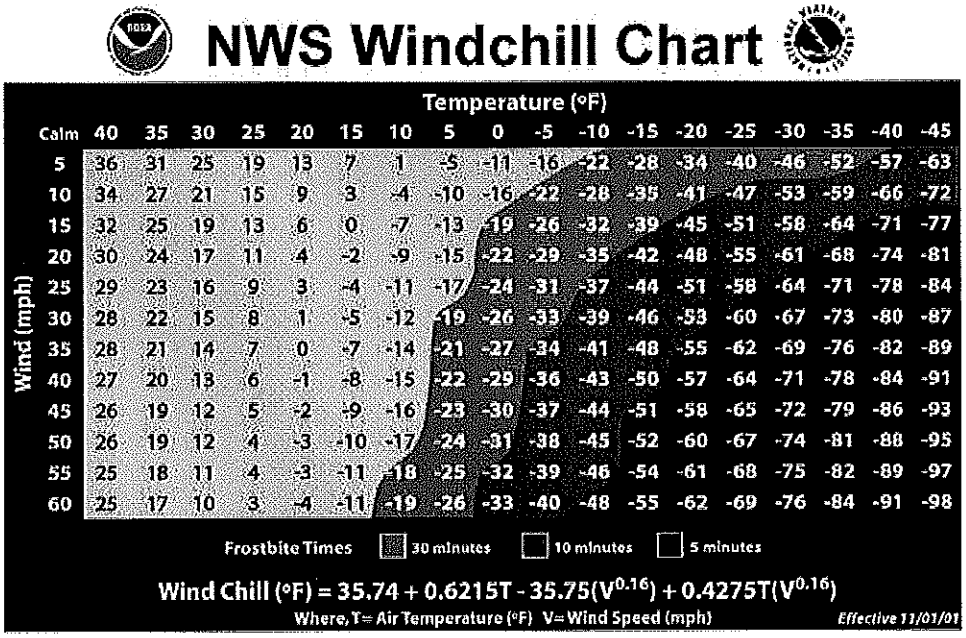
For the next plan update, Duxbury will more closely monitor winter storms and collect data to determine the worst extent possible on the Town. Based on past occurrences, the worst anticipated winter weather Duxbury could experience would be 2-3' of snow with more at higher elevations and several days of power outages. The worst recent storm was in March 2011, and after that the Blizzard of 1888. Extent data can be based on volumes of snow, winter weather alerts issued, or wind chill factor. See tables below for descriptions and scales.

Extent Scale - Winter Weather Alerts

Winter Weather advisory	This alert may be issued for a variety of severe conditions. Weather advisories may be announced for snow, blowing or drifting snow, freezing drizzle, freezing rain, or a combination of weather events.
Winter storm watch	Severe winter weather conditions may affect your area (freezing rain, sleet or Heavy snow may occur separately or in combination).
Winter Storm Warning	Severe winter weather conditions are imminent.
Freezing rain or freezing drizzle	Rain or drizzle is likely to freeze upon impact, resulting in a coating of ice Glaze on roads and all other exposed objects.
Sleet	Small particles of ice usually mixed with rain. If enough sleet accumulates on the ground, it makes travel hazardous.
Blizzard Warning	Sustained wind speeds of at least 35 mph are accompanied by considerable falling or blowing snow. This alert is the most perilous winter storm with visibility dangerously restricted.
Frost/freeze warning	Below freezing temperatures are expected and may cause significant damage to plants, crops and fruit trees.

Wind Chill	A strong wind combined with a temperature slightly below freezing can have the same chilling effect as a temperature nearly 50 degrees lower in a calm atmosphere. The combined cooling power of the wind and temperature on exposed flesh is called the wind-chill factor.

Wind Chill Extent Scale



One of the major problems associated with ice storms is the loss of electrical power. Major electric utility companies have active, ongoing programs to improve system reliability and protect facilities from damage by ice, severe winds and other hazards. Typically, these programs focus on trimming trees to prevent encroachment of overhead lines, strengthening vulnerable system components, protecting equipment from lightning strikes and placing new distribution lines underground.

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Duxbury is served by two energy utilities, Green Mountain Power and Washington Electric

Cooperative. Both entities' power generation is based upon substations, which are not set by jurisdictional lines. As a result, frequency and specific dates of power shortage/failure could not be attained. This level of detail could be provided in the future by working directly with the utilities in order to research this data.

The meeting, however, did provide a general description of power shortages. Duxbury's Washington Electric customers are some of the furthest from the electric source. As a result they appear to be some of the most susceptible to power outages. Attendees at the meeting stated that they characterize the frequency of outages to approximately 1-2 days per winter. Some residents have experienced prolonged outages, such as 48 hours in 2002 and 5 days without power during an ice storm in 1999. Green Mountain Power residents appear to be less susceptible to prolonged outages.

Vulnerable populations, such as the elderly and handicapped are of greatest risk to this hazard. If this type of multiple hazard event takes place for an extended period of time, back-up power would be necessary for critical facilities such as the Crossett Brook Middle School, Thatcher Brook Primary School building, Harwood Union High School, Town Offices, and Town Highway Garage.

Duxbury does have a Homebound Persons Phone Tree that lists vulnerable residents. This list is disseminated to members of the community with All-Terrain Vehicles or Snowmobiles who volunteer to rescue their homebound neighbors in the case of a hazard.

By observing winter storm watches and warnings, adequate preparations can usually be made to lessen the impact of snow, ice and sleet, and below freezing temperature conditions on the Town of Duxbury. Providing for the mass care and sheltering of residents left without heat or electricity for an extended time and mobilizing sufficient resources to clear broken tree limbs from roads, are the primary challenges facing community officials. Shelter locations include: Crossett Brook School, Harwood Union High School and Thatcher Brook Elementary (Waterbury). The Town encourages residents who are in remote locations to be equipped with generators and backup fuel supplies in the event of prolonged power outages and travel restrictions.

Other major problems include closed roads and restricted transportation.

Hazard	Location	Vulnerability	Extent	Impact	Probability
Extreme Cold/Winter or Ice Storm in conjunction with power failure	Town Wide	Elderly & handicapped populations, remote structures, old/under insulated	Minimal to Moderate depending on severity; 18+" in March 2011 event	Depends on severity – additional sheltering/ plowing/ emergency services costs	High

		structures, utilities, trees		for town	

6. Mitigation

6.1 Town Plan (June, 2008) Goals that Support Local Hazard Mitigation

- To preserve and enhance Duxbury's rural character
  - o Protect and enhance the quality of ground and surface waters:
    - Ensure that any development in any riparian area have a careful and appropriate site plan;
    - Establish a 100-foot setback for any development along Ridley, Dowsville and Crossett Brooks;
    - Adopt a Town septic ordinance
- To foster orderly and harmonious growth:
  - o Ensure that new development is compatible with Duxbury's rural character, natural resources, land capabilities and financial limitations:
    - Direct growth to those areas already served by the existing road and utility networks

Duxbury's town plan will be updated no later than 2013 and the Local Hazard Mitigation Plan will be amended to reflect any town plan changes. The Town is interested in adding goals which related to mitigation planning goals. The goal of this Local Hazard Mitigation Plan is:

- To take actions to reduce or eliminate the long-term risk to human life and property from flash flood/flood/fluvial erosion, hurricanes/severe storms/tropical storms, and wildfire/forest fires.

Specific hazard mitigation strategies related to goals of the Plan include:

- Ensure existing and future drainage systems are adequate and functioning properly
- Preserve and prevent development in areas where natural hazard potential is high
- Ensure that all residents and business owners are aware of the hazards that exist within Duxbury and ways they can protect themselves and insure their property
- Ensure that emergency response services and critical facilities functions are not interrupted by natural hazards

6.2 Proposed Hazard Mitigation Programs, Projects & Activities

Hazard mitigation programs, projects and activities that were identified for implementation at the Duxbury Local Hazard Mitigation meeting:

Hazards Mitigated	Mitigation Action	Local Leadership	Prioritization	Funding Resources	Time Frame
Flooding, Severe storms	Upgrade and expand culvert at Pollander Brook and Crossett Hill Rd	SB, Road Foreman	High	HMGP, town funds	1-2 years
Flooding, Severe Storms	Upgrade and expand 6 foot culvert on Stevens Brook Rd	SB, Road Foreman	Medium	HMGP, town funds	2-3 years
Flooding, Severe Storms	Upgrade and expand culvert on Atwood Rd	SB, Road Foreman	Medium	HMGP, town funds	2-3 years
Flooding, Severe Storms	Upgrade and expand bridge on Pitts/Camels Hump Rd	ANR, SB, Road Foreman	Medium	HMGP, town funds	2-3 years
Flooding, Severe Storms	Upgrade and expand bridge on Scrabble Hill/Camels Hump Rd	ANR, SB, Road Foreman	Medium	HMGP, town funds	2-3 years
Flooding, Severe Storms	Upgrade and expand box culvert on Lars/Camels Hump Rd	ANR, SB, Road Foreman	Medium	HMGP, town funds	3 years
Flooding, Severe Storms	Upgrade and replace abutment on Bridge 41 on Camels Hump Rd	ANR, SB, Road Foreman	Medium	HMGP, town funds	3 years
Flooding, Severe Storms	Enroll in CVRPC post Irene river debris assessment	ANR, CVRPC, SB	High	ANR	1 year
Wild fire	Work with State to develop alternative water supplies in State Forest for wildfire suppression purposes	P.C, Fire Dept, VT ANR	Med	EMGP	3 years
Wild Fire	Distribute public education materials about reducing wild fire risk	Fire Dept, Select Board	Med	USDA	3-4 years
Emergency Preparedness	Generator education and training for	Select Board, Fire Dept	Low	General Funds, EMGP	2-3 years

	residents				
Winter storms/ extreme cold/ice storms	Upgrade electrical systems in municipal buildings and shelters to prevent surge/equipment damage from fluctuating current during ice and wind storms	Fire Dept, Select Board	Med	General Funds, EMGP, DPIG	3-4 years
NFIP Compliance	Work with elected officials, the State and FEMA to correct existing compliance issues and prevent any future NFIP compliance issues through continuous communications, training and education	P.C, ANR, S.B, Road Foremen	Med	Town, USDA	2-3 years

VEM also emphasizes a collaborative approach to achieving mitigation on the local level, by partnering with ANR, VTrans, ACCD, Regional Planning Commissions, FEMA Region 1 and other agencies, all working together to provide assistance and resources to towns interested in pursuing mitigation projects and planning initiatives.

The mitigation activities are listed in regards to local leadership, possible resources, implementation tools, and prioritization. Prioritization was based upon the economic impact of the action, the Community's need to address the issue, the action's cost, and the availability of potential funding. The action's cost was evaluated in relation to its benefit as outlined in the STAPLEE guidelines.

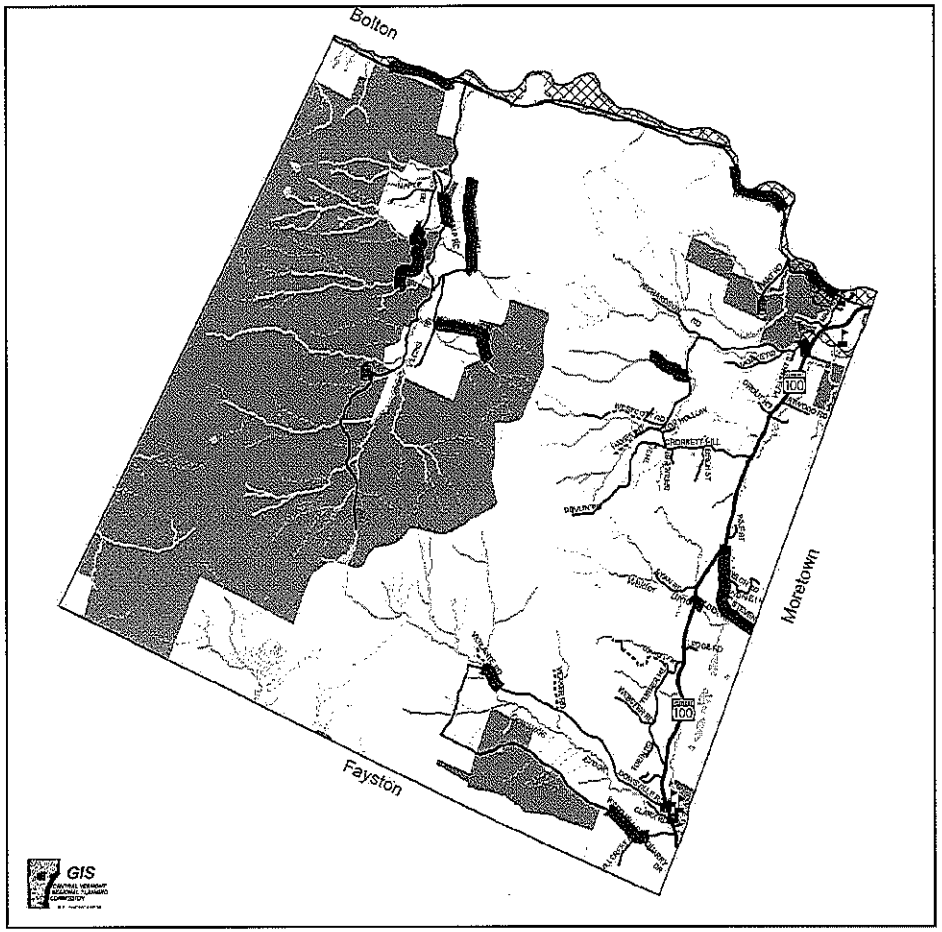
Duxbury understands that in order to apply for FEMA funding for mitigation projects that a project must meet FEMA benefit cost criteria. The Town must also have a FEMA approved Hazard Mitigation Plan as well.

A High prioritization denotes that the action is either critical or potential funding is readily available and should have a timeframe of implementation of less than two years. A Medium prioritization is warranted where the action is less critical or the potential funding is not readily

available and has a timeframe for implementation of more than two years but less than four. A Low prioritization indicates that the timeframe for implementation of the action, given the action's cost, availability of funding, and the community's need to address the issue, is more than four years.

Attachments

- Areas of Local Concern Map
- 5 year plan maintenance and review process
- Town Resolution Adopting the Plan



Town of Duxbury

Areas of Local Concern

Legend

Facilities

Facilities

- Government
- Church
- School
- Railroad
- 100 Year Flood Plain
- Flood Prone Areas
- Lake
- River

Streams

- Intermittent
- Perennial

Conserved Land

N

0 0.5 1 2 Miles

SOURCE:
Roads:VAOT, 2004.
Surface Waters: 1:5000 CVRPC Surface Water.
Map created 3-26-2005 by CVRPC
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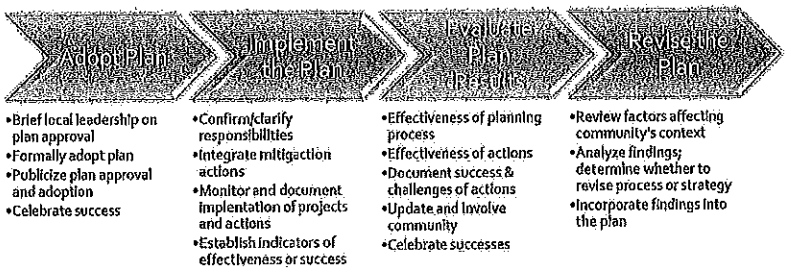
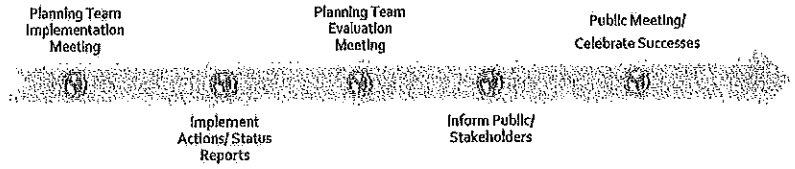
Data is only as accurate as the original source.
This map is for planning purposes only.
This map may contain errors and omissions.

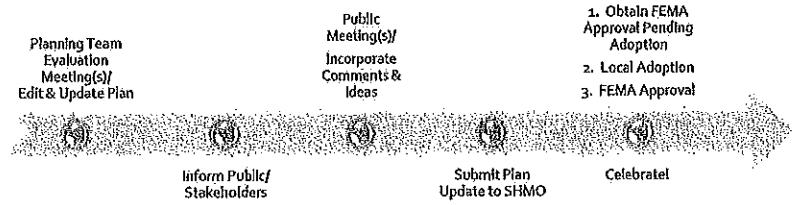
5-Year Plan Review/Maintenance



After Plan Adoption-Annually
Implement and Evaluate



Fifth Year, and After Major Disaster
Evaluate and Revise



CERTIFICATE OF ADOPTION

The Town of Duxbury
Select Board
A Resolution Adopting the Local Hazard Mitigation Plan
Sept 24, 2012

WHEREAS, the Town of Duxbury has worked with the Central Vermont Regional Planning Commission to identify hazards, analyze past and potential future losses due to natural and manmade-caused disasters, and identify strategies for mitigating future losses; and

WHEREAS, the Duxbury Local Hazard Mitigation Plan contains several potential projects to mitigate damage from disasters that could occur in the Town of Duxbury; and

WHEREAS, a duly-noticed public meeting was held by the Town of Duxbury Select Board on Sept 24, 2012 to formally adopt the Duxbury Local Hazard Mitigation Plan;

NOW, THEREFORE BE IT RESOLVED that the Duxbury Select Board adopts the Duxbury Local Hazard Mitigation Plan.

Chair of Select Board

Member of Select Board

ATTEST

Duxbury Clerk