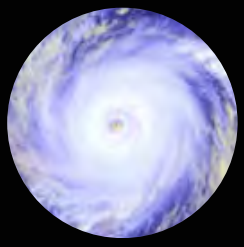
Southeastern Regional Planning & Economic Development District

Natural Hazard Pre-Disaster Regional Mitigation Plan

2004



MITIGATION:

ANY ACTION TAKEN TO REDUCE OR ELIMINATE THE LONG TERM RISK TO HUMAN LIFE AND PROPERTY FROM NATURAL HAZARDS.

Prepared by:
Regional Community Planning Team
Southeastern Regional Planning & Economic Development District (SRPEDD)
88 Broadway
Taunton, MA
02780

Adopted by the SRPEDD Commission on September 22, 2004.
With revisions of November 23, 2004.

Funding for this project provided by Massachusetts Emergency Management Agency (MEMA) and the Massachusetts Department of Conservation and Recreation with federal Pre-Disaster Mitigation Funds.

Staffing: Marijoan Bull, AICP Principal Planner, Author
Maisy McDarby, GIS Specialist, Mapping (resigned)
Gregory Guimond, Comprehensive Planning Director
Stephen C. Smith, Executive Director

SRPEDD REGION NATURAL HAZARD DISASTER MITIGATION PLAN

TABLES, FIGURES, AND MAPS

Maps on the Accompanying CD

In the Folder: Maps in Regional Plan

Map A: Municipalities of the SRPEDD Region
Map B: Watershed Regions
Map C: Rivers
Map D: Floodplains and Urbanized Areas
Map E: Barrier Beaches
Map F: Average Long Term Shoreline Change Rate (Ft/Yr
Map G: Regulated Dams
Map H: Urbanized Areas
Map I: Elderly and Disabled
Map J: Transportation Network
Map K: 1999 Land Use
Map L: Historic Sites and Historic Buildings
Map M: Cranberry Bogs and Chapter 61 Lands
Map N: Water and Wastewater Systems

In the Folder: Regional Natural Hazards Maps (11 Maps)

SRPEDD Municipalities Regional Hazard Map: Earthquake Data
SRPEDD Municipalities Regional Hazard Map: Blizzard Data
SRPEDD Municipalities Regional Hazard Map: Tornado Data
SRPEDD Municipalities Regional Hazard Map: Hurricane Data
SRPEDD Municipalities Regional Hazard Map: Flood Data
SRPEDD Municipalities Regional Hazard Map: Forest Vegetation & Wildfire Data
SRPEDD Municipalities 2000 Census Data: Disabled & Elderly Populations
SRPEDD Municipalities Critical Facilities in 100 Year Floodplain
SRPEDD Municipalities Land Use/100 Year Floodplain
SRPEDD Municipalities Repetitive Flood Loss Claims
SRPEDD Municipalities Evacuation Routes

ACRONYMS USED IN THIS PLAN

BDS – Bureau of Dam Safety, Massachusetts Department of Conservation and Recreation.
CIP – Capital Improvement Program
CPT- Community Planning Team
CRS – Community Rating System
CZM- Office of Coastal Zone Management, Massachusetts Executive Office of Environmental Affairs
DCR- Massachusetts Department of Conservation and Recreation
DFWELE- Massachusetts Department of Fisheries, Wildlife and Environmental Law Enforcement.
EOEA- Massachusetts Executive Office of Environmental Affairs
FEMA- Federal Emergency Management Agency
GATRA – Greater Attleboro Transit Regional Authority
GPS- Global Positioning Service
MassGIS – Massachusetts Geographic Information System
MEMA- Massachusetts Emergency Management Agency
MHD- Massachusetts Highway Department
MPO- Metropolitan Planning Organization
NESEC- Northeast States Emergency Consortium
NFIP- National Flood Insurance Program
NFPA- National Fire Protection Agency
NWS- National Weather Service
SLOSH- Sea and Lake Overland Surge from Hurricanes
SRPEDD- Southeastern Regional Planning and Economic Development District
SRTA- Southeastern Regional Transit Authority

Chapter One

Introduction

Purpose

New England weather is renowned for its mercurial and dramatic nature. Late summer hurricanes, major winter blizzards, and summer droughts are all part of life in the southeastern Massachusetts region. These events are frequent enough to be familiar--in the course of the development of this plan, Cobb Brook in Taunton flooded forty basements, Dartmouth homes sustained an earthquake of magnitude 2.0, and area firefighters responded to a 35-acre wildfire that came within 40 feet of homes in Plymouth. **The intersection of these natural hazards with the man-made environment can transform these routine events into natural disasters.** The historical development pattern of southeastern Massachusetts makes such an outcome more likely. Drawn to the waterways as transportation corridors and sources of power, many of the region's villages and cities are sited in riverine floodplains and along the unprotected coastline.

This plan examines the natural hazards facing this region, assesses the vulnerabilities of the area's residents and businesses, and makes recommendations on ways to mitigate the negative effects of typical natural hazards. The effort has drawn from the local knowledge of a large group of officials and residents, and the recommendations presented are meant to be realistic and effective steps for mitigating natural hazards. Ultimately it is hoped these actions will translate into savings—fewer lives lost, less property destroyed, and minimal disruption to essential services.

Ultimately it is hoped these actions will translate into savings—fewer lives lost, less property destroyed, and minimal disruption to essential services.

Development of the Plan

In November of 2002 the Southeastern Regional Planning & Economic Development District (SRPEDD), wrote to the governing body of each of its twenty-seven (27) member communities asking for appointments to a regional Community Planning Team (CPT). These appointments, along with representatives from NSTAR (a local utility), Northeast States Emergency Consortium (NESEC), and the National Fire Protection Agency (NFPA), formed the membership of the CPT. The plan was developed over the course of nine (9) CPT meetings at the SRPEDD offices. SRPEDD staff drafted the plan working closely with the CPT members and consulting with numerous outside agencies including: meteorologists at the National Weather Service in Taunton, the Department of Conservation and Recreation (DCR), Bureau of Dam Safety, the Riverways Program of DFWELE, the Waterways division of DCR, and the EOEA Office of Coastal Zone Management. DCR and MEMA staff provided assistance with data gathering and research. As part of the CPT's meeting schedule, the NFPA's FIREWISE program gave a presentation and SRPEDD's transportation staff shared computer models that simulate traffic circulation after a natural disaster has disrupted roadway infrastructure. The

MassHighway's Pictometry program was also discussed within the context of disaster mitigation. (See Appendix A for copies of all materials related to the development and operation of the CPT – appointment letter; membership list, schedule of meetings, and outreach and contacts with local communities.)

This regional plan was developed concurrently with multiple local disaster mitigation planning initiatives. The CPT deliberately designed feedback loops into the development of the regional plan. A draft regional plan completed in April of 2004 provided information that supported the local planning efforts, yet information generated through the local planning processes was added to and enriched the final form of the regional plan.

The completed draft was circulated to MEMA, DCR, and CZM for comments, and two public hearings on the plan were held. One meeting was held on May 5, 2004 at 2:00 pm in the Fall River Fire Department Training Facility and a second meeting occurred on September 22, 2004 as part of the regular meeting of the SRPEDD governing body, the SRPEDD Commission (See Appendix A). The SRPEDD Commission voted to adopt the plan at the September 22 meeting (See Resolution and meeting minutes in Appendix B.)

Obstacles

The two major obstacles to effective disaster mitigation in southeastern Massachusetts are complacency and capacity. As indicated in Chapter Three, this region has not seen a major hurricane (Category 3, 4, or 5) in 50 years. Likewise, the last substantial wildfire was the 1957 Carver to Plymouth burn that consumed 18,000 acres and stopped only when it reached the ocean. During these years of relative quiet, new residences and businesses have been built in areas vulnerable to natural disaster. The past twenty years has seen a regional population increase of 13.9% versus the state increase of 10.6%; and for the period 1960-2000 the region's population grew by 40% versus a statewide increase of 23%. **These new residents lack first hand knowledge of the ferocity nature can show this region.**

A FEMA sponsored April of 2000 telephone survey of residents in coastal counties of northern states found homeowners perceived the risk from hurricanes to be "minor". This study suggests that the education of residents is an "acute challenge" because only 19% of homeowners reported having had actual hurricane damage to their homes.[1] This lack of experience translated into many being unprepared -- 76% have not taken actions to protect their homes from the impact of a hurricane and 77% do not have disaster supply kits to use in the event of a hurricane.[2] Combating complacency is a difficult task that requires creative and visual educational approaches, and the fortitude to not tire of repeating the message.

The SRPEDD region includes 10 communities that have 10,000 residents or fewer. These small rural towns have few financial resources and a limited professional capacity. This means there is no staff to write grants, no staff to oversee construction projects, and no staff to keep plans up to date. Many of the Emergency Management Directors are volunteers or receive a nominal

[1] *National Hurricane Survival Initiative Poll* in FEMA NEWS www.fema.gov/nwz00/pollresult.shtm . Accessed March 10, 2003.
[2] Ibid.

stipend for their work. Of the twenty-seven communities in the region only 11 have a full time planner, another 7 have a part-time planner and 9 have no planner position. Even the larger communities face a myriad of demands on a limited supply of employees and volunteers. Resources will need to be identified in order to accomplish the action items in this regional plan. Some success may come from the recommendations that rely on institutionalizing mitigation thinking within existing practices, but even these actions need a facilitator. **Long term capacity-building within the area of disaster mitigation will be needed to fully achieve the vision of this plan**.

Chapter Two: Profile of the SRPEDD Region

Maps for this section are provided at the end of the chapter.

A. Geography, Geology, and Topography

The 800 square mile SRPEDD region covers most of the expanse of southeastern Massachusetts below greater Boston and before Cape Cod. It is bounded along the west and southwest by the Rhode Island border, to the north and northeast by the greater Boston region, and to the south and southeast by open water. It stretches for over 35 miles from the shoreline of Wareham, to its northern interior in Plainville. This region of twenty-seven communities can be divided into sub-regions of communities grouped by geographically dominant characteristics:

- *South Coastal* – seven communities with coastline along Buzzards Bay: Acushnet, Dartmouth, Fairhaven, Marion, Mattapoisett, New Bedford, Wareham, and Westport;
- *Cranberry Country* – four low density communities with large areas of cranberry bogs: Carver, Rochester, Lakeville and Middleborough;
- *Greater Fall River* – five communities in the Fall River urban area: Fall River, Freetown, Somerset and Swansea;
- *Greater Taunton* – four communities in the Taunton urban area: Berkley, Dighton, Raynham and Taunton;
- *Greater Attleboro* - seven communities in the Attleboro urban area: Attleboro, Mansfield, Norton, North Attleborough, Plainville, Seekonk, and Rehoboth.

MAP A: Municipalities of SRPEDD Region

Geologists classify the southeastern Massachusetts area as part of the Northeast Coastal Lowlands/Coastal Plain region. The area is characterized by the conditions created over 12,000 years ago when massive glaciers receded. These characteristics include: low hills; highly porous soils; deposits of sand and gravel; multiple swamps, lakes, rivers and ponds; and a high water table. The glaciers left behind glacial till that contains thick deposits of both sand and gravel, lying over bedrock. There are occasionally boulders, known as glacial erratics, of different rock types that were carried from northern regions and left behind as the glaciers receded.

As the name lowlands infers, the region is generally low lying ranging from sea level along the coast to higher, but still modest, elevations at the most inland portions. The highest point is in Plainville, at 420 feet above sea level. The topography includes many basin areas that are generally wetlands and marshes that provide recharge to the local aquifers. Approximately 22.1% of the region is classified as wetland areas according to Mass GIS. The soils in the area are glacial drift (till and outwash of sand and gravel) that overlies bedrock

There are twenty-nine named rivers within the region, most of which are short and shallow (see Table 2-1). The Taunton River is the longest river in the region, and it runs for over 44 miles, dropping only 20 feet in elevation as it travels from its headwaters at the Town and Matfield Rivers, to Mount Hope Bay. According to the watershed groupings of the Massachusetts Executive Office of Environmental Affairs (EOEA), the SRPEDD region is part of four major

watersheds: Taunton River (562 square miles); Mount Hope/Narragansett Bay (112 square miles); Buzzards Bay (432 square miles); and Ten Mile River (54 square miles). Within the region are several major inland water bodies with the two largest lake areas being the Assawompset Ponds complex in Lakeville, and the Wattupa Ponds in Fall River.

MAP B: Watersheds within the Region

MAP C: Rivers

Table 2-1: Major Rivers of the SRPEDD Region

River Name	***SRPEDD Communities Along the River***
Acushnet River	Acushnet, New Bedford
Agawam	Wareham
Assonet River	Lakeville, Freetown
Bungay River	Attleboro
Canoe River	Mansfield, Norton
Cole River	Dighton, Swansea
Cotley River	Berkley, Taunton
Forge River	Raynham
Kickamuit River	Swansea
Lee River	Swansea
Mattapoisett River	Rochester, Mattapoisett
Mill River	Taunton
Nemasket River	Middleboro, Lakeville
Palmer River	Rehoboth, Swansea
Paskamansett River	Dartmouth, New Bedford
Quequechan	Fall River
Rumford River	Mansfield, Norton
Runnins River	Seekonk
Segreganset River	Dighton, Taunton
Seven Mile River	North Attleboro, Attleboro
Sippican – West & East	Middleboro, Rochester, Marion, Wareham
Slocum River	Dartmouth
Snake River	Norton, Taunton
Taunton River	Middleboro, Raynham, Berkley, Taunton, Dighton, Somerset, Fall River, Freetown
Ten Mile River	Attleboro, North Attleborough, Plainville, Seekonk
Three Mile River	Norton, Taunton, Dighton
Wading River	Mansfield, Norton
Wankinco River	Carver, Wareham
Wareham River	Wareham
Westport River – West & East	Westport
Weweantic River	Carver, Middleboro, Wareham
Winnetuxet River	Carver, Middleboro
Note: This is not an inclusive list of all rivers, streams, and brooks in the region.	

It is not uncommon for flooding to occur in the spring as some of the rivers in the region overflow their banks. In particular, rivers that are in more developed areas are problematic. These rivers have typically been channeled or covered, and receive heavy influxes of point and non-point run-off from impervious surfaces such as roadways and parking lots. It is worth noting that of the entire region, 17% or approximately 141 square miles are within the100-year

floodplain and an additional 4% in the five-hundred year flood plain. As Map D indicates by the use of the US Census urbanized areas definitions, much of the floodplain area is already developed. See Chapter Three for additional information on undeveloped land in the 100-year floodplain.

MAP D: Floodplains with Urbanized Areas

> ***"Weather causes dramatic change; nature takes it time."***
> -Kevin Mooney, Waterways Division
> Massachusetts Department of Conservation and Recreation

Within the region, there is a total of approximately 348 miles of tidal shoreline. This includes the coastline and tidal areas along the Taunton River. The south coastal communities along Buzzards Bay account for over ¾ off this total, with nearly 275 miles. This area is subject to strong natural forces such as wind, waves, tides, sea level fluctuation, and climatic variation that influence the movement of sand. The loss (erosion) and gain (accretion) of coastal land is a continuous process. The Massachusetts Office of Coastal Zone Management (CZM) has interpreted data on shoreline change from maps and orthophotos covering the period of the early 1800s through 1994. CZM has mapped the amounts of change during this period and with the use of linear regression developed a model that estimates these south coastal communities will lose .5 – 1.5 feet of shoreline per year, into the foreseeable future. These changes are part of a natural cycle, a cycle that beach and shore projects need to respect.

Also of importance is the length of barrier beach that exists along the south coastal sub-region. The Coastal Zone Management Agency notes,

> "*barrier beaches are narrow, low-lying strips of beach and dunes that are roughly parallel to the coastline, and are separated from the mainland by a body of water or wetland. In 1980, Executive Order No. 181 was enacted to strengthen the protection of barrier beaches in Massachusetts. This order recognized that: the dynamic nature of the barrier is essential for barrier beaches to provide storm damage prevention and flood control; human-induced changes to barrier beaches can decrease these storm damage prevention and flood control capacities; inappropriate development on barrier beaches results in the loss of lives and property; and future storm damage to development on barrier beaches is inevitable due to sea level rise."*

As indicated on Map E, the communities of Dartmouth, Fairhaven, Marion, Mattapoisett, Somerset, Swansea, Wareham, and Westport all have barrier beaches. The Department of Conservation and Recreation designs projects that acknowledge the natural cycles of shoreline areas, and aim to maintain dunes along barrier beaches. These land masses modify the impacts of major storm events.

Map E: Barrier Beaches

An additional feature of these shoreline areas is the availability of safe harbor areas—places that ships can take refuge when a storm approaches. The channels in and out of these harbors are part of the infrastructure network. Channel sedimentation is a continual problem resulting from physical processes. The movement of sand from littoral currents and wave action leads to build-ups at the mouths of rivers and channel entrances. The shape and forces within each channel are unique, so some have sufficient currents to create a natural scouring action. Changes to channels and beaches can be incremental through tides and weather changes or dramatic due to major storm events. Dredging is an expensive undertaking that also requires extensive permitting.

MAP F: Average Shoreline Change

Dams are a significant infrastructure within the Commonwealth and this region. The 313 dams in southeastern Massachusetts represent 10% of the state's dams. Map G indicates the location of regulated dams in the region. The Bureau of Dam Safety (BDS), a division of DCR, has jurisdictional authority over dams that meet the following criteria: dam structure six feet or higher, or impoundment of 15 acre feet[3] or more, or a significant downstream hazard as determined by staff review (e.g. campground, densely developed area, major thoroughfare, etc.). This includes government and privately owned dams. New regulations went into effect at the end of 2003 that require owners to register the dams and have them professionally inspected at the owner's expenses on a periodic basis that, depending on size, ranges from two-ten years. BDS has a nearly complete data set that includes preliminary hazard ratings within three categories: high hazard; significant hazard; or low hazard. Within the region, 24 dams are categorized as high hazard, 57 as significant, 205 as low, and 28 lack a rating.

Table 2-2 Classification System of Dams from 302 CMR 10

Hazard Classification	Hazard Potential
High Hazard (Class I):	Dams located where failure or misoperation will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).
Significant Hazard (Class II):	Dams located where failure or misoperation may cause loss of life and damage home(s), industrial or commercial facilities, and secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities.
Low Hazard (Class III):	Dams located where failure or misoperation may cause minimal property damage to others. Loss of life is not expected.

Of the 313, only 20% are owned by a government entity, and approximately another 20% are related to the cranberry industry. A detailed listing of the dams is provided in Appendix C. While the monitoring of dam condition falls to the owner, be it a private or public entity, damage from dam failure may include multiple owners and even property across town boundaries. Coordination between towns may be important, especially concerning the release of water to adjust levels before and during storm events.

[3] Acre foot = Amount of water that fills one acre of land to a depth of one foot, approx. 300,000 gallons of water.

Table 2-3: Number of Regulated Dams by Community	
Community	**Number**
Acushnet	4
Attleboro	16
Berkley	0
Carver	60
Dartmouth	12
Dighton	9
Fairhaven	4
Fall River	11
Freetown	12
Lakeville	7
Mansfield	12
Marion	6
Mattapoisett	2
Middleborough	17
New Bedford	3
North Attleborough	10
Norton	10
Plainville	7
Raynham	5
Rehoboth	9
Rochester	21
Seekonk	3
Somerset	1
Swansea	7
Taunton	17
Wareham	44
Westport	4
Total	313
(Source: Bureau of Dam Safety, DCR) Also see appendix.	

MAP G: Regulated Dams

B. Climate

Massachusetts in general has a humid continental climate with temperatures that average 68 to 72 degrees in the summer and about 28 to 32 degrees in the winter. The coastal communities of Dartmouth, Fairhaven, Marion, Mattapoisett, New Bedford, Wareham, and Westport have cooler summer temperatures because of the moderating effects of the ocean which also give this sub-region somewhat warmer temperatures in the winter. The mean annual precipitation ranges from 40 to 46 inches, with 1/3 of this in snow. The growing season, from the last killing frost in the spring to the first killing frost in the fall, is about 160 days. The coastal areas have a slightly expanded growing season of 180 – 200 days. The area is subject to a variety of severe weather

events: hurricanes, Northeasters, thunderstorms, blizzards, tornadoes, and drought. All of these are discussed more fully in Chapter Three: Natural Hazards Risk Assessment.

C. Political Boundaries & Population Concentrations

The SRPEDD region includes twenty-seven communities, twenty-three of which are towns and four of which are cities (Attleboro, Fall River, New Bedford, and Taunton). These communities are located in three counties: 19 in Bristol County; 7 in Plymouth County; and 1 in Norfolk County. According to the 2000 US Census, the regional population totals nearly 600,000 with individual communities ranging in population from a low in Rochester of 4,581 persons to a high in New Bedford of 93,768. The majority of the communities in the region (19) have fewer than 20,000 persons. The four urban areas have 47.5 % of the regional population and have population densities in the range of 2,254 – 4,655 persons per square mile. This contrasts with the more rural areas of the region where the densities are generally less than 300 persons per square mile. New Bedford stands out in the region because it has the greatest population and is a significant outlier in terms of density. Table 2-4 indicates the total population, land area, and density for each community in the region.

Table 2-4: Population, Land Area, and Density by Community			
Community	***Population (1)***	***Land Area (Square Miles) (2)***	***Population Density (Persons/Square Mile) (3)***
Acushnet	10,161	18.42	552
Attleboro	42,068	27.46	1,532
Berkley	5,749	16.49	349
Carver	11,163	37.51	298
Dartmouth	30,666	62.67	489
Dighton	6,175	22.34	276
Fairhaven	16,159	12.39	1,304
Fall River	91,938	31.48	2,921*
Freetown	8,472	36.58	232
Lakeville	9,821	29.83	329
Mansfield	22,414	20.42	1,098
Marion	5,123	14.60	351
Mattapoisett	6,268	16.50	380
Middleborough	19,941	69.36	288
New Bedford	93,768	20.10	4,665
North Attleborough	27,143	18.60	1,459
Norton	18,036	28.64	630
Plainville	7,683	11.04	696
Raynham	11,739	20.45	574
Rehoboth	10,172	46.45	219
Rochester	4,581	33.82	135
Seekonk	13,425	18.27	735
Somerset	18,234	8.09	2,254
Swansea	15,901	23.34	681
Taunton	55,976	46.51	1,204
Wareham	20,335	37.34	545
Westport	14,183	51.55	275
TOTALS	597,294	780.25	765.51
*US Census (2) SRPEDD Fact Book (3) Column ½; * Fall River has large amount of preserved open space in the state forest and Wattupa pond areas – over 30% of its land area- that make the density seem lower than it actually is.*			

The US Census Bureau classifies areas by population density, establishing lines to indicate "urbanized areas". The definition of an urbanized area is:

> "*a densely settled area that has a census population of at least 50,000. An Urbanized Area generally consists of a geographic core of block groups or blocks that have a population density of at least 1,000 people per square mile, and adjacent block groups and blocks with at least 500 people per square mile.*"
> (http://www.census.gov/mso/www/pres_lib/geo_con/sld018.htm)

For the purposes of determining the extent of risk that natural hazards pose in the region, this plan uses the US Census Bureau's mapped urbanized areas to approximate population concentrations. Map H indicates the urbanized areas within this region. Of the total land area in the region, 40.47% is within the urbanized area. This indicates the majority of the land area in the region is low-density rural lands while it is clear from Map H that much of the rural area is located in the interior of the region.

Map H: Urbanized Areas

It is also important to note that several of the SRPEDD coastal communities experience major population swells during the summer months. While there are no reliable figures on this phenomenon, the following communities report major increases during the summer months: Wareham, Westport, Mattapoisett, Marion, and Fairhaven. Using Census figures on seasonal housing units and the community's average household size, estimates on the seasonal populations are calculated in Table 2-5. This seasonal population increase should be considered during mitigation planning particularly in light of the fact that hurricane season overlaps with summer population swells. Many of these communities believe these estimates are low. Both the Census classification of units as seasonal, and the use of the average household size are questioned. Many homes that are year-round, are in fact occupied on a seasonal basis and often vacation rentals have larger parties than the average year-round household. In addition, seasonal influxes would include population at hotels, motels, and bed and breakfast establishments. The number below should be considered a conservative figure.

Table 2-5: Estimated Seasonal Population Increases

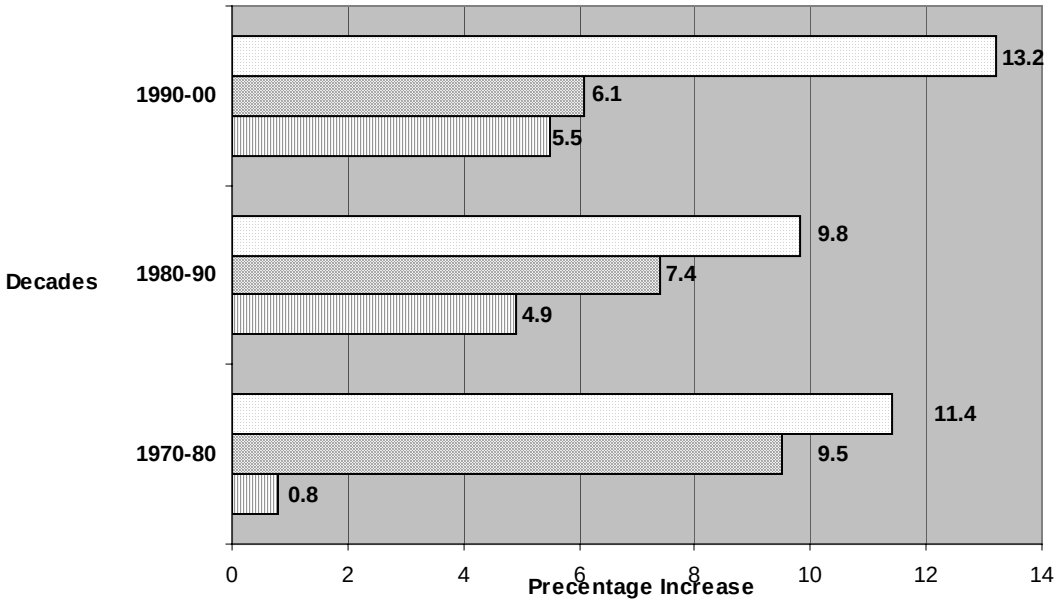
Community	Total Housing Units	Seasonal Housing Units	Average Household Size	Estimated Summer Population Increase	Year Round Population	Summer Increase as Percent of Year round Population
Fairhaven	7,266	413	2.38	983	16,159	6%
Marion	2,439	344	2.51	863	5,123	17%
Mattapoisett	3,172	538	2.46	1,323	6,268	21%
Wareham	10,670	2,020	2.44	4,929	20,335	24%
Westport	6,143	598	2.62	1,567	14,183	11%
TOTAL				9,665	62,068	16%

Source: 2000 US Census – SRPEDD calculations see narrative in this chapter.

C. Population Growth & Vulnerable Populations

The SRPEDD region has experienced steady growth over the past twenty years and has been growing faster than the state. During the period of 1980 – 2000, the total population of the SRPEDD region increased from 524,389 to 597,294, a 13.9 % increase. During the same period, the population statewide increased only 10.7%. Figure One compares the growth of the SRPEDD region with that of the state and the country for the period of 1970 – 2000.

Figure 2-1: Comparison of Population Growth: United States, SRPEDD Region, and Massachusetts 1970 - 2000



	1970-80	1980-90	1990-00
United States	11.4	9.8	13.2
SRPEDD Region	9.5	7.4	6.1
Massachusetts	0.8	4.9	5.5

It is expected that this region will continue to see rapid growth as the transportation network is improved; real estate costs in the greater Boston region remain high; and workers continue to accept commutes of up to one hour. Figure two reflects the growth of the region over the past thirty years, and the anticipated population growth of the next twenty years and Table 2-6 reflects population projections by SRPEDD community as developed for the region's Transportation Plan.

Figure 2-2: SRPEDD Region Population and Projections

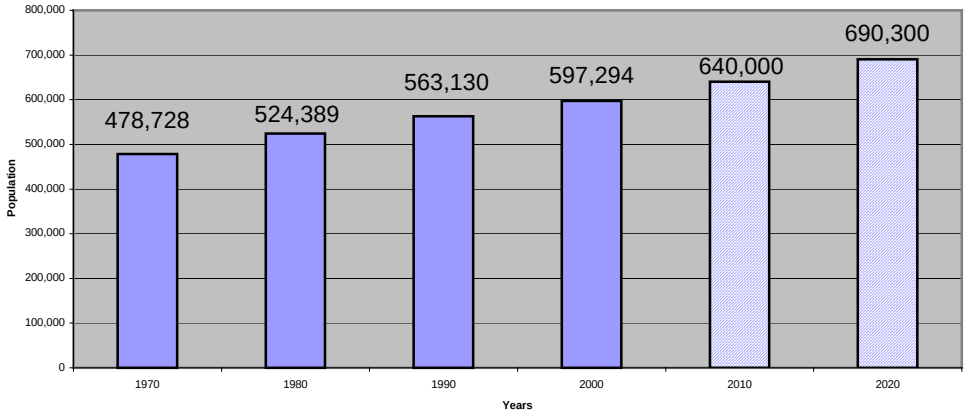


Table 2-6 Population Projections by Community 2000-2025						
	2000	2005	2010	2015	2020	2025
Community	**U.S. Census**	**Projection**	**Projection**	**Projection**	**Projection**	**Projection**
Acushnet	10,161	10,854	11,197	11,780	12,363	13,038
Attleboro	42,068	44,044	45,610	47,650	49,689	52,093
Berkley	5,749	6,670	7,240	8,053	8,866	9,750
Carver	11,163	11,931	12,338	13,078	13,737	14,539
Dartmouth	30,666	32,312	33,590	35,243	36,907	38,838
Dighton	6,175	6,763	6,960	7,422	7,884	8,408
Fairhaven	16,159	16,599	16,657	17,030	17,402	17,899
Fall River	91,938	93,285	94,226	95,739	97,251	99,458
Freetown	8,472	8,962	9,117	9,549	9,980	10,483
Lakeville	9,821	10,792	11,271	12,161	12,850	13,736
Mansfield	22,414	24,454	26,116	28,114	30,112	32,336
Marion	5,123	5,664	5,814	6,193	6,572	7,000
Mattapoisett	6,268	6,672	6,686	6,974	7,261	7,602
Middleborough	19,941	21,222	22,107	23,420	24,583	26,003
New Bedford	93,768	94,408	94,657	95,767	96,727	98,452
N. Attleborough	27,143	28,346	29,174	30,418	31,552	32,973
Norton	18,036	19,558	20,704	21,889	23,074	24,430
Plainville	7,683	8,253	8,423	8,914	9,405	9,966
Raynham	11,739	12,733	13,329	14,251	15,072	16,055
Rehoboth	10,172	11,238	11,911	12,847	13,783	14,823
Rochester	4,581	5,181	5,427	5,964	6,501	7,087
Seekonk	13,425	13,959	14,128	14,565	15,002	15,548
Somerset	18,234	18,678	18,743	19,114	19,484	19,995
Swansea	15,901	16,569	16,906	17,510	18,114	18,849
Taunton	55,976	58,824	61,230	64,316	67,202	70,681
Wareham	20,335	21,035	21,274	21,991	22,597	23,425
Westport	14,183	14,894	15,165	15,748	16,330	17,033
District Total	597,294	623,900	640,000	665,700	690,300	720,500
Overall growth estimate by MassHighway, community distribution based on SRPEDD analysis.						

While the urbanized areas indicate present population concentrations, if growth continues in the pattern of the past twenty years, the new growth will occur outside of the urban core areas. During the past ten years the fastest growing communities in terms of percent increases were the communities of Berkley (+35.7%), Mansfield (+35.3%), Norton (26.4%), and Lakeville (+26.2%). Over the next twenty years it is projected that the communities of Berkley, Rochester and Rehoboth will have the largest percentage increases in population. In addition, the four cities are projected to continue to decline as a percentage of the total regional population (See Table 2-7).

Table 2-7: Population and Projections for Cities Within SRPEDD Region					
Area	***1980***	***1990***	***2000***	***2010****	***2020****
Attleboro	34,196	38,383	42,068	45,610	49,689
Fall River	92,574	92,703	91,938	94,226	97,251
New Bedford	98,478	99,922	93,768	94,657	96,727
Taunton	45,001	49,832	55,976	61,230	67,202
Urban Total	270,249	280,840	283,750	295,723	310,869
SRPEDD Total	524,389	563,130	597,294	640,000	690,300
Urban as % of Total	51.5	49.9	47.5	46.2	45.0
Source: 1980 – 2000 US Census Bureau, 2010-2020 SRPEDD projections.*					

As growth continues in a pattern that disperses residents through out the region, the geographic area that is populated increases and thus, the area vulnerable to natural hazards increases. The traditional urban core areas remain focus areas for mitigation efforts due to the concentration of residents and older housing, but as homes are built in the rural areas, the loss of life and property in these areas becomes more of a concern. It is particularly critical that each of these rural communities identify their high-risk areas and work to direct new development away from these areas.

It is projected that over the next twenty years the proportion (and absolute figure) of the population that is in the vulnerable category of "elderly" will increase. This is consistent with the national projections that see the "baby-boom" generation aging and the population in general, living longer. While in 1980 13.1% (68,781) of the population was 65 or older, this figure was 14.5% (81,845) in 1990, and 14.2% (84,777) in 2000. While this population generally has a higher incidence of special needs for emergency response-- due to health afflictions and mobility restrictions-- overall this population is a healthier and more active group than they were thirty years ago. The federal Administration on Aging notes the following as reasons the elderly are more vulnerable to disasters:

- They have difficulty getting assistance due to progressive physical and mental impairments and other frailties that accompany aging;
- They are slower to fill out forms for disaster notification and/or disaster relief assistance;
- They are often at higher post-disaster nutritional risk and medication risk;
- They are often targeted by fraudulent contractors; and
- They may be susceptible to abuse as overall family stress levels increase in the later stages of a disaster.[4]

Individual communities should respond to the anticipated increase in the elderly population by adopting a method for assessing the particular emergency response needs of this population within their community. For the purposes of regional hazard mitigation planning the elderly population was narrowed to those 75 and older, and mapped by Block Groups of the 2000 US Census.

Other vulnerable populations are youth and the disabled. Youth are vulnerable due to their need for supervision and guidance in times of emergency—especially groups of children under the care of a limited number of adults. This is best assessed at the local level through critical

[4] "Disaster Preparedness for Older Americans", 2002. Business Publishers, Inc.: Silver Spring, MD, p.1.

facilities identification of childcare centers and schools. Projections indicate the number of youth in the region will remain constant.

The 2000 Census represents the first time that data on the disabled was collected. The Census long form allowed self-reporting by the respondent on questions that would indicate disabilities of various types:

- sensory disability,
- physical disability,
- mental disability,
- self-care disability,
- going outside the home disability, and
- employment disability.

For the purposes of this plan, sensory, physical, self-care and going outside the home disabilities are used to narrow the field to a population that would be particularly vulnerable during a natural hazard event. The special circumstances of the disabled population that may affect disaster response include:

- the visually-impaired are reluctant to leave familiar surroundings;
- those with mental retardation or cognitive impairment may not understand or may become confused;
- guide dogs and other assistance animals may become disoriented in a disaster;
- proper transport techniques are required to reassure anyone being carried that they will not be dropped;
- many respiratory illnesses are aggravated by stress;
- medically-dependent individuals may not be able to communicate their needs; and
- all temporary shelters must meet accessibility standards.[5]

Map I indicates the regional location of these vulnerable residents, along with concentrations of elderly, defined as 75 or older.

Map I: Elderly and Disabled

Another group to consider for vulnerability is non-English speaking populations. This is a small group within the SRPEDD region (7.8 % of the total population over age 5), although the four cities have a higher concentration of non-English speakers (12.7 % of the population over age 5). Individual communities should consider these needs with regard to translating materials on preparation and evacuation, and coordinate such activities with local community groups.

[5] Ibid, p.20.

E. Transportation Network

Within the SRPEDD region it is estimated that there are over 90 miles of federal interstate highways and 3,321 miles of arterial, collector, and local roadways. Table 2-8 lists the roadway length for each community. In general, the road network is in fair-good condition with major improvements ongoing throughout the region. Map J indicates the federal and state routes within the region. The road network is a vital part of the region's emergency response so mitigation planning must address the need for adequate maintenance and upgrades of this critical infrastructure. The Transportation Improvement Plan (TIP) completed annually by the Metropolitan Planning Organization (MPO), with the assistance of SRPEDD's transportation staff, lists projects that are necessary to meet the region's expanding transportation needs. These projects include new transportation infrastructure, as well as, improvements or upgrades to existing transportation infrastructure. Two regional transit authorities operate fixed route bus routes within the region, the Greater Attleboro/Taunton Regional Transit Authority (GATRA) and the Southeastern Regional Transit Authority (SRTA).

Table 2-8: Roadway Mileage by Community					
COMMUNITY	***Interstate***	***Arterials***	***Collector***	***Local***	***Total***
ACUSHNET	0	8.13	13.41	42.23	63.77
ATTLEBORO	7.72	33.94	8.05	131.36	181.07
BERKLEY	0	8.71	6.34	44.9	59.95
CARVER	0	4.88	20.96	77	102.84
DARTMOUTH	4.51	27.06	41.03	131.92	204.52
DIGHTON	0	7.39	11.99	43.02	62.4
FAIRHAVEN	3.6	16.62	7.2	76.83	104.25
FALL RIVER	3.15	51.4	25.53	197.33	277.41
FREETOWN	0	11.35	27.06	63.41	101.82
LAKEVILLE	0	10.84	24.58	73.43	108.85
MANSFIELD	5.75	14.97	15.31	87.72	123.75
MARION	2.9	0	9.18	28.31	40.39
MATTAPOISETT	3.55	0	13.2	40.93	57.68
MIDDLEBOROUGH	14.19	26.49	39.84	113.41	193.93
NEW BEDFORD	2.95	72.33	21.19	185.32	281.79
NORTH ATTLEBOROUGH	6.29	18.32	18.4	86.09	129.1
NORTON	4.4	15.79	11.85	73.74	105.78
PLAINVILLE	1.46	11.05	7.85	30.94	51.3
RAYNHAM	4.44	18.04	6.15	53.31	81.94
REHOBOTH	1.41	27.5	19.5	84.39	132.8
ROCHESTER	0.23	0	25.08	42.43	67.74
SEEKONK	2.88	18.36	10.77	73.92	105.93
SOMERSET	2.19	18.67	9.07	67.02	96.95
SWANSEA	5.27	19.81	13.57	80.92	119.57
TAUNTON	2.6	42.54	28.08	149.21	222.43
WAREHAM	7.32	5.75	37.01	129.75	179.83
WESTPORT	3.66	15.3	36.54	98.77	154.27
Total	**90.47**	**505.24**	**508.74**	**2307.61**	**3412.06**

A critical component of the road network is the bridges within the region. There are 481 bridges within the SRPEDD region including 373 bridges under the jurisdiction of the Massachusetts Highway Department (MHD). The remaining 107 bridges are owned and maintained by the communities in which they are located. One bridge in Taunton is owned and maintained by another state agency. On a regular basis, MHD personnel inspect each bridge and compile ratings based on acceptable federal standards. Each bridge is then classified as being within one of the following categories: (1) structurally deficient; (2) functionally obsolete; and (3) meeting standards.

Bridges are classified as structurally deficient if the bridge deck, pavement, or supporting structure fails to meet standards. The Massachusetts Transportation Facts 1998 edition defines a structurally deficient bridge as "one that has experienced deterioration significant enough to potentially reduce its load-carrying capacity." Structurally deficient bridges are frequently regulated by weight restrictions and are sometimes closed due to severely deteriorated components. Weight restrictions or bridge closings severely affect the movement of traffic and

are especially troublesome for buses and trucks. In the SRPEDD region, 55 bridges (11.4%) are rated as structurally deficient.

A functionally obsolete bridge is one that cannot accommodate the amount and type of traffic in use on that particular bridge. Functionally obsolete bridges usually have inadequate width or vertical clearance. In some cases, bridges are classified as functionally obsolete due to changes in adjacent roadway layout, such as road widening or lane additions. In other cases, bridges may be considered functionally obsolete because of changes in engineering standards. There are currently 95 bridges (19.8%) rated as functionally obsolete within the SRPEDD region. Appendix D includes lists of the Structurally Deficient and Functionally Obsolete Bridges in the SRPEDD region.

The region is served by four airports, freight and passenger railways, and commercial ports and passenger ferry service. The four airports are: Mansfield, New Bedford, Plymouth, and Taunton. (Since the Plymouth airport, located right outside the SRPEDD region, also serves the communities within SRPEDD it is included.) Of these, New Bedford is the only one with a FAA operated tower, while light private planes use the other three. Table 2-9 provides a comparison of the airports along basic data.

Table 2-9: Comparison of the Region's Four Airports 2003

	New Bedford	Taunton	Mansfield	Plymouth
Classification Type	General aviation, passenger, air cargo, military	General aviation, air cargo, military	General aviation	General aviation, military
Foreign Trade Zone	Yes	Yes (subzone of N.B.)	No	No
Total Operations (1)	65,106	55,000	69,000	85,000
No. of Runways	2 (paved)	2 (1 paved; 1 gravel)	2 (1paved; 1 turf)	2 (paved)
Runway Width x Length	1) 150' x 4998' 2) 150' x 5000'	75' x 3500' 60' x 1900'	75' x 3500' 100' x 2300'	75' x 4350' 75' x 3450'
No. of Taxiways	6 (each 50' wide)	1 (40' x 3500')	2 (each 30' wide)	
Total Acres	823	256	252	755
Control Tower	Yes (FAA contracted)	No	No	No
Instrument Landing System (ILS)	Yes	No	No	No
Based Aircrafts	100+	105	110	165
No. of Hangars	6	10 (con+ T-hangars)	3	33
Aircraft Parking	67 (leased) 49 (transient)	76	85	116
Auto Parking	645 (public paid parking, seasonal)	135	52	200
Flight School	Yes	Yes	Yes	Yes
Highway Access	Interstate 195 and Routes 6 and 140	Interstate 495 and Routes 24, 44 and 140	Interstates 495 and 95	Interstate 495 and Routes 44 and 3

1.Operations represent takeoffs and landings that are counted individually. Figures are estimates from the Airport Manager.

Both Fall River and New Bedford have commercial port operations and passenger ferry service exists between New Bedford and the islands of Cuttyhunk and Martha's Vineyard. Map J reflects the region's transportation infrastructure.

Map J: Transportation Network.

F. Land Use: Housing, Commerce, Industry, and Agriculture.

The region includes a variety of residential, commercial, industrial and agricultural land uses. As discussed earlier, growth in the region continues to occur outside of the urban areas, with commercial growth generally locating along major transportation corridors. A 1999 analysis of land coverage completed by SRPEDD found that 42.7% of the region's roughly 516,000 acres was urbanized-- that is developed for residential, commercial, industrial, transportation, or other man-made use. An additional 22.1% of the region was wetlands; and 14.6% was permanently protected open space. The remaining 20.6% was undeveloped land or farmland.

Map K: 1999 Land Use

The legacy of the region's Native American and colonial heritage takes the form of archeological sites, structural remains, and a variety of intact structures. These cultural artifacts include such things as shipbuilding sites, native burial grounds, old mill sites, and restored homesteads. Each of these sites is unique and irreplaceable, and some contain additional artifacts. In planning for the protection of life and property the unique value of the region's heritage should also be considered and steps taken to inventory and protect these resources. Map L indicates the regional location of sites that are listed on the State Registry of Historical Places. Local communities may choose to include additional sites that have local but not state level significance.

MAP L: Historic Sites and Historic Buildings

The region has followed national trends of moving from a manufacturing based economy to a service based economy. Transportation improvements planned for the coming twenty years will likely influence the development pattern. The completion of the Route 44 re-location and upgrade from Middleborough to Plymouth will decrease travel times and make Carver and Middleborough more desirable locations for both residential and commercial development, and the extension of commuter rail to Fall River and New Bedford has the potential to accelerate growth in the region.

According to the 2000 Census, 30.4% of the SRPEDD residents over 16 who are employed are in professional or management positions; 26.3% in sales and office; 17.5% in production, transportation and material moving occupations; 15.4% in service occupations; 9.5% in construction, extraction and maintenance occupations; and .4% in farming, fishing, and forestry occupations. Given that the 2000 Census reports that 92.7% of the 284,397 workers travel to work by car, truck or van, and that the average length of trip is 27.6 minutes, peak commute times are periods when the transportation network is particularly vulnerable. This has implications for hazard events, as well as, evacuation planning.

Overall, the housing stock in the region is predominately single family (57.3 %) and 76.2% of the region's 104,975 multi-family housing units are located within urban areas. The age of the housing stock is an important indicator of vulnerability, because housing constructed prior to the 1978 National

Flood Insurance Program (NFIP) that has not been retrofitted, may not meet construction standards for elevation above the base flood level. Within the SRPEDD region, the 2000 US Census reports that 77.8 % of the residential structures were built in 1969 or prior; 64.1% in 1959 or prior; and 33% in 1939 or prior. This is a high percentage of housing that can be classified as Pre-FIRM structures, given the adoption of the program in 1968, and its full implementation at a later date. Within the urban core (four cities) of the SRPEDD region these figures are: 74.2% in 1969 or prior; 65% in 1959 or prior; and 45.7% in 1939 or prior. There are no figures presently available on the number of these structures that have been retrofitted. MEMA and the Massachusetts DCR report that all the SRPEDD communities participate in the NFIP program and there are 5,732 properties (commercial and residential) covered with a total value of $813,263,100. Table 2-10 breaks this down by community.

The NFIP also offers a Community Rating System (CRS) that was implemented in 1990 as a program for recognizing and encouraging community floodplain management activities that exceed the minimum standards. Under the CRS, flood insurance premium rates are adjusted to reflect the reduced flood risk resulting from community activities that meet the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance. There are ten CRS classes: class 1 requires the most credit points and gives the largest premium reduction; class 10 receives no premium reduction. The CRS recognizes 18 creditable activities organized under four categories: Public Information, Mapping and Regulations, Flood Damage Reduction, and Flood Preparedness. Within this region, only Norton participates in the CRS program (it is one of only fourteen Massachusetts communities in the program). The credit rating of 9 makes properties owners eligible for a 5% reduction in flood premiums.

Table 2-10: Flood Insurance Policies in SRPEDD Region As of 12/31/02		
Community	***Policies in Force (#)***	***Property Value Insured ($)***
Acushnet	7	884,900
Attleboro	102	12,918,100
Berkley	50	6,957,800
Carver	3	448,700
Dartmouth	436	68,779,800
Dighton	97	13,132,300
Fairhaven	680	83,007,300
Fall River	38	4,131,700
Freetown	88	11,425,800
Lakeville	28	3,366,400
Mansfield	50	5,940,900
Marion	378	71,028,600
Mattapoisett	669	110,853,000
Middleborough	25	3,154,500
New Bedford	190	42,765,500
North Attleborough	57	8,639,500
Norton	78	10,566,800
Plainville	13	1,818,400
Raynham	9	1,039,500
Rehoboth	10	2,000,000
Rochester	2	348,000
Seekonk	11	3,386,300
Somerset	167	23,471,000
Swansea	376	47,075,200
Taunton	219	27,975,400
Wareham	1671	200,914,000
Westport	278	47,234,700
TOTALS	5732	813,264,100

Also of interest is the number of properties that are repetitive loss structures under the flood insurance program. Table 2-11 indicates by community the total number of structures that have had repetitive loses and the total dollar value paid out.

Table 2-11: SRPEDD Region Repetitive Loss Structures				
Community	**Total Losses Paid Out**	***Total Losses* ($)**	**Total Repetitive Loss Structures (Two or more Claims)**	**Total Repetitive Loss Claims Paid ($)**
Acushnet	1	14,622.31	0	0
Attleboro	23	419,968.30	2	3,362
Berkley	9	14,752.91	1	11,493
Carver	8	24,148.60	0	0
Dartmouth	110	688,416.80	3	104,817
Dighton	57	261,549.95	3	91,056
Fairhaven	388	3,217,817.05	15	506,855
Fall River	15	79,969.47	1	32,555
Freetown	19	73,315.44	1	6,937
Lakeville	8	17,682.16	0	0
Mansfield	5	2,486.03	0	0
Marion	170	2,868,197.20	6	451,728
Mattapoisett	460	6,706,467.48	13	315,127
Middleborough	13	68,834.74	0	0
New Bedford	45	605.847.45	0	0
N. Attleborough	16	16,328.17	0	0
Norton	36	194,995.70	3	21,006
Plainville	1	0	0	0
Raynham	0	0	0	0
Rehoboth	2	5,576.0	0	0
Rochester	0	0	0	0
Seekonk	5	55,042.73	1	53,025
Somerset	38	42,312.44	2	9,715
Swansea	90	361,767.39	3	68,391
Taunton	28	426,638.79	3	305,647
Wareham	802	11,239,856.22	18	733,536
Westport	102	1,073,388.05	3	87,000
Total	2,450	28,480,035.38	78	2,802,250
(Source:National Flood Insurance Program (NFIP) data obtained from DCR's Flood Hazard Management Department.)				

While agriculture is decreasing in the region, there remain active operations in vegetable/truck farming and cranberries. Map M reflects the cranberry bogs within the region, and agricultural lands that are currently under MGL Chapter 61 that permits a reduced local property tax burden for agricultural, forestry, and recreational lands. This totals roughly 70 square miles or 9% of the region. (As noted on the map, the MassGIS layer for Chapter 61 lands is considered incomplete.) As generally undeveloped areas, these uses are pervious coverage that absorbs rainfall and assuming proper agricultural practices, are managed to prevent erosion under major storm events. The cranberry bog operations can play another critical role relative to flooding, as many of these operations include dam and sluice controls. The use of these controls can affect downstream areas. No reliable regional overview is available on the nature and location of these controls.

MAP M: Cranberry Bogs and Chapter 61 Lands

G. Utilities

Basic utilities – those needed for homes, businesses and government operations to run-- include electrical service, gas service, drinking water, and wastewater treatment. Table 2-12 indicates electric and gas service providers within the region, by community. All the communities within the region have electrical and gas service, although in some of the smaller communities gas service may be limited to only a portion of the community. No maps are available for the location of these lines, although major power lines appear on the regional base map for critical facilities.

Table 2-12: Utilities within the SRPEDD Region				
Community	***Electric Provider***	***Gas Provider***	***Water Source***	***Wastewater***
Acushnet	NSTAR	NSTAR	From New Bedford	Partial New Bedford
Attleboro	Massachusetts Electric	Bay State Gas	Municipal Wells;	Partial Attleboro
Berkley	TMLP	Bay State Gas	Private Wells	ISDS
Carver	NSTAR	NSTAR	Private Wells, small portion Middleborough	ISDS
Dartmouth	NSTAR	NSTAR	Municipal Wells, New Bedford	Partial Dartmouth
Dighton	Massachusetts Electric	Bay State Gas	Municipal Wells; Taunton	Taunton/ Partial ISDS
Fairhaven	NSTAR	NSTAR	Municipal Wells; New Bedford	Partial Fairhaven
Fall River	Massachusetts Electric	New England Gas	Surface water- Wattupa Ponds	Fall River
Freetown	NSTAR	NSTAR	Private Wells/Partial Fall River, New Bedford	ISDS
Lakeville	Middleboro Electric	Middleboro Gas	Private wells, Middleborough	ISDS
Mansfield	Mansfield Electric	Bay State Gas	Municipal Wells	Partial Mansfield
Marion	NSTAR	NSTAR	Municipal Wells	Partial Marion
Mattapoisett	NSTAR	NSTAR	Municipal Wells	Partial Fairhaven
Middleborough	Middleborough Electric	Middleborough Gas	Municipal Wells	Partial Middleborough/ISDS
New Bedford	NSTAR	NSTAR	Surface water-Lakeville ponds	New Bedford
North Attleborough	No. Attleborough Electric	New England Gas	Municipal wells	Partial North Attleborough
Norton	Massachusetts Electric	Bay State Gas	Municipal wells	Norton
Plainville	Massachusetts Electric	New England Gas	Municipal wells	Partial North Attleboro
Raynham	TMLP	Bay State Gas	Municipal wells	Partial Taunton/ISDS
Rehoboth	Massachusetts Electric	Bay State Gas	Private wells	ISDS
Rochester	NSTAR	NSTAR	Private wells	ISDS
Seekonk	Massachusetts Electric	Bay State Gas	Reservoir	ISDS
Somerset	Massachusetts Electric	New England Gas	Municipal wells	Somerset
Swansea	Massachusetts Electric	New England Gas	Municipal wells	ISDS
Taunton	TMLP	Bay State Gas	Lakeville Ponds	Taunton/ISDS
Wareham	NSTAR	Cape Cod Gas	Municipal wells/private wells	Wareham/ISDS
Westport	NSTAR/ Massachusetts Electric	New England Gas	Private wells	ISDS
TMLP= Taunton Municipal Lighting Plant ISDS= Individual Septic Disposal Systems.				

Map N indicates the water and wastewater treatment facilities within the region. There are twelve sewer treatment plants in the region that service portions of seventeen communities; an additional six communities have no public water service – that is all homes and businesses rely on private wells and Individual Septic Disposal Systems (ISDS). In some communities water and wastewater is not available to all areas. No maps of the service areas are available at this time.

Map N: Water and Wastewater Systems

While not located with the SRPEDD region, the Pilgrim Nuclear Power plant in Plymouth is significant due to the effects an evacuation related to an incident at the site would have on the region. Taunton is one of three communities (the other two are outside this region – Braintree and Bridgewater) designated as a receiving site for Plymouth residents and the Taunton Emergency Management Agency undergoes regular preparedness training in anticipation of such an event. Carver falls within the 10-mile emergency evacuation zone. The Carver Emergency Management Agency is equipped for directing a town-wide evacuation to Bridgewater.

H. Other Critical Facilities

Seven hospitals and two residential rehab centers are located within the region. Most of these facilities play a regional role – that is provide emergency and long term care for residents of multiple surrounding communities. The regional plan and the individual host community plans need to assess the maintenance of access during and after natural disasters, as well as, facility preparedness.

Table 2-13: Hospitals and Residential Rehab Centers in SRPEDD Region

Host Community	***Facility***	***Beds***
Attleboro	Fuller Memorial	82 – Psychiatric
Attleboro	Sturdy Memorial	178- General
Fall River	Charlton Memorial	324 – General 31- Infant
Fall River	St. Anne's Hospital	182 – General
Middleboro	Cranberry Specialty	68- Adult
New Bedford	Mediplex Rehab	89- General
New Bedford	St. Luke's Hospital	475- General 35 - Infant
Taunton	Morton Hospital	198 – General
Wareham	Tobey Hospital	89 – General 9 - Infant
Source: American Hospital Association Guide to the Health Care Field.		

I. Conclusions

The following general characteristics of the region, drawn from this profile, are relevant to the design of a disaster mitigation strategy:

- Forty percent of the SRPEDD region is urbanized;
- Some of the major population centers are located along the coast;
- Harbors are an important part of the economic infrastructure for both commercial and recreational reasons;
- Over 50% of the region's housing stock pre-dates 1950;

- The historical development pattern of the region, mostly related to the period of industrialization, includes development along the coast and riverfront areas often within the floodway;
- The infrastructure is aging: bridges, roadways, and dams;
- Growth is occurring outside of the urban areas;
- The region is characterized as low lying with many streams, rivers, and bogs;
- The region has a high number of dams many related to the cranberry industry;
- An increase in the amount of impervious surfaces has exacerbated flooding and several urban areas routinely encounter flooding problems including Attleboro, Taunton, New Bedford and Wareham; and
- Due to the geography of the area, several points are susceptible to isolation from a storm event.

Chapter Three: Hazard Identification and Risk Assessment

Southeastern Massachusetts faces a variety of seasonally related natural hazards. This chapter will discuss these hazards and evaluate the risk they pose residents, homes and businesses. Each natural hazard is identified and profiled with information on the hazard's dimensions, history, and risk factors. Risk will be examined in terms of the likelihood of the natural hazard occurring; the geographic area that the natural hazard could affect; and the impacts that could be expected.

The "likelihood" or probability of an event occurring is determined by reviewing historical events and consulting expert opinion, while GIS mapping is used to evaluate the area that could be affected. Information on regional development characteristics from *Chapter Two: Profile of the Region* is used to estimate the impacts of natural hazards on critical facilities, vulnerable populations, and infrastructure.

The Regional Disaster Mitigation Community Planning Team produced an overall Hazard Index (see Table 3-1) that rates the categories of natural hazards in terms of likelihood, location, and magnitude of impacts. Each of these criteria was rated with a point value along a scale as indicated in Table 3-2. The Hazard Index in Table 3-1 is a gross assessment that was used to shape the focus areas of the Mitigation Plan. For this region, however, the results of this exercise indicate that three of the four general hazards are of equal concern, with only geologic hazards – earthquakes and landslides—rating as a low priority area.

The discussion here on Risk Assessment follows the outline of Table 3-1, with a presentation on the types of events that contribute to the risk category and an assessment along the criteria of likelihood, location, and magnitude of impacts. A series of regional maps – *SRPEDD Municipalities Regional Hazard Maps* have been prepared to accompany the narrative. The maps address categories of risks – flood related hazards; wind related hazards; geological related hazards; wildfire related hazards and vulnerable populations. They include:

Hurricane Data: Wind and Flood Related Hazards;
Flood Data: Flood Related Hazards;
Tornado Data: Wind Related Hazards;
Earthquake Data: Geological Related Hazards;
Nor'Easters/Blizzards: Flood and Wind Related Hazards;
Forest Vegetation and Wildfire Data: Fire Related Hazards;
Disabled and Elderly Population;
Critical Facilities in 100-Year Flood Zones;
Evacuation Routes; and
Repetitive Flood Losses.

Maps for this section are provided on an accompanying CD.

A. Flood Related Hazards: Regional Maps Hurricane Data: Wind and Flood Related Hazards*;* Flood Data: Flood Related Hazards; Nor'Easters/Blizzards: Flood and Wind Related Hazards

The state Hazard Mitigation Plan of 1999, records flooding as the number one hazard faced within the state.[6] This is not surprising given that a number of natural hazards can cause flooding including: hurricanes, Nor'easters, thunderstorms, and winter storms. Southeastern Massachusetts is particularly susceptible to flooding, as there are approximately 275 miles of coastline and 1,800 miles of major rivers in the region. The inland area is predominately low-lying, with parts of the river systems artificially channeled. This, in combination with increasing amounts of impervious coverage from sprawl-type development, exacerbates flooding by burdening the river systems with large quantities of fast-moving run-off during heavy precipitation. According to the figures prepared by Mass GIS the urbanization of the SRPEDD region from 1971 to1999 involved the development of 45,938 acres or an increase of 53.2%. A large amount – but not all-- of this development would have been impervious surfaces, including buildings, parking areas, and roadways. Commenting on the severe flooding in Delaware in September of 2003, a spokesperson for the US Geological Survey noted, "there is speculation that urbanization is playing a part"[7] in the flooding and suburban sprawl may be worsening that region's vulnerability to flash flooding. Increasing impervious surfaces may also affect parts of southeastern Massachusetts.

[6] Massachusetts Hazard Mitigation Plan, 1999 Update, p.10.
[7] Montgomery, Jeff. "Sprawl may make flooding worse", The News Journal, September 17, 2003. Available on-line at www.delawareonline.com/newsjopurnal/local/2003/09/17sprawlmaymakefl.html> Accessed on 9/18/2003.

Table 3-1: Hazard Index				
Natural Hazard	**Likelihood/ Frequency**	**Impact Area Assessment**	**Severity/ Magnitude**	**Hazard Index**
FLOOD RELATED HAZARDS ➢ Riverine ➢ Coastal ➢ Erosion ➢ Dam Failures ➢ Thunderstorms ➢ Winter Storms ➢ Coastal Storms/ Nor'easters ➢ Hurricanes	Highly Likely (3)	Medium (2)	Limited (1)	6 Pts.* Rank #1
WIND RELATED HAZARDS ➢ Hurricanes ➢ Coastal Storms/ Nor'easters ➢ Winter Storms ➢ Downspouts ➢ Tornadoes	Highly Likely (3)	Medium (2)	Limited (1)	6 Pts.* Rank #1
FIRE-RELATED HAZARDS ➢ Drought ➢ Wildfires ➢ Urban Fires ➢ Flooding	Highly Likely (3)	Medium (2)	Limited (1)	6 Pts.* Rank #1
GEOLOGIC HAZARDS ➢ Earthquakes ➢ Landslides ➢ Sink Holes ➢ Subsidence	Possible (1)	Small (1)	Limited (1)	3 Pts. Rank #4
				* equally ranked

Table 3-2: Point Values

FREQUENCY/ LIKELIHOOD		
POINT VALUE	**CATEGORY**	**CHARACTERISTICS**
3	Highly Likely	Near 100% Probability in the next year
2	Likely	Between 10 – 100% probability in the next year; or at least one chance in 10 years
1	Possible	Between 1- 10% probability in the next year; or at least one chance in the next 100 years
0	Unlikely	Less than 1% probability in the next 100 years

IMPACT ASSESSMENT		
POINT VALUE	**CATEGORY**	**CHARACTERISTICS**
3	Large	Relative to total land area and concentrations of population/structures and critical facilities
2	Medium	Relative to total land area and concentrations of population/structures and critical facilities
1	Small	Relative to total land area and concentrations of population/structures and critical facilities

MAGNITUDE/SEVERITY		
POINT VALUE	**CATEGORY**	**CHARACTERISTICS**
3	Catastrophic	Multiple Deaths. Complete shutdown of facilities for 30 days or more. Property severely damaged >50%.
2	Critical	Injuries and/or illness result in permanent disability. Complete shutdown of critical facilities for at least two weeks. Property severely damaged <50%, >25%.
1	Limited	Injuries and/or illness do not result in permanent disability. Complete shutdown of critical facilities for more than one week. Property severely damaged <25%, >10%.
0	Negligible	Injuries and/or illnesses are treatable with first aid Minor quality of life loss. Shutdown of critical facilities and services for 24 hours or less. Property severely damaged <10%.

(Source: State of North Carolina Emergency Management Agency)

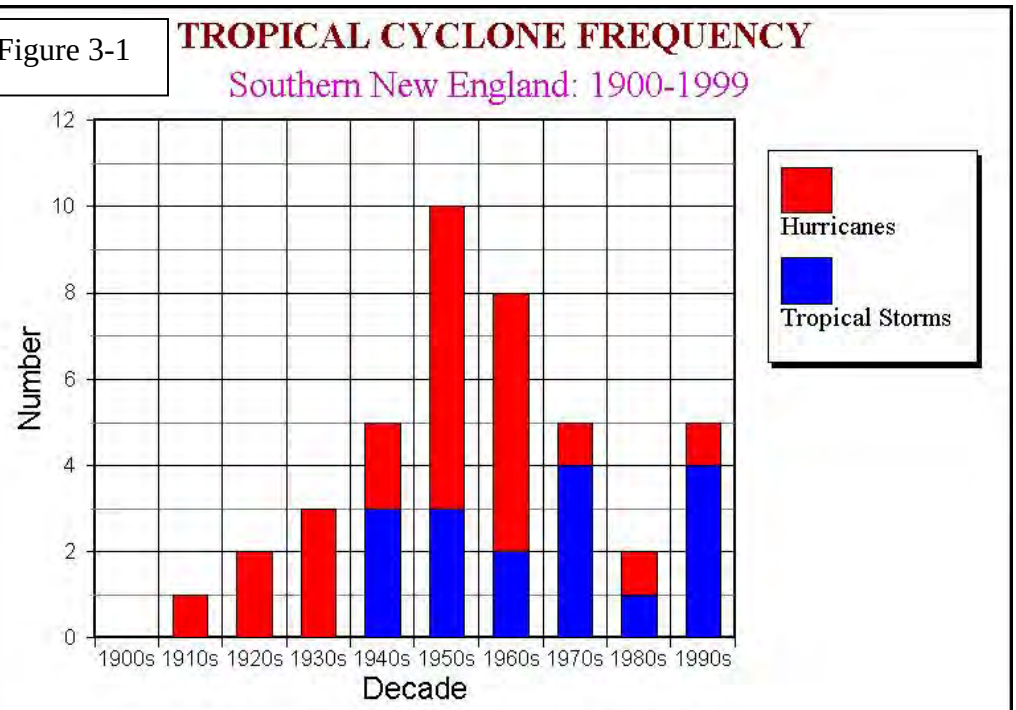
Hurricanes

While New England is not the area of the United States most burdened by hurricanes, the Atlantic coast of the United States can expect to see an average of 2 major hurricanes (Category 3, 4, or 5) every 3 years[8] and New England can expect one major landfall in each decade.[9] This is in part due to the geography of Massachusetts—its projection easterly into the Atlantic places it in the typical path of storms that originate in Cape Verde or the Bahamas. Hurricanes are tropical storms that obtain wind speeds of 74 miles per hour or greater and are accompanied by heavy rainfall. Since hurricanes are formed at sea, storm surge is a concern when hurricanes make landfall. The National Weather Service reports, "southern New England has been affected by forty-one such storms since 1900, 12 of which made landfall with significant impact." [10] Table 3-3 reflects the history of these events. The tracks of storms that made landfall within the region are reflected on the regional map, *Hurricane Data: Wind and Flood Related Hazards*. It should be noted, however, that these historical paths are neither indicators of future behavior nor the full representation of hurricane impacts in the region. The heaviest areas of hurricane damage are on the eastern side of landfall, as the storm moves in a large counter-clockwise spinning spiral. **The most damaging storms have actually made landfall and tracked to the west of this region-** including the major 1938 unnamed hurricane that made landfall in Milford Connecticut and the 1954 Hurricane Carol that made landfall in Old Saybrook, Connecticut. Mapping the paths of hurricanes that made landfall in the region since 1860 shows that eight hurricanes, of varying intensity, crossed the region. The inset tells a more complete story about hurricane damage, by indicating those hurricanes that made landfall as far west of the region as the Rhode Island border. Figures 3-1 and 3-2 indicate the frequency of hurricane events in southern New England during the past hundred years, by year and by month. Clearly, it is "**highly likely**" that southeastern Massachusetts will experience a hurricane.

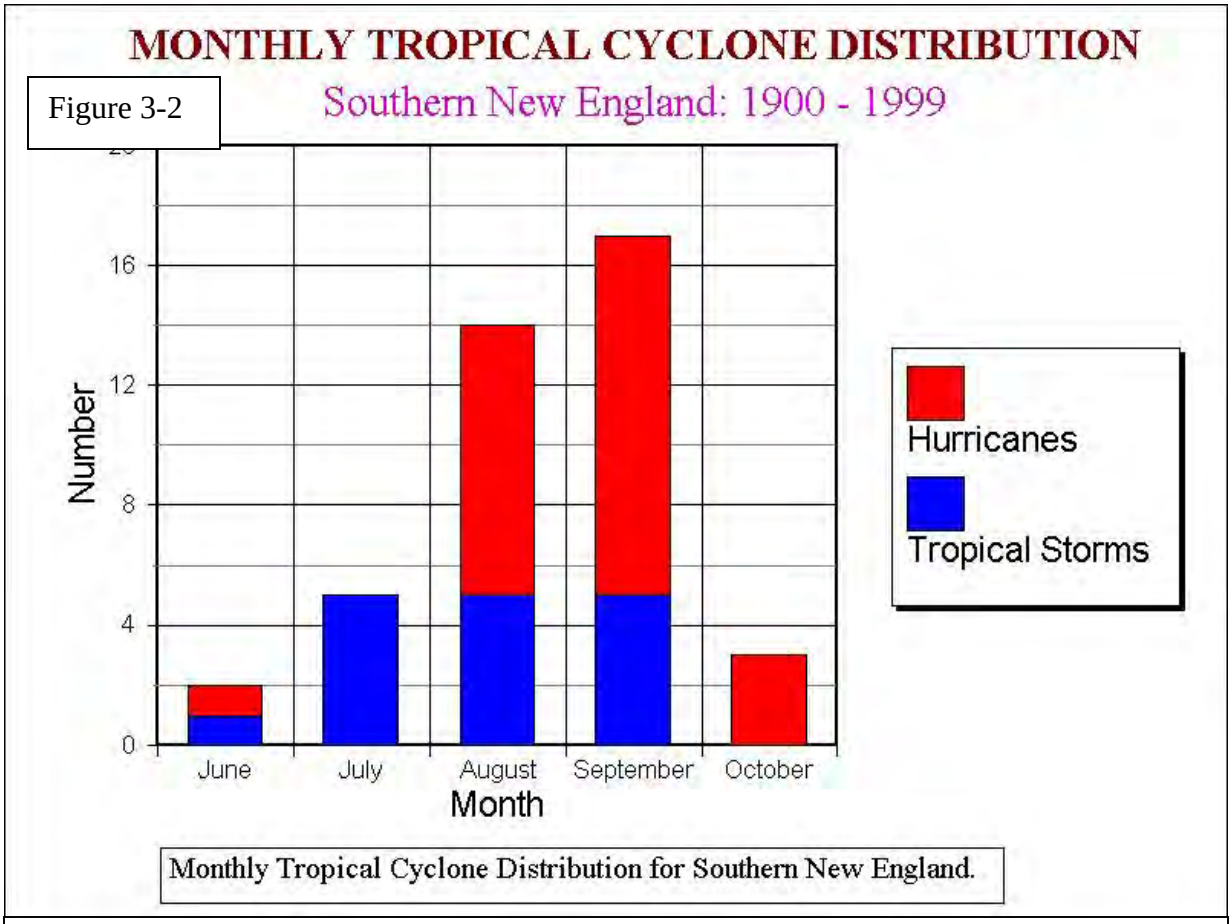
[8] Jarrell, J et al. "The Deadliest, Costliest, and Most Intense United States Hurricanes from 1900 – 2000. NOAA Technical Memorandum NWS TPC-1 Oct 2001. [Available at www.aoml.noaa.gov/hrd/Landsea/deadly/index.html], p. 4.
[9] Vallee, D. "A Centennial Review of Major Land Falling Tropical Cyclones in Southern New England. [Available at: www.erh.noaa.gov/er/box/tropical_cyclones.htm], p.2.
[10] Ibid, p1.

Table 3-3 History of Hurricanes in Southern New England		
Twelve significant tropical cyclones impacted southern New England, 1900-1999. Storm intensity at landfall is given by the Saffir/Simpson scale or TS for tropical storm.		
NAME	**DATE**	**INTENSITY**
Unnamed	7/21/1916	CAT 1
Unnamed	9/21/1938	CAT 3
Unnamed	9/14-15/1944	CAT 3
Carol	8/31/1954	CAT 3
Edna	9/11/1954	CAT 3
Diane	8/18-20/1955	TS
Donna	9/12/1960	CAT 2
Belle	8/9-10/1976	CAT 1
Gloria	9/27/1985	CAT 2
Bob	8/19/1991	CAT 2
Bertha	7/12-13/1996	TS
Floyd	9/18/1999	TS
Source: Vallee, D. "A Centennial Review of Major Land Falling Tropical Cyclones in Southern New England. [Available at: www.erh.noaa.gov/er/box/tropical_cyclones.htm]		

Figure 3-1



Tropical Cyclone Frequency in Southern New England.



Vallee, D. "A Centennial Review of Major Land Falling Tropical Cyclones in Southern New England. [Available at: www.erh.noaa.gov/er/box/tropical_cyclones.htm], p.2.

The Massachusetts Hazard Mitigation Plan of 1999 reports that southeastern Massachusetts is particularly vulnerable to storm surge due to the presence of Buzzards Bay. This document states, "…the configuration of the bay can cause a funneling phenomenon on tidal surges. Ocean waters entering Buzzards Bay become more restricted causing higher flood levels with continued movement into the upper reaches of the bay." [11] Experts at the National Weather Service (NWS) in Taunton, MA support this assessment. NWS Meteorologist David Valle notes that the town of Wareham is "the Miami of the north." The geography of Wareham and the closed bay area make it highly susceptible to hurricane damage as indicated by the SLOSH zones on the regional map *Hurricane Data: Wind and Flood Related Hazards*. SLOSH (Sea and Lake Overland Surge from Hurricanes) is a model that uses topography, tides, and past hurricane behavior to predict what areas would be inundated by hurricane events. The zones are related to the intensity of the storm, according to the Saffir-Simpson scale (see Table 3-4) and the tide at the time of the storm. Under the worst-case scenario of an event,

> ***"Wareham is the Miami of the north."***
> -NWS Meteorologist David Vallee

[11] Massachusetts Hazard Mitigation Plan, 1999 Update, p. 20.

approximately 51.7% of the land area of Wareham and 54.5% of the land area of Marion would be under water. Other communities with large SLOSH zones are Dartmouth, Fairhaven, Mattapoisett, Rehoboth, and Westport. New Bedford's hurricane barrier, built in 1966, protects the densely developed coast of this city from storm surge, but residents would still experience the high winds and heavy rains of a hurricane.

Table 3-4: Saffir-Simpson Scale for Hurricane Classification

Strength	Wind Speed (mph)	Pressure (millibars)	Storm Surge (feet)
Category1	74-95	>980mb	4-5 ft.
Category 2	96-110	965-979mb	6-8 ft.
Category 3	96-113	945-964	9-12 ft.
Category 4	131-155	920-944	13-18 ft.
Category 5	>135	919	18 ft.
Tropical Cyclone Classification			
Tropical Depression		20-34 kt or 23-39 mph	
Tropical Storm		35-64 kt or 40-73 mph	
Hurricane		65+ kt or 74+ mph	

While the coastal communities of southeastern Massachusetts generally take the brunt of hurricanes, flooding and winds also affect the inland areas. The sustained rains of the storm contribute to river flooding, and high winds cause widespread power outages and property damage. An assessment of the hurricane risk in terms of location affected must be categorized as "**medium"**. That is, at least half of the region would be affected by a hurricane. Given the densely developed coast the affected area would incorporate a major portion of the region's population. In addition, the communities of Dartmouth, Fall River, Fairhaven, Marion, Mattapoisett, Somerset, Swansea, and Wareham have the additional concern of boats moored or anchored in local exposed harbors. The hurricane barrier protects some of New Bedford and Fairhaven moorings.

In assessing the magnitude or severity of damage from a hurricane in southeastern Massachusetts, consideration must be given to the timing of the event. Hurricanes that make landfall during high tide will have much greater storm surge and thus flood larger areas. In addition, hurricane season runs from June 1 to November 30, a period that includes the summer population swells experienced by several southeastern Massachusetts communities. As reported in the Profile Chapter, a rough approximation of the summer population increase for the communities of Wareham, Fairhaven, Westport, Marion, and Mattapoisett is 9,665 residents. In assessing the severity of a storm event, it must be considered that the storm is likely to occur during the summer period and thus involve nearly 10,000 additional people. Hurricane Bob (1991) resulted in saltwater contamination of private wells in the Great Neck section of Wareham and the Assonet Bay Shires in Freetown. Following this event the Wareham Fire/Water District and Freetown

> ***"Anything with a name in North Carolina is our worry."***
> -NWS Meteorologist David Vallee

extended water service to these areas.[12] Such impacts are possible in other coastal communities that rely on private wells such as Westport. Finally, the timing of the storm relative to other weather events also has a bearing on the overall impact of the hurricane. If a hurricane follows another hurricane or a major rain event, the effects can be magnified as flooding is greater, and weakened or loosened trees are more susceptible to toppling.

The severity of an event considers the potential for loss of life, property damage, and critical facility or business interruption. **Most experts anticipate that the next major New England hurricane will have severe impacts because present residents are unaware of the serious danger and major property investment has increased the value of structures in the region.** Given that the last major storm event was nearly twelve years ago, there is concern that those who have re-located to the area during this period or come of age during this period, are unaware of the real danger posed by a powerful hurricane. NOAA (National Oceanic and Atmospheric Administration) estimates that 80-90% of the population now living in United States coastal areas has never experienced a major hurricane.[13] This lack of firsthand knowledge can cause lax response to warnings and poor or little preparedness.[14] When residents are slow to respond to warnings the severity of impacts can be expected to be greater.

The new population has come with increased residential construction. As described in the Profile section, the southeastern Massachusetts region has a fair amount of old housing that was not built to today's standards, along with new housing constructed to accommodate the 13.9% population growth of the years 1980 - 2000. Also worth noting is that this period has been a fairly prosperous one with smaller coastal homes being torn down and replaced by large expensive structures. Thus, in terms of dollars amount of damage, it is likely that a major storm will result in a higher amount of property damage than prior events.[15] Given the rating categories within severity of impacts (see Table 3-2), "**limited**" described as "complete shutdown of critical facilities for more than one week, up to 25% property damage, and injuries but no permanent disabilities" appears to fit the severity of damages southeastern Massachusetts could expect.

Nor'easters, Winter Storms, and Thunderstorms

The Massachusetts Hazard Mitigation Plan reports that while hurricanes strike the area with much more force than Nor'easters, the state suffers more damage from Nor'easters because they are a more frequent occurrence.[16] Nor'easters are a common winter event in New England (1-2 each year[17]) and they bring high winds and sustained rains. They are more problematic in part because they have a longer duration – 12 hours to 3 days, versus 6 to12 hours for hurricanes. Many southeastern Massachusetts communities will have flooding associated with the heavy

---

[12] Wareham Open Space and Recreation Plan 1997-2002, p.16; SRPEDD information.
[13] "Hurricanes: Unleashing Nature's Fury", August, 2001, ARC 5030, NOAA/PA 94050, p.8.
[14] Jarrell, J et al. "The Deadliest, Costliest, and Most Intense United States Hurricanes from 1900 – 2000. NOAA Technical Memorandum NWS TPC-1, Oct. 2001, [Available at www.aoml.noaa.gov/hrd/Landsea/deadly/index.html], p. 8.
[15] Pielke, Jr. R.A. and C. W. Landsea 1998 "Normalized Hurricane Damages in the United States: 1925-1995", Weather and Forecasting, 13:621-631. [Available at: www.aoml.naa.gov/hrd/Landsea/Usdmg/index.html].
[16] Massachusetts Hazard Mitigation Plan, 1999, p.11.
[17] Ibid.

precipitation of Nor'easter storms. Problems can be exacerbated when the rains fall and the melting of snow and ice is added to the flow. The large chunks of ice that are freed can clog drainage passages and increase localized flooding. This flooding can affect private residences, businesses, and public infrastructure such as roadways and storm drains.

The regional hazard map, *Nor'Easters/Blizzards: Flood and Wind Related Hazards* indicates snowfall patterns for the southeastern Massachusetts region. Over 52.6 % of the region (predominately the coastal areas) fall within a band of lower average annual snowfall 24.1 to 36 inches per year, with the other 47.4 % recording an average annual snowfall of 36.1 to 48 inches. According to NOAA, the greater Providence area (covering the western section of southeastern Massachusetts) has a 20 % chance each year of having at least 1 snowfall amounting to 12 inches or more, and is likely to experience 9.88 snowstorms each year. The greater Boston area (covering the northern/central area of southeastern Massachusetts) has a 33 % chance each year of having at least 1 snowfall amounting to 12 inches each year and is likely to experience 10.33 snowstorms annually.[18] While melting snow adds to flooding, snowfall also presents a non-flooding hazard as access to critical facilities may be compromised by large amounts of snowfall. Variations on this hazard are a snowstorm in combination with rain that produces a very heavy wet snow or ice storms both of which weigh down trees and power lines. In February of 2004, the American Meteorological Society initiated a rating scale for winter storms. The Category 1-5 scale is intended to be used to assess damage rather than predict impacts. Snowstorms are difficult to predict and small temperature fluctuations determine the difference between snow and rain. The scale presents categories of increasing intensity- notable, significant, major, crippling and extreme storms- based on the amount of snow, area affected, and population impacted.[19]

Table 3-5: Northeast Snowfall Impact Scale

Category	Cat 1 Notable	Cat 2 Significant	Cat 3 Major	Cat 4 Crippling	Cat 5 Extreme
Snow Depth	4-10 inches	10+ inches	10-20 inches	20+ inches	10,20 or 30 inches
Area	Size of RI	Southern New England	1-3 times NY State	Northeast	Northeast
Population Affected	10 million	10-20 million	20-40 million	50 million	60 million

(Source: American Meteorological Society)

Riverine Flooding and Dam Failures

Within the southeastern Massachusetts region, 17% of the land area is within the one hundred year flood plain and an additional 4% is in the five hundred year floodplain. These are areas determined by the Army Corps of Engineers to have a 1% or .2% probability of flooding in any given year. As indicated by the regional map, *Flood Data: Flood Related Hazards,* the floodplain areas are located along riverine corridors throughout the region.

[18] http://www.erh.noaa.gov/box/climate/snow-climate.html
[19] Allen, Diane. "Snow Watchers now rate the effects from 1-5." *The Boston Globe*, March 17, 2004, p.B4.

A very gross, first cut analysis is included with this report, to indicate areas that should receive protection from future development. The Land Use/Flood Zone Analysis map (included on the CD) indicates land area within the 100- year floodplain that as of 2000 was undeveloped, not preserved in perpetuity, and not under the jurisdiction of the Rivers Protection Act. The total land area that meets these criteria is 45.4 square miles. Individual communities should do a closer analysis of these lands to determine if wetlands issues will protect them from development or if they represent a part of a larger lot that would permit development outside of the flood zone. These areas are those considered at risk from development. **In order to decrease future flooding damage and preserve areas to hold floodwaters, local communities should consider the mitigation value of conserving properties within this grouping when setting priorities for acquisitions and conservation restrictions.**

Some local communities have scheduled drainage improvements for areas of repetitive flooding problems within their municipal Capital Improvement Programs (CIPs) and others await state funding. Property owners have learned to cope by equipping their homes with sump pumps and leaving basement areas unfinished. Some local Emergency Management Agencies routinely pump out flooded basements.

> ***"Failures at dams generally don't sneak up on you, they develop over 10–15 years."***
> -Ryan Scott, Massachusetts Bureau of Dam Safety

Within southeastern Massachusetts, a 1998 dam release caused downstream flooding along the Ten Mile River. North Attleborough released waters without properly notifying and coordinating with its downstream neighbor, Attleboro. The release caused localized downstream flooding but also led to better communication and coordination between the two communities. The Massachusetts Bureau of Dam Safety reports that the region's dams, like the other parts of New England infrastructure, are an aging infrastructure that is expensive to repair. Routine maintenance is necessary to control the growth of trees and keep the area clear so defects can be detected. In addition to aging, the region's dams are often doing work beyond their original design. The increase in impervious surfaces leads to increased flows in some streams and rivers and thus greater demands are placed on the dams. In 2003, a dam in a north shore community "overtopped" after heavy precipitation. When this happens the dams can fail quickly as the earthen structures are subject to erosion pressures. The new state requirements for inspections noted in Chapter Two of this plan, should identify problem areas.

The Riverways Program within the Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE), has been studying the larger environmental costs of both operational dams and dam failures. Dam failures may cause loss of life and property downstream, but they may also degrade the environment. Many dams act as a holding area for contaminated sediments. With a dam failure, these sediments are released and can damage wildlife and the ecology of the river system. An associated cost of dam failures is the potential for such destruction to affect fish ladders or culverts for directing water. The Riverways program is looking to develop an assessment tool for evaluating dams for all aspects of safety, including environmental safety.

As reported in *Chapter Two Profile of the Region*, all twenty-seven SRPEDD communities participate in the National Flood Insurance Program. As of the end of the 2002 calendar year, there had been 2,451 claims from the region with $28,480,035 in payments. This represents an average claim of approximately $11,000 for the period 1978 –2002.

In summary, flooding due to a variety of causes (hurricanes, Nor'easters, thunderstorms, winter storms, dam failure) is **highly likely** in southeastern Massachusetts, and would affect a large geographic area and population base thus having an **impact of medium** degree. The **severity** of the impacts on persons, property, and public infrastructure can be expected to be significant but **limited**.

B. Wind Related Hazards: Regional Maps Hurricane Data: Wind and Flood Related Hazards; Tornado Data: Wind Related Hazards; Nor'Easters/Blizzards: Flood and Wind Related Hazards;

A number of the storm events discussed under "Flood Related Hazards", also represent wind hazards to the region. Hurricanes and Nor'easters typically have high winds that can topple trees, knock out power lines, and carry dangerous debris. Consistent with flooding, the occurrence of these storm events can be expected to be "**highly likely**" that is the frequency of 1-2 times each year means that southeastern Massachusetts communities need to be prepared for high wind events. Wind has primary and secondary impacts. That is, property damage may occur as roofs are blown off or power lines blown down, but this is often followed by secondary impacts as the debris from one structure is blown into another structure or vehicle, and downed power lines cause fire or electrocution.

The regional map, *Tornado Data: Wind Related Hazards,* reflects the 100-year wind exposure zones defined by the American Society of Civil Engineers (ASCE) construction standards for the SRPEDD communities. The wind exposure standard is used to determine the construction needed to withstand an average wind gust lasting 3 seconds at 33 feet off the ground. Twenty-one percent of the region is in 110 mph zone; seventy-four percent in the 120 mph zone; and four percent in the 130 mph zone. The highest wind load zone is 150 mph. The ASCE standards are only used for high-rise structures, but the mapped zones indicate wind patterns as determined through readings and modeling. These patterns are consistent with the general regional weather patterns that indicate inland areas have less severe winds than coastal areas.

Occasional contributors to wind hazards are tornadoes. Since 1950, the southeastern Massachusetts region has experienced 15 tornadoes. The regional map, *Tornado Data: Wind Related Hazards,* indicates the location, date, and intensity of these storms. Table 3-6 lists the dates and intensity of the event as determined by the tornado Fujita Scale, which is detailed in Table 3-7. Within this region, tornadoes tend to be more likely in the months of May – September and the hours of 3 – 6PM. The National Weather Service reports that despite technological advances in equipment, the warning window for a tornado is still only about 2 minutes. In addition, this warning is very general, typically covering an area as large as a county.[20] Massachusetts ranks nationally as 35th in occurrences of tornadoes for the period 1950

[20] Interview with Glenn Field, July 2003.

– 1995, but 16th in fatalities and 12th in property damages based on these same events.[21] Massachusetts can expect on average, three tornadoes per year through out the state.[22] Tornadoes and other natural hazards that bring high winds, can affect the entire southeastern Massachusetts region. Thus all populations are vulnerable, but given that 38% of tornado fatalities are in mobile homes[23], mobile home park residents are a more vulnerable group than the general population. The higher fatalities does not reflect the fact that mobile home parks are more likely to be hit by a tornado, but rather that if hit mobile homes are more vulnerable to damage. **Local communities should identify the mobile home parks within their boundaries.**

Table 3-6 Tornadoes 1950 – 1995 Bristol & Plymouth Counties

Bristol County	Date	F-Scale
	June 9, 1953	F3
	September 7, 1958	F0
	August 9, 1968	F1
	August 9, 1968	F1
	August 2, 1970	F1
	August 28, 1970	F2
	September 14, 1972	F0
Plymouth County	**Date**	**F-Scale**
	September 7, 1958	F0
	July 4, 1964	F1
	June 9, 1965	F0
	November 18, 1967	F2
	August 9, 1968	F1
	September 16, 1986	F1
	July 10, 1989	F1
	July 10, 1989	F0

Table 3-7 Fujita Tornado Damage Scale

SCALE	WIND (MPH)	TYPICAL DAMAGE
F0	< 73	Light Damage: Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged
F1	73-112	Moderate Damage: Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable Damage: Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground
F3	158-206	Severe Damage: Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating Damage: Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible Damage: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yds); trees debarked; incredible phenomena will occur.

[21] http://nebraskaweather.unl.edu/severe/USspc_state_tornado_information_alpha_2.htm
[22] http://www.ncdc.noaa.gov/img/climate/severeweather/small/avgt5095.gif
[23] http://nebraskaweather.unl.edu/severe/UStornfacts.htm

In summary, wind damage due to a variety of causes (hurricanes, Nor'easters, winter storms, tornadoes) is **highly likely** in southeastern Massachusetts, and would affect a large geographic area and population base thus having an **impact of medium** degree. The **severity** of the impacts on persons, property, and public infrastructure can be expected to be significant but **limited**.

C. Fire-Related Hazards: Regional Map Forest Vegetation and Wildfire Data: Fire Related Hazards

Wildfires are a natural part of the southeastern Massachusetts ecosystem. Fires keep the forest floor clean of debris, encourage the growth of grasses that serve as wildlife feed, and ensure that trees have plenty of room to grow. Natural fires, recurring in a cyclical manner, can recycle nutrients and create a diversity of natural habitats. In these ways, wildfires that occur in isolated areas can be a positive force. Increasingly, however, development is encroaching into isolated areas and wildfires present a danger to human life and manmade facilities. **Forest fires that were in remote areas are now forest fires in people's backyards.** The dual issues of human suppression of forest fires and human encroachment into forest areas, has increased the risks associated with wildfire. Portions of southeastern Massachusetts are classified as "pine barrens". These are areas where the vegetation is predominately pitch pine with an understory of scrub oak and black huckleberry. Not only is this vegetation highly flammable, the ecosystem of the pine barrens relies on periodic fire to perpetuate the barrens.[24]

The dispersion of growth into rural and undeveloped areas described in the Profile Chapter is consistent with the national phenomenon documented in discussions of the Wildlands/Urban Interface. The Wildlands/Urban Interface is getting attention because as development (particularly low-density residential development) pushes into flammable vegetative areas the threats of wildfires increase. In the southeastern Massachusetts region the Wildlands/Urban Interface is visible in many of the western communities that border the 15,000 acre Myles Standish State Forest, but also in those surrounding the Fall River Bioreserve/Freetown State Forest, and the 1,500 acre Massasoit State Forest. In addition, towns like Rehoboth, Wareham, and Westport all feature low-density development sited within forested landscapes.

[24] Barbour, Henry et al, "Our Irreplaceable Heritage: Protecting Biodiversity in Massachusetts" 1998, p.46-7(NHESP & MA Audubon).

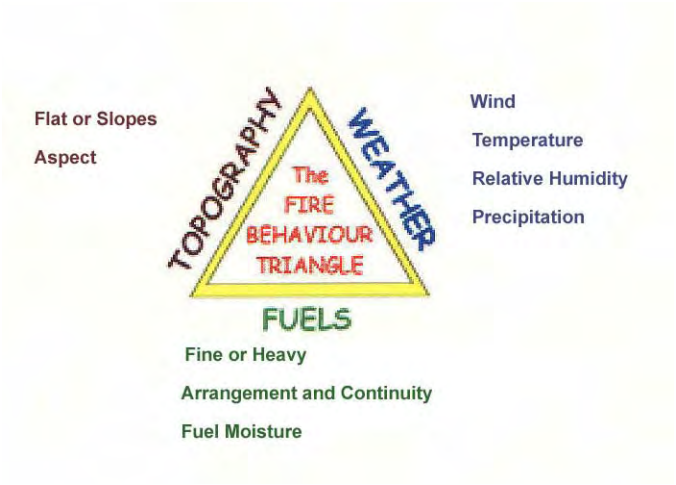
Table 3-8: Vegetative Coverage in Southeastern Massachusetts		
Vegetation Type	**Acres**	**Percent of Total**
Pitch Pine/Scrub Oak	120,332.00	23 %
Northern Hardwood	41,423.49	8 %
Red Maple Dominant	19,191.91	4 %
Oak/Maple Birch	3,908.96	1 %
Open Meadow	7,283.46	1 %
Forested Wetlands	56,101.70	11 %
Mixed Hardwood Pine	42,023.78	8 %
Suburban Forest	92,233.93	18 %
Water Bodies/Beaches/No Vegetation	132,883.69	26 %

The regional map, *Forest Vegetation and Wildfire Data: Fire Related Hazards* indicates vegetative coverage of the region that can be used to assess flammability. Pitch pine/scrub oak vegetation is resiny and waxy, characteristics that make it the most highly flammable vegetation in the region. All of the red areas on the *Forest Vegetation Map*-- a total of 23% of the land area-- is pitch pine/Scrub oak vegetation. Table 3- 8 indicates all of the vegetative categories and the breakdown of the remaining coverage for the southeastern Massachusetts region. The other vegetation covers in Bristol and Plymouth County have an understory of mountain laurel, as well as, a mix of Juniper and Atlantic Cedar. These are also flammable and given the right conditions are quick to burn.

The regional *Forest Vegetation Map* includes major power lines and railroads since both of these corridors are often the starting point for fires. Like state forests, power lines and railroad tracks attract humans who may carelessly start fires, and often trains themselves can spark fires. Also indicated on the map are the locations of the six Fire Towers within the southeastern Massachusetts region (North Attleborough, Acushnet, Rehoboth, Middleborough, Carver, Fall River) operated by the Massachusetts Bureau of Forest Fire Control.

Wildfires are influenced by three major factors: weather, topography, and fuel. The fire triangle illustrates that these three factors can combine in different ways to produce different levels of wildfire threats. Weather, in particular long periods of drought but also lightning strikes and winds, influence the behavior of wildfires. Fire hazard is generally higher in the spring and fall when there are dry and windy conditions. Topography is a factor as steep slopes and gulleys can act as a chimney for fires and the presence or lack of fuel – low shrubs and branches, wood roofs, wood piles, etc – can certainly shape the resulting fire.

Figure 3-3:
Fire Triangle



As detailed in the Profile section, southeastern Massachusetts is a flat area so the generalized topography does not encourage high-speed wildfires. However, at the local level conditions may be such that slopes play a role in directing fires. Given the right combination of temperature, wind, relative humidity, and topography a wildfire can burn at a rate of 30+ acres per minute. Due to the generally flat topography in this region, The Bureau of Fire Control estimates wildfires in the region, under the right combination of factors can burn at 20 acres per minute. The Bureau reports that nearly 98% of fires in Massachusetts are started by human carelessness. Over the past century, progress has been made in controlling fire by focusing response efforts and improving detection. Bureau records indicate that the average fire in 1911 was 34 acres in size, while today the average fire is only 1.17 acres.[25] Table 3-9 outlines a general history of fires in the region. Unfortunately, records on wildfires are not readily available or necessarily complete. Today's technology – GPS, aerial photos—will mean information for the future will be more accurate.

Table 3-9: History of Wildfires in Southeastern Massachusetts

AREA/LOCATION **Myles Standish State Forest: (Plymouth County)** Areas of Plymouth, Wareham and Carver				
YEAR	**1957**	**1963, 1964, 1966**	**1970 – 1977**	**1991, 1995**
SIZE	18,000 acres burned to the ocean	6,600 acres burned	1,750 acres burned	1,350 acres burned
AREA/LOCATION **Town of Lakeville**				
YEAR	1995			
SIZE	300 acres			

[25] Forest Fire Facts available at < http://www.state.ma.us/dem/programs/firecont/facts.htm> [Accessed on January 10, 2004].

AREA/LOCATION Freetown/Fall River Forest				
YEAR	1981	Multiple other events		
SIZE	1000 acres			
AREA/LOCATION **Massasoit State Forest**				
YEAR	1980s			
SIZE	50+			
AREA/LOCATION **Various locations: Attleboro, North Attleborough, Marion, Mattapoisett, Middleborough, Rehoboth, Seekonk, Swansea, Rochester, Westport**				
YEAR	Various times			
SIZE	25 – 200 acres			
Source: Compiled by the MA Bureau of Fire Control.				

The types of injuries that wildfire can cause include: loss of life, loss of property, and environmental damage. Fighting fires relies on having adequate access to the area and sufficient water. **Of the communities indicated as high risk for wildfires, several do not have a public water system.** In these communities, fire fighters rely on water tankers and fire ponds and it can be expected that homes will be lost. Post wildfire there is the potential for increased erosion, hydrophobic soils, and major shifts in habitat, depending on the severity and speed of the burn.

Similar to hurricanes, one of the largest risk factors for wildfires is the complacency of a population that is unfamiliar with the danger. Nearly 50 years have passed since the large Plymouth fire that burned through the pine-barrens to the shore. Today there are many new homes located in this highly flammable vegetation and homeowners are unaware of the risk.

In conclusion, the probability of wildfire in southeastern Massachusetts is "**highly likely**" and the area that could be affected is rated along Table 3-2 as "**medium**". The severity of the impacts that could be expected from wildfire in the region are best categorized as "**limited**", and would include property damage, injuries and disruption of critical facilities.

Drought

Drought is the main factor that determines the intensity of a wildfire season - the less moisture present in trees and vegetation, the more likely they are to ignite and the hotter they will burn. Table 3-10 indicates the amount of time it takes for vegetation to dry after rainfall, to reach its point of flammability.

Table 3-10: Drying Hours to Reach Flammability	
Size of Fuel	**Hours Post Rain to Reach Flammability**
¼" diameter or less	1 hour
¼ – 1" diameter	10 hours
1 - 3" diameter	100 hours
4 – 7" diameter	1,000 hours
8" + diameter	10,000 hours
Source: MA Bureau of Fire Control.	

Within this region, the 1999-2000 drought contributed to a variety of wildfires including a major burn at a wildlife refuge in Seekonk.

Beyond its role as a factor leading to wildfire, drought also has impacts on public safety for all firefighting activity, agricultural production, and economic vitality of large users such as golf courses or industrial processes. According to the 2002 Massachusetts Drought Management Plan, Massachusetts generally has enough precipitation to support the demands residents and businesses place on water. Periods of drought are not unheard of though, with the 1960s and more recently 1999 – 2000 and 2002 being notable times of water stress in the southeastern region.[26] DEP works closely with local water suppliers on preparing for drought situations. Local suppliers are encouraged to develop Drought Plans that include drought indicators and drought triggers. Following the plan may lead to the institution of voluntary or mandatory water use restriction policies. According to the state plan, "Municipal governments are critically important to managing drought situations and assessing the impact of drought situations."[27] Within the SRPEDD region eight communities have either no public water supply or a supply that serves only a portion of the community. In these communities drought may lead to the failure of individual wells and there is a significant financial cost to replace these wells.

D. Geologic Hazards – Regional Map Earthquake Data: Geological Related Hazards

The hazards that are least likely to have impacts on southeastern Massachusetts are geologic hazards such as earthquakes and landslides. The United States Geological Service (USGS) categories the region as one of low risk for earthquakes, although small-scale earthquakes (under 3 on the Richter scale) are common in the region. The Weston MA Observatory of Boston College tracks earthquake activity throughout New England and reports that recent earthquakes in the vicinity of this region include an April 1996 3.5 Mn magnitude in Swansea; a July 11, 2002, 3.0 Mn magnitude in Martha's Vineyard; and a February 23, 2004 2.0 Mn magnitude in Dartmouth.

The regional map, *Earthquake Data: Geological Related Hazards* indicates the recorded earthquakes in the region for the period 19xx-2004 and indicates Peak Ground Acceleration (PGA) zones. The PGA zones are based on modeling data that indicates areas where there is a 10% chance in the next fifty years of an earthquake exceeding the PGA for that zone. PGA is a measurement that compares the shaking of the ground with the force of gravity. While the likelihood of a powerful earthquake in the region is low, the actual risk is high because of how old the buildings are and because few structures have been built to withstand earthquakes. Critical infrastructure such as bridges and dams would be vulnerable. The regional earthquake map also indicates that there is a small portion of southeastern Massachusetts that is moderately susceptible to landslides, but the vast majority of the region is not susceptible. This assessment is consistent with the level topography of the region.

Overall the likelihood of a geological hazard in the region is considered to be **possible** but the type of event would be such that the impacts would be **small** and the severity **limited**.

---

[26] Working Draft: Massachusetts Drought Management Plan, p4, December 21, 2001.
[27] Ibid, p.18.

Table 3-11 Richter Scale	
M= 1-3	Recorded on local seismographs, but generally not felt
M= 3-4	Often felt, no damage
M= 5	Felt widely, slight damage near epicenter
M= 6	Damage to poorly constructed buildings and other structures within 10's km
M= 7	"Major" earthquake, causes serious damage up to ~100 km
M= 8	"Great" earthquake, great destruction, loss of life over several 100 km
M= 9	Rare great earthquake, major damage over a large region over 1000 km

Chapter Four: Existing Disaster Mitigation Measures

Within the SRPEDD region, emergency managers, planners, conservation groups and others working with MEMA, DCR, and CZM have successfully implemented many mitigation measures. These range from beach nourishment projects to dam repairs and a Transfer of Development Rights program that includes a river corridor. This plan builds on the years of work completed by these groups and dedicated individuals. This chapter is an assessment of existing protection measures within the region based on a questionnaire distributed to local communities (See Appendix E). The mitigation activities are reviewed as being part of a group that exists along a continuum of actions that runs between the extremes of highly regulatory (acquisition) to completely voluntary (education and awareness). Figure 4-1 illustrates this continuum.

A. Capital and Structural Improvements

Mitigation may be achieved by constructing new drainage facilities, re-locating structures, purchasing new equipment, or improving emergency access. These capital projects are generally quite expensive and are a challenge for local communities to fund. There are some state and federal resources that can be used to supplement local funding of these projects.

At least eight SRPEDD communities do not complete an annual Capital Improvement Program (CIP) and half of those who complete a plan note that local funding is rarely available for major projects. No doubt, the lack of funding has an effect on the practice of CIP. Enthusiasm dwindles when the effort becomes merely an exercise. Several communities noted that projects with a mitigation component had recently been funded with CIP money – two street reconstruction projects with drainage improvements, dam repairs, and a beach nourishment program.

Besides local funding, federal and state money is available for projects that may include mitigation measures. The use of federal transportation funds is determined through a regional planning process under the control of the Metropolitan Planning Organization (MPO). The MPO produces a prioritized project list known as the Transportation Improvement Plan (TIP) that schedules transportation improvements over a five-year period. The current TIP (2003-2007) for the SRPEDD region includes over thirty (30) projects in line for federal transportation funding. While the primary focus of these projects is improving transportation efficiency and safety, some projects include features that address mitigation concerns such as drainage improvements to alleviate flooding, bridge upgrading to support emergency vehicles, or capacity expansion that could support evacuation needs.

An additional source of funds has been grants for dam improvements through the Bureau of Dam Control and Hazard Mitigation Grant funding. Very few SRPEDD communities have participated in these programs. One or two have received grants for dam repairs including a $85,000 grant in 2004 to Rehoboth for repairs to the Village Dam and Perryville Dam. Only one community in the region has received Hazard Mitigation Grant funds and that is New Bedford for drainage improvements. These programs have been very competitive and given the tight federal and state fiscal conditions for 2004, it appears the need will continue to be much greater than funds. **Another obstacle for communities interested in the HMGP funds has been the**

matching requirement. The 25% match is often more than local budgets can spare. With the new PDM fund also available communities have additional opportunities for matching funds for mitigation projects.

SRPEDD communities have not been very proactive in addressing repetitive loss structures—NFIP insured properties that have made two or more claims. This makes sense for most communities since they have few properties in this category. Three communities, however, represent a full 59% of all repetitive loss properties in the region– Fairhaven (15), Mattapoisett (13), and Wareham (18). A response by these communities would be appropriate.

With regard to forest fires, the Massachusetts Bureau of Forest Fire Control has a limited budget for establishing fire-breaks, constructing water holes, and conducting fuel suppression work. The Bureau also works to meet the equipment needs of small rural communities through the Federal Excess Property Program and the USDA's Rural Community Fire Protection program.

B. Regulations, Bylaws, and Codes

Bylaws, ordinances, codes, and regulations that regulate development can promote disaster mitigation. The most established of these is, of course, flood plain zoning. The federal government played a major role in this area by mapping flood plains and establishing a flood insurance program. The advantages of participating in the NFIP acted as an incentive for local communities to adopt the regulations required by the federal government. Other regulations could be used to support disaster mitigation including provisions that address soil erosion problems, drainage design, and limits to impervious coverage.

Of the twenty-seven communities in the region, Carver is unique in not having Flood Plain Zoning, although Berkley has this provision as a general bylaw rather than a zoning bylaw. **As a result of this process Carver will consider a floodplain zoning bylaw at a 2005 Town Meeting.** At least three of the communities cite instances of variances to the bylaw standards. Some comments indicate training in this area could be useful. Building Inspectors are the ones making determinations about the 50% rule and the floor elevation requirements, and these individuals are often part-time and overworked.

About half of the communities have stormwater treatment bylaws, although several mentioned that they will be updating these standards in order to meet the new EPA Phase II regulations. All twenty-seven SRPEDD communities have an area classified by the US Census Bureau as "urbanized" that is included in the EPA regulations, although in several communities (Carver, Rehoboth, Freetown) it is a very small area. This work can become the basis of improved understanding of stormwater problem areas and capacity issues. Stormwater capacity varies within subdivision regulations of the region's communities. Most size detention/ retention areas for a 100-year storm and pipes and culverts for a 25-year storm. There are a few exceptions such as Acushnet's 5-year storm and Dighton's 15-year storm for connections into the stormwater system of these communities. Fairhaven has a provision that requires a full twenty-year maintenance surety on drainage facilities- a provision that provides the community with funds to repair a faulty system.

Fifteen (15) communities report having zoning bylaws that address additional concerns about development in sensitive areas or specific requirements about flooding and erosion control such as Site Plan Review standards and Aquifer Protection districts. All except one have a general bylaw to regulate gravel operations that includes standards to address the concerns associated with such operations such as erosion, sedimentation, and restoration. Eleven (11) of the responding communities have a local wetlands bylaw with provisions that go beyond those of Chapter 131, and thus presumably address wetlands preservation and infiltration issues with local conditions in mind.

Cluster or Conservation Subdivision regulations can support mitigation by reducing impervious coverage and by clustering homes away from wetlands or floodplain areas. Within the SRPEDD region eighteen (18) of the twenty-seven (27) communities have such provisions. Another regulation that is helpful to preserving wetlands, and thus reducing flooding, is an upland requirement for each lot. For instance, a community with a 1½ acre lot requirement, would require that a certain portion of that lot be composed of uplands. The net effect of such provisions is less intrusion into and conversion of wetlands, as property owners have sufficient uplands for normal residential activities such as gardening, play areas, and open lawns. Raynham and Carver are the only communities within the region with an adopted Transfer of Development Rights (TDR) bylaw. TDR involves transferring development from an inappropriate site for development (such as river corridor or floodplain area, or coastal area) known as the sending area to an appropriate area for development known as the receiving area. In Raynham the sending area is not mapped, but the bylaw specifies that only residentially zoned land that the Planning Board determines has "visual prominence, potential vista impairment, ecological significance, fragility, special importance as farmland, value for recreation, future Town water supply, or because of its importance to the Town's Open Space Plan and/or Master Plan" is eligible for the transfer. The Town has received an application for land along the Taunton River that provides flood capacity. The development capacity for this property was under dispute so the application has not gone forward. The Carver provision is new in 2004, with the village areas as receiving areas and sending areas defined by environmental sensitivity. Many communities are interested in TDR bylaws but lack the staff capacity to tackle this complex development tool. Such an initiative requires a major education campaign and the overall effectiveness depends on the ability to match sending and receiving parcels in a timely manner.

C. Operations, Administration and Enforcement

Beyond the bylaws and regulations, daily enforcement and operations can be part of an effective disaster mitigation plan. Two concerns, which generally fall under the public works department, are the maintenance of drainage facilities and the trimming of trees within the street right-of-way. If drainage swales are filled with grass clippings or cluttered with fallen branches, they can stop working effectively and exacerbate flooding problems. Most communities find keeping these areas clear is a time-consuming job. The typical level of maintenance is an annual clearing. This is an area where private homeowners, if properly trained, can be helpful in terms of calling when they see a problem and monitoring activity to ensure that no improper dumping is occurring. Almost all of the communities (15 out of 17 responding) reported that the Department of Public Works or Tree Warden responds to specific requests for limb trimming and attempts an annual sweep within the town. Many noted that this work is not funded adequately.

Trimming dead limbs and limbs near power lines, can prevent the blocking of streets, injuries, and power outages. Several utility providers also conduct annual trimming along their lines.

Another area of disaster mitigation has to do with internal coordination and disaster warning systems. While all communities believed they had adequate disaster coordination between municipal departments, comments suggested some could benefit from upgraded radio equipment. Some communities noted that the days of an audible warning system are over, and the present system relies on cable TV supported with bullhorns, when needed. It was noted that it is expensive to keep audible warning systems maintained especially systems that are forty years old or more.

Two questions were asked about municipal buildings – one on the presence of animal shelters and the other on safety audits for all municipal buildings. Of the thirteen communities reporting, eight have an animal shelter, and all report it is located outside of disaster prone areas. The other five do not have a shelter within the community. When asked about safety audits, few communities considered the evaluations done to date to be complete in this manner. While public buildings generally have fire code evaluations, few have a complete audit that also considers disaster mitigation issues. One community mentioned that they had worked with the local insurance group to complete a review.

D. Special Programs – Incentives and Voluntary

The State library Commission is working cooperatively with the New England Document Conservation Center to develop an on-line planning template for conservation planning. This program is aimed at libraries, historical societies, and museums that store sensitive materials. Once completed, the conservation plan template will take each organization through a set of instructions for determining if their holdings are at risk and what actions they might pursue. According to the State Library Commission, four libraries suffered from flood losses during the winter of 2003-4. These were floods related to plumbing and heating equipment failures, but the potential for damage from natural floods exists. The State Library Commission is also holding training on developing a conservation plan. Local communities are encouraged to communicate with their libraries, museums, and historical societies in order to facilitate such planning. For the four (4) communities in the region that have passed the Community Preservation Act (Acushnet, Dartmouth, Wareham, and Westport) local funding may be available for improvements under the historical provision of the locally controlled CPA fund.

Recent news articles have highlighted how private insurers are deciding to not insure properties in high risks areas of southeastern Massachusetts.[28] This is noted as a trend that is being spurred by recent catastrophic losses and new computer models that indicate that extensive damage is possible. This action may be what is needed to encourage the involvement of local communities in preventative measures for properties. Some of the properties along the coast are publicly owned so municipalities may find themselves facing the problem of affordable and adequate property insurance.

[28] "Fearful insures cancel policies" Standard Times, March 7, 2004. Available atwww.s-t.com/daily/03-04/03-0704/a011o328.htm. Accessed on March 8, 2004. "Cape residents face harsh reality" Boston Globe, February 27, 2004, p.D1.

E. Plans

Twenty (of 25 reporting) communities have current Open Space Plans. Only a handful of communities reported that their Open Space Plan includes references to disaster mitigation, predominately the issue of flooding prevention. Due to the direct connection between funding and Open Space Planning, however, most communities keep these plans up-to-date. There are opportunities for integrating mitigation into the regular updating process. One noted that their Master Plan addressed mitigation measures, but it is worth noting that several do not have a Master Plan and others have plans that are over 10 years old. Integrating disaster mitigation into land use planning is a new idea that is just now coming to be accepted and expected. Master Plans are updated much more infrequently so it will take longer to get mitigation as part of these local Master Plans. As mentioned in Chapter Three, water suppliers must complete a Drought Management Plan as part of the Water Management permitting process, so these plans are in place for the region.

F. Educational Activities

Few communities (4) report being able to afford training for staff and volunteers. The same number have been active in doing educational activities such as speaking to school and civic groups, writing columns for local papers, or sponsoring workshops through the library. Some emergency management managers report that in the past 5-10 years there has been a dramatic decline in participation. The number of volunteers has declined and interest in public programming is low. Some programs have been dropped due to this lack of interest. This is not universally true, as during this planning period Taunton ran a nine-week training session for emergency volunteers and had over thirty people attend.

Conclusion

SRPEDD communities could be doing more in almost all of these mitigation areas. This summary highlights the need to identify more capital projects and match them with federal funding opportunities; add local capacity for maintenance activities; develop some new creative educational programs; fund training; and promote mitigation thinking in planning documents.

Category of Protection Measure	*Description*	*Area Covered*	*Effectiveness and/or Enforcement*	*Improvements or Changes Needed*
Capital Improvement Planning/ Structural Improvements	Capital Improvement Planning – at least 8 communities indicate they do not complete CIPs on an annual basis.	Region	Funding on as possible basis – many local budgets do not have funds for capital items. This leads to discouragement among Department Heads who repeatedly submit items.	Ideal would be for all communities to complete this process.
	Dredging	Harbor areas; critical channels Westport has completely recently.	Dredging generally good for 5- 10 years depending on storm events. Very expensive to complete and permitting is a major obstacle.	Dredging as a routine and regional maintenance item needs to be explored.
	Dune restoration	Barrier Beach areas within region. (Swansea has completed in last five years.)	Serves to mitigate impacts of storm events.	More funds needed – Waterways Dept. of DCR tries to connect sand needs with dredging operations.
	TIP projects	Region	Several bridge projects underway, some roadway projects include upgrades to stormwater treatment.	Additional funding required to complete waiting projects.
	Roadway Improvements	Region	Local drainage improvements for several areas identified in local plans.	Funding constraints.

Category of Protection Measure	*Description*	*Area Covered*	*Effectiveness and/or Enforcement*	*Improvements or Changes Needed*
Regulations/ Bylaws/Codes	Floodplain Zoning	NFIP defined areas	Carver does not have Floodplain zoning. Other communities have in place, with generally effective enforcement.	Adoption in Carver. Continue training (by DCR) for building inspectors.
	EPA Phase II Stormwater Treatment	Census urbanized areas	A variety of projects that deal with water quality but also mitigate flooding.	Ongoing as funding allows.
	Upland requirements for residential lots.	Seven(7) communities within the region have this provision.	Each residential lot must have adequate upland area – this protects floodplain areas by giving the resident enough useable land area for building and landscaping, i.e. prevents encroachment in floodplain/wetland areas.	More communities should adopt.
	Subdivision Regulations- underground utilities required	Almost all communities have for new subdivisions (with exception of the cities)	Generally Enforced.	None

	Description	*Area Covered*	*Effectiveness and/or Enforcement*	*Improvements or Changes Needed*
Regulations/ Bylaws/Codes (cont.)	Cluster or Conservation Subdivisions	Nine (9) communities in the region.	Clustering of new homes allows for design flexibility to buffer floodplain areas.	Encourage by-right cluster to get more private developers using this development form.
	Soil Conservation Regulations- regulations that could impact sedimentation build up in waterways as a result of run-off from sand and gravel operations.	All but one.	Generally sufficient.	Enforcement could be improved.
Operations, Administration, and Enforcement	Tree Maintenance	Within public street ROW - region wide.	As funding permits Highway Departments or Tree Wardens complete and the power company utilizes subcontractors to complete work on a regular basis.	More funds
	Inter-department Emergency Coordination through Local Emergency Planning Committee	All communities.	Acceptable.	Strengthen through Homeland Security addition.
	Disaster Warning System	All communities	Acceptable.	Share approaches.
	Radio Communication	Town-wide	Interoperability achieved for Police/Fire/Highway	Could use additional portable radios for volunteers in times of disaster.

Operations, Administration, and Enforcement	***Description***	***Area Covered***	***Effectiveness and/or Enforcement***	***Improvements or Changes Needed***
	Maintenance of Drainage Facilities	Region wide	On an as needed basis, routine annual program followed as permitted generally by the Highway Department.	None
Planning	Comprehensive Plan	Only a few mention disaster mitigation	Part of consideration for purchases; CPA funds provides $ for land acquisition on annual basis.	Try to introduce mitigation planning into this process.
	Open Space Plan	Only a few mention disaster mitigation	Includes objectives and actions relative to purchasing land in velocity zones and protecting beach areas and restoring dunes.	Try to introduce mitigation planning into this process.
Education & Training	Training	Most do a limited amount.	Low participation.	Get creative on ways to integrate this training into other programs.
	Speaker Programs	To special interest groups as requested.	Adequate	Could do more.
	Written Materials and Pamphlets.	Region wide	Adequate but could do a new initiative.	Try to widen distribution – consider mailing with tax bill or utility bill.

Figure 4-1
Continuum of Mitigation Actions

Reduce the loss of life, property, infrastructure, and cultural resources from natural disasters.

VOLUNTARY						REGULATORY		
Community Awareness	**Education& Training**	**Planning**	**Fiscal Incentives**	**Regulations & Enforcement**	**Public Improvements**	**Easements**	**Advance Acquisition**	**Acquisition**
*Signs e.g. marking past flood elevations	*Free Home Inspections *Business Audits & Public Building Evaluations	*Integration into Comprehensive Plan	*Tax Abatements for Improvements	*Zoning – Overlay, density, TDR, Incentives, Upland Requirements, Cluster Subdivisions.	*Bonding	*PDR, APR, Conservation Restrictions	*Land Bank – Prioritize purchase of vulnerable property	*Buy Out Most vulnerable
*Exhibits highlighting past events and preparedness	*Target Vulnerable Populations with training – e.g. elderly, young, disabled, mobile home parks	*Capital Improvements Plan (CIP)	*Low Interest Loans	*Subdivision Regulations	*Grant Assistance			
*Informational Presentations	*Work with Conservation Commission	*CEM Plan		*Building Code				
*Billboards		*Create Coalitions around similar goals		*General Police Powers				

Chapter Five: Goals & Objectives

The Community Planning Team adopted the following statement that lists objectives all identified as ways to reach the stated goal of the plan: Reduce the loss of life, property, infrastructure, and cultural resources from natural disasters. This listing reflects objectives the CPT believed were appropriate and achievable within the SRPEDD region.

Project Prioritization

The CPT recognizes that a comprehensive approach to mitigation is required, and the action that is most critical in one community, is not necessarily the same in another. The mitigation actions have been categorized by type and not prioritized against each other. Education is as critical as structural improvements, so rather than set a regional priority list the CPT has put forth a comprehensive listing that will be pursued simultaneously as the appropriate resources become available. The actions are diverse, and thus may not be competing for the same types of funds. In addition, some of the actions do not even require funds but rely on integration into existing procedures. The CPT expects the region to implement the actions as appropriate resources become available moving forward in all six identified realms: Capital Improvements; Regulations and Bylaws; Administration and Enforcement; Special Programs, Planning, and Educational Activities. The CPT would expect Capital Projects to be prioritized based on the Benefit/Cost Analysis (BCA) that is part of the application procedure. Local plans will follow this same philosophy, pursuing all realms simultaneously, and prioritizing projects by the BCA score but pursuing projects in accordance with resource availability. That is, a project may have a higher BCA score but the community may not yet have identified a source for the local match, so a project with a lower BCA score, but with identified matching funds, may be pursued first.

Regional and Local Plan Monitoring and Maintenance

The SRPEDD Commission has accepted the role as monitor for the plan's implementation. This will be accomplished through a review at the annual anniversary of the plan's acceptance-September. Prior to the Commission's September meeting staff will survey the twenty-seven local communities to determine what projects have gotten done, what disasters have affected the communities, and what new concerns or changed conditions should be reported. This survey will serve as a means of evaluating conditions, creating a feedback loop, and identifying new directions for future planning efforts. At the regular September meeting of the SRPEDD Commission staff will give a report on the results of the survey. Significant findings from this survey will be posted on the website or printed in the newsletter and widely distributed. This September meeting will serve as an additional forum for regional and public comment. At the local level the plan coordinator (in some cases the planner in others the Emergency Management Director) will be responsible for monitoring plan implementation. The SRPEDD survey will serve as an impetus for the local contact to undertake this work.

When the five-year renewal period occurs, the Commission will convene a CPT similar to the one that produced this plan, by requesting appointments from each member community and reaching out to non-profit groups and utilities. This renewal period will also be a time to better coordinate these efforts with Homeland Security, as the current Natural Hazards Plan was

completed prior to the establishment of regional Homeland Security efforts. The newly constituted CPT will determine the scale of the five-year review in large part through the annual survey data. This review will be completed through open public meetings. It is important to note that the availability of resources may impact this work. SRPEDD does not have funding for staff time to complete a major overhaul of this plan. If the CPT determines such an effort is necessary than funding sources, such as PDM, will have to be pursued. It is possible that a very limited update effort might be able to be completed within the agency's ongoing work. The revised plan will be made available for comment (website, mailings referencing where to read the plan) and voted on after a presentation at a public meeting of the SRPEDD Commission.

NATURAL HAZARD DISASTER MITIGATION PLAN

GOAL: Reduce the loss of life, property, infrastructure, and cultural resources from natural disasters.

Capital/Structural

Objective One: Identify and prioritize capital/structural mitigation projects that are cost-effective and technically feasible as they are submitted in local Annexes (drainage, dams, seawalls, beach nourishment).

Objective Two: Increase the number of local communities that utilize Hazard Mitigation Grant or Pre-Disaster Mitigation Grant funds.

Administration/Enforcement/Coordination

Objective Three: Identify implementing body and pursue funding that builds local capacity and supports grant-writing for mitigation actions identified in the regional and local PDM plans.

Objective Four: Increase communication/coordination between federal, state, regional, county, municipal, private, and non-profit agencies in the area of pre-disaster mitigation. In particular, coordinate planning around prisons, colleges, and large employers.

Objective Five: Maintain and enhance working relationships with the utilities including the annual meetings with emergency personnel, and satellite spaces within each community for temporary emergency headquarters.

Objective Six: Improve hazard warning systems and notification to vulnerable populations.

Education

Objective Seven: Combat complacency and foster appropriate individual responsibility for mitigating disaster impacts by educating all parts of the community including: school children, elderly, employers, school administrators, and municipal employees.

Objective Eight: Promote use of full range of federal and state resources related to disaster mitigation such as educational materials, training, and National Weather Service forecasts.

Objective Nine: Develop a means for sharing information on a regional basis about successful disaster mitigation planning and programs & create a feedback loop to improve pre-disaster planning by establishing a formal post-disaster assessment that asks what could have been done better?

Planning

Objective Ten: Find funding to review and update the regional and local disaster mitigation plans on a five-year cycle.

Objective Eleven: Incorporate disaster mitigation actions into appropriate local and regional plans – Master Plans, land use, transportation, open space, and capital programming.

Objective Twelve: Integrate disaster mitigation concerns into transportation projects (e.g. drainage improvements, underground utilities, etc.).

Objective Thirteen: Increase the number of local communities that undertake annual Capital Improvement Programs.

Objective Fourteen: Identify PDM actions that are consistent with the objectives of other interest groups, and reach out to collaborate on achieving these initiatives. (For example conservation or environmental groups that support wetlands protection, river corridor acquisition, or reducing runoff.)

Objective Fifteen: Improve the information available on at-risk properties and repetitive loss structures, in order to refine strategies.

Objective Sixteen: Work with SRPEDD's Transportation Department on computer modeling for evacuation planning & re-routing post-disaster.

Regulatory

Objective Seventeen: Encourage the adoption of underground utility requirements in local subdivision regulations and floodplain zoning for Carver.

Objective Eighteen: Incorporate disaster mitigation concerns into the MEPA review process.

Objective Nineteen: Integrate disaster mitigation concerns into subdivision, site plan review, 40B reviews, and other zoning reviews. In particular require the consideration of downstream flooding impacts caused by new projects—even if the impacts cross town lines—and urban/wildland interface concerns in high-risk areas. Work on model bylaw language for urban/wildland interface and model parking standards to reduce the amount of impervious coverage.

Emergency Response Preparedness

Objective Twenty: Ensure that each community has a Unified Incident Command program in place, with special attention to communities that have federal, state, or county facilities within their borders.

OBJECTIVE ONE: ***Identify and prioritize capital/structural mitigation projects that are cost-effective and technically feasible.***			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Compile list from local annexes.	SRPEDD/CPT	Post Nov 2004	Local annexes.
Work with MEMA on Cost: Benefit analysis of submittals.	SRPEDD/CPT	2005	Needs funding for training.
OBJECTIVE TWO: ***Increase the number of local communities that utilize Hazard Mitigation Grant or Pre-Disaster Mitigation Grant funds.***			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Ask for DCR/MEMA training within the region.	DCR/MEMA	Schedule as necessary	
Advertise successful projects through DCR/MEMA newsletter, SRPEDD website and SRPEDD newsletter.	DCR/MEMA/SRPEDD	Ongoing	SRPEDD needs notification of awards.
OBJECTIVE THREE: ***Identify implementing body and pursue funding that builds local capacity and supports grant-writing for the mitigation actions identified in the regional and local PDM plans.***			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Appoint SRPEDD Commission as body to implement actions in the regional plan.	SRPEDD	Ongoing	Funding as needed for some actions or for staff assistance time.
Consider use of SRPEDD municipal assistance hours for assistance	Local Communities	Ongoing	Part of annual budget – 40 hours total per community per year.
OBJECTIVE FOUR: Increase communication/coordination between federal, state, regional, county, municipal, private, and non-profit agencies in the area of pre-disaster mitigation. In particular, coordinate planning around prisons, colleges, and large employers.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Develop or use existing town websites.	Local Communities	Ongoing	May need funding or use student labor.

OBJECTIVE FIVE: ***Maintain and enhance working relationships with the utilities including the annual meetings with emergency personnel, and satellite spaces within each community for temporary emergency headquarters.***			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
This exists – local communities need to maintain this relationship.	Local Communities	Ongoing	No funds needed, space exists.
OBJECTIVE SIX: ***Improve hazard warning systems and notification to vulnerable populations.***			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Coordinate this action with Homeland Security planning and implementation actions. Review Cable capabilities.	Local Communities	2005	Homeland Security funding may be available to address this concern.
Share ideas on successful ways of tracking vulnerable populations through SRPEDD/DCR/MEMA newsletters such as Visiting nurses, self-identify card with tax bill, or COA coordination.	SRPEDD/Local Communities	ongoing	Plugs into existing program.
OBJECTIVE SEVEN: ***Combat complacency and foster appropriate <u>individual responsibility</u> for mitigating disaster impacts by educating all parts of the community including: school children, elderly, employers, school administrators, and municipal employees.***			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Use all existing websites – town and SRPEDD.	Local Communities and SRPEDD.	Ongoing	Uses existing channels.
Use newspaper insert for regional papers during hurricane season, for instance.	SRPEDD	2005	Funding Needed – possible PDM project.
Display PDM mapping series at local libraries and at major regional events.	Local Communities and SRPEDD.	2005	May need small stipend to complete, possible PDM project
Develop educational materials on the floodplain and floodways and do targeted mailing to residents.	Communities with major flooding issues working with SRPEDD.	2005	Needs funding of staff time and mailing costs, possible PDM project.

OBJECTIVE EIGHT: Promote use of full range of federal and state resources related to disaster mitigation such as educational materials, training, and National Weather Service forecasts.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Set a goal of 5 communities certified as "Storm Ready" by 2010. (Right now Taunton is only community certified.)	Local Communities	2004-2010	Interest and commitment.
OBJECTIVE NINE: Develop a means for sharing information on a regional basis about successful disaster mitigation planning and programs & create a feedback loop to improve pre-disaster planning by establishing a formal post-disaster assessment on what could have been done better.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Recommend that MEMA create a listserve for Emergency Management Directors to communicate on the internet.	CPT & SRPEDD recommend to MEMA	Future	Funding to establish and maintain.
Use regional groups (e.g. Southeastern Emergency Mgt. Group) for this purpose.	Local Emergency Mgt. Directors/MEMA regional office	Future/Ongoing	Use existing mechanisms.
OBJECTIVE TEN: Find Funding to Review and Update the Regional and Local Disaster Mitigation Plans on a Five Year Cycle.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Fund staff time to convene process and review and update plan.	MEMA/DCR – identify funding; SRPEDD & communities pursue funding opportunities.	Future	Funding will be needed to complete this work.
OBJECTIVE ELEVEN :Incorporate disaster mitigation actions into appropriate local and regional plans – Master Plan, Open Space Plan, Transportation Plan, and Capital Programming.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
SRPEDD educate communities as they update all of these plans; local representatives also indicate a need for this. Annexes should identify connections.	SRPEDD/Local Communities	Ongoing	Done within other planning process funded with local or state funds, as available.

OBJECTIVE TWELVE: Integrate disaster mitigation concerns into transportation projects (e.g. drainage improvements, underground utilities, etc.).			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
SRPEDD and local representatives need to speak about these concerns during project development.	SRPEDD/Local Communities	Ongoing	Coordination with project planning processes.
OBJECTIVE THIRTEEN: Increase the number of local communities that undertake annual Capital Improvement Programs – use materials developed by the Massachusetts Municipal Association.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
By use of a survey determine interest in training and if warranted host a Massachusetts Municipal Association training.	SRPEDD	2005	None
OBJECTIVE FOURTEEN: Identify PDM actions that are consistent with the objectives of other interest groups, and reach out to collaborate on achieving these initiatives. (For example conservation or environmental groups that support wetlands protection, river corridor acquisition, or reducing runoff.)			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Local representatives must identify these common goals – especially through the Open Space or Master Plan planning process	Local Communities	ongoing	Staff time and interest
OBJECTIVE FIFTEEN: Improve the information available on at-risk properties and repetitive loss structures, in order to refine strategies.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Survey high-risk communities to determine interest in HAZUS training or in undertaking a repetitive loss initiative.	SRPEDD	2005	Survey first step. If interest is found will need funding such as PDM grant.

OBJECTIVE SIXTEEN: Work with SRPEDD's Transportation Department on computer modeling for evacuation planning and & Re-routing post-disaster in co-ordination with state and local comprehensive emergency management plans.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Support the inclusion of such work in the Unified workplan of the SRPEDD Transportation Department.	SRPEDD Commission/MPO	2004-2007	Funding to be provided through MassHighway, if approved.
OBJECTIVE SEVENTEEN: Encourage the adoption of underground utility requirements in local subdivision regulations & Floodplain Zoning in Carver.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
SRPEDD work with Carver on model bylaw language and encourage other communities during SRPEDD bylaw reviews	SRPEDD	Draft provided assistance ongoing.	Ongoing part of RPA work.
OBJECTIVE EIGHTEEN: Incorporate disaster mitigation concerns into the MEPA review process.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
SRPEDD review of MEPA projects will consider relevant mitigation issues in the design.	SRPEDD staff	Ongoing	Existing process and mechanism in place.

OBJECTIVE NINETEEN: ***Integrate disaster mitigation concerns into subdivision, site plan review, 40B reviews, and other zoning reviews. In particular require the consideration of downstream flooding impacts caused by new projects—even if the impacts cross town lines—and urban/wildland interface concerns in high-risk areas. Work on model bylaw language for urban/wildland interface and review parking standards with a goal of reducing impervious surfaces.***			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Survey local communities – particular high risk ones relevant to wildfire to assess interest in bylaw provisions	SRPEDD	2005	If interest shown pursue funding for the work.
Complete a review of parking standards in the bylaws of all 27 communities with the aim of encouraging revisions to reasonable standards and the promotion of shared parking to reduce impervious coverage	SRPEDD	2005, 2006	Integrate this as part of the Unified Work Program of the transportation department.
OBJECTIVE TWENTY: Ensure that each community has a Unified Incident Command program in place, with special attention to communities that have federal, state, or county facilities within their borders.			
Action	***Responsible Parties***	***Timeline***	***Resources Needed***
Support efforts to get training funds and to integrate this training in other programs.	Local Emergency Management Personnel	Ongoing	Funds for training is needed.