CHAPTER 11

LIVABILITY AND CLIMATE CHANGE

Federal Highway Administration (FHWA) describes Livability as tying the quality and location of transportation facilities to broader opportunities such as access to good jobs, affordable housing, quality schools, and safer streets and roads.

As part of the Department of Transportation's Livability Initiative, FHWA works within the HUD/DOT/EPA Interagency Partnership for Sustainable Communities which developed the following principles to guide efforts:

- Provide more transportation choices.
- Promote equitable, affordable housing.
- Enhance economic competitiveness.
- Support existing communities.
- Coordinate policies and leverage investment.
- Value communities and neighborhoods.

PVPC is determined to aid local communities and organizations in improving livability in the region. This includes mitigation and adaptation to change in the weather patterns and other climate characteristics. In the Pioneer Valley we are most concerned about temperature and precipitation changes.

A. REGIONAL WEATHER TRENDS AND ANTICIPATED CHANGES

The transportation sector is a significant source of greenhouse gases, accounting for 1/3 of the Pioneer Valleys emissions. While it is widely recognized that emissions from transportation have a major impact on climate, climate change will have a major impact on transportation.

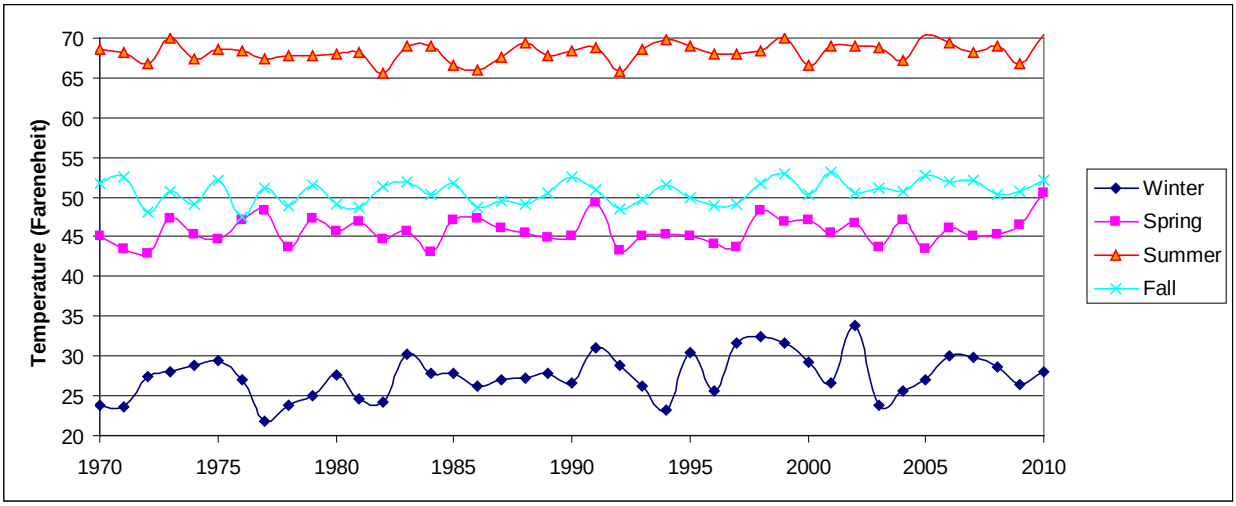
1. Temperature

Since the 1970s the Pioneer Valley had a small temperature increase in the spring, summer and fall months. Winter months have increased 2 degrees Fahrenheit on average during that same time period. The increase in temperature has resulted in many other climate-related changes, including:

- More frequent days with temperature above 90 degrees Fahrenheit
- A longer growing season
- Reduced snowpack
- Earlier breakup of winter ice on lakes and rivers
- Earlier spring snowmelt resulting in earlier peak river flows

- More freeze-thaw conditions are projected to occur in northern states, creating frost heaves and potholes on road and bridge surfaces and resulting in load restrictions on certain roads to minimize the damage.

Figure 11-1 – Regional Temperature Trends by Season (1970-2010)



The 2009 U.S. Global Change Research Program (USGCRP) report anticipates a continued seasonal increase of temperatures; winter months are expected to have the highest average temperature increase. The USGCRP reports evaluated weather conditions under a low and a high emission scenario when calculating predicted weather changes. The two scenarios allow for demonstration of uncertain future mode share changes and transportation enhancements for emissions. Using these two scenarios a range of anticipated "likely" and "very likely" weather conditions can be created over the next 19 years.

Table 11-1 below summarizes anticipated temperature changes and temperature change range by season. Both low and high emission scenarios anticipate a minimum increase of 2 degree for each season. Additionally, the "likely" and "very likely" ranges for each season predict increases in temperature for each season. The northeast should anticipate a continued temperature increase over the next 19 years.

Table 11-1 – Northeast Anticipated Temperature Changes by Season

Anticipated Temperature Changes for the Northeast	Average Temperature Increase for Northeast (F°)		Average Temperature Increase Range for Northeast from 2010 to 2029	
Season	B1 (Low Emission Scenario)	A2 (High Emission Scenario)	Likely	Very Likely
Winter	2.8	3	1.8 to 3.8	0.9 to 4.7
Spring	2.3	2.5	1.8 to 3.1	1.3 to 3.7
Summer	2	2.2	1.2 to 3.0	0.4 to 3.8
Fall	2.5	2.7	1.9 to 3.3	1.2 to 3.9
Source: USGCRP				

Figure 11-2 – Potential Future Summer Heat Index for Massachusetts

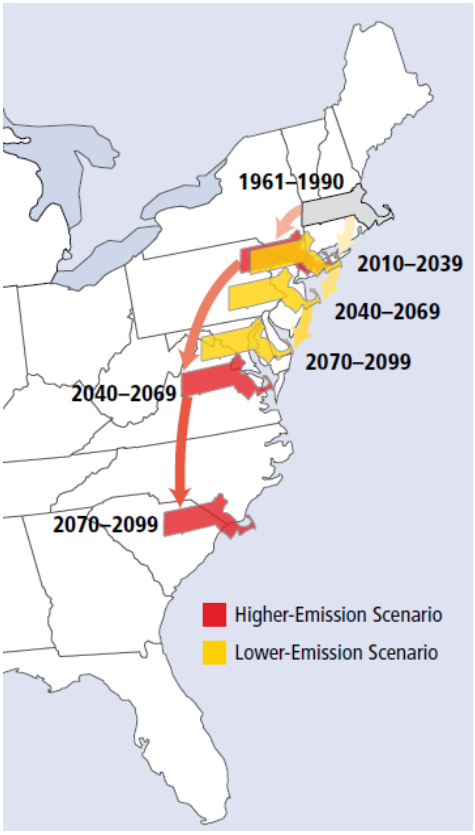


Figure 11-2 displays the anticipated change in the average summer heat index for Massachusetts. This prediction was guided by the low and high emission scenarios created in the USGCRP report. The heat index is measured by combining air temperature and relative humidity. The heat index measurement provides the human perceived temperature. The higher temperatures and climate change could affect the quality of life in the future of Massachusetts residents. The emissions scenarios predict what the perceived summer temperatures might feel like over the next century. The red arrows track the higher emissions scenario while the yellow tracks the low emission scenario.

The USGCRP report predicted extreme heat conditions for the City of Hartford. Hartford is located 20 miles south of Springfield, MA and weather conditions are consistently similar. The Pioneer Valley should anticipate similar future weather patterns due to this geographic proximity. Extreme heat is the approximate number of days per year of extreme heat greater than 90 degrees F. Hartford is predicted to average 22 to 25 days from 2010-2040 which is an increase from 1960-1990 when the city averaged 15 days. From

2001 to 2005 the average summer in Massachusetts included nearly 20 days that did not meet EPA's air-quality standards for ground-level ozone, putting additional stress on people with respiratory diseases.

Source: NEICA

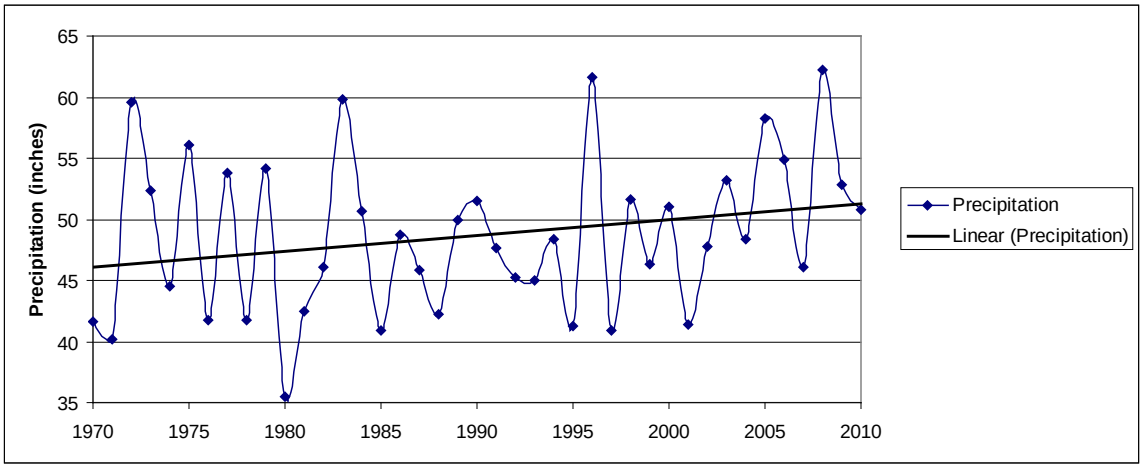
- Longer periods of extreme heat in summer can damage roads in several ways, including softening of asphalt that leads to rutting from heavy traffic.
- Extreme heat can cause deformities in rail tracks, at minimum resulting in speed restrictions and at worst causing derailments.
- Increases in very hot days and heat waves are expected to limit construction activities due to health and safety concerns for highway workers.
- Extreme heat creates poor air quality which reduces the length of time individuals can spend outside. Exposure to poor air quality has been connected to respiratory alignments such as asthma. Furthermore, children have proven to be the most susceptible to poor air quality due to their increased respiratory rate.

2. Precipitation

Throughout the northeast heavy, damaging rainfall events have increased measurably in recent decades. The Pioneer Valley was also subject to an increase in total rainfall and an increase in heavy rain events. This has also caused flooding events on many of the regions river's including the Mill River in Northampton in March of 2011. The increase in precipitation has resulted in many other climate-related changes, including:

- Increased heavy precipitation events
- Less winter precipitation as snow and more as rain
- Increased frequency of flooding events

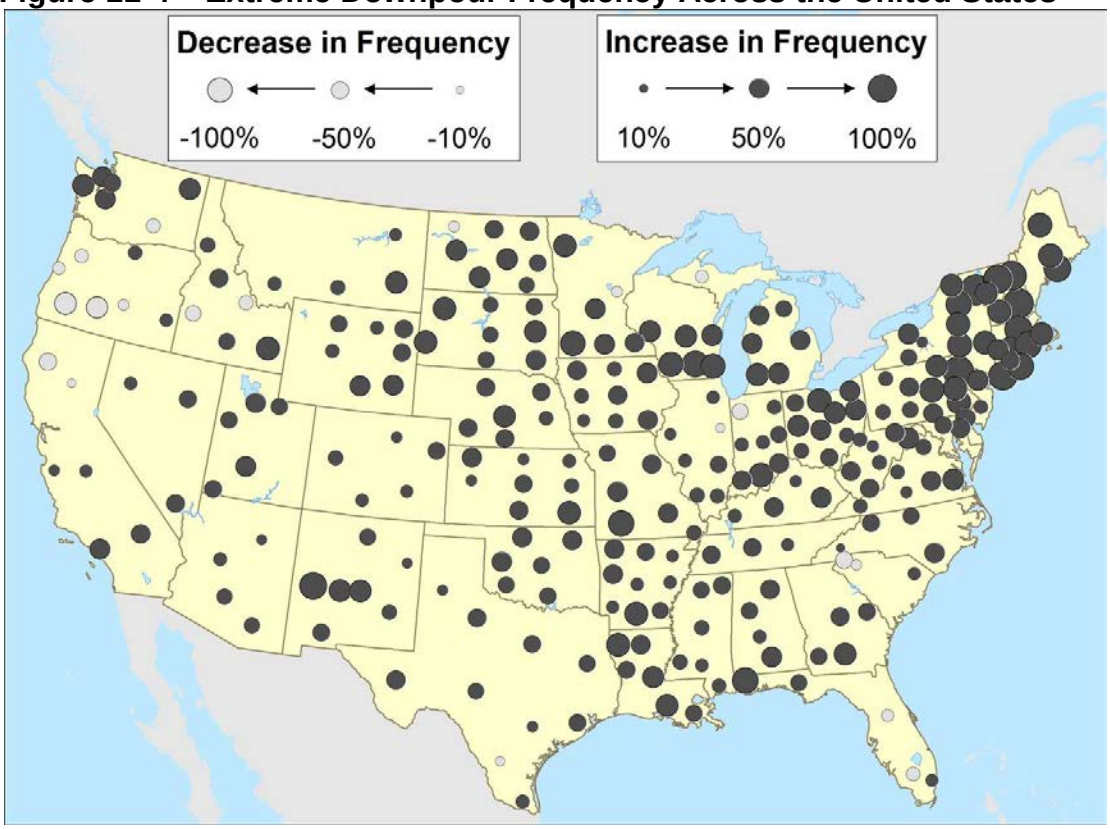
Figure 11-3 – Regional Precipitation Trends by Season (1970-2010)



The 2009 USGCRP report anticipates a continued precipitation increase annually from 2010 to 2040. The Northeast region is projected to see an increase in winter precipitation on the order of 20 to 30 percent. The ranges reflect the uncertainty of future weather events, as shown in the "very likely" range precipitation has a small potential to decrease over this 30 year period.

Environment America Research & Policy Center analyzed more than 80 million daily precipitation records from across the contiguous United States reveals that intense rainstorms and snowstorms have already become more frequent and more severe. Figure 11-4 shows how frequency of extreme downpours has increased in the US. Heavy rain is causing flooding in the Pioneer Valley region and is damaging to local roads and transportation infrastructure.

Figure 11-4 – Extreme Downpour Frequency Across the United States



Source: Environment America Research and Policy Center

The Northeast Climate Impacts Assessment (NEICA) reports that the number of days with rain greater than 2 inches to increase 1 day (low scenario) to 1.25 day (high scenario). The increase in heavy precipitation could potentially result in weather-related crashes, delays, and road closures in a network already challenged by increasing congestion. Other effects that climate change will have on the transportation system include:

- Increased flooding of roadways, rail lines, and underground tunnels
- Drainage systems will be overloaded more frequently and severely, causing backups and street flooding. Areas where flooding is already common will face more frequent and severe problems.
- Limitation on visibility because of precipitation and windshield obstruction
- Decreased skid resistance affecting vehicles performance, including traction and maneuverability, resulting in loss of control and skidding
- Lower travel speeds and greater speed variability resulting from differing driving habits and abilities

These climate change effects may reduce roadway capacity, travel speed, increase delay, increase crash risk and flooding events may cause road closures.

Table 11-2 – Northeast Anticipated Precipitation Annual % Change

Anticipated Northeast Precipitation Events	Average % Change for Northeast		Average % Change Range for Northeast from 2010 to 2029	
	B1 (High Emission Scenario)	A2 (Low Emission Scenario)	Likely	Very Likely
Annual	3.2%	2.9%	0.5 to 5.8%	(-2.0) to 8.0%

Table 11-2 above summarizes anticipated precipitation percentage change and precipitation percentage change range by season. Both low and high emission scenarios anticipate a percentage increase of approximately 3%. The "likely" and "very likely" percentage change ranges demonstrate the unpredictability of future weather trends. While the "likely" range anticipates there will be an increase in precipitation, the "very likely" range demonstrates that there is a possibility of a reduction in precipitation.

An increase in precipitation and flooding events could potential impact critical transportation links in the region. Figure 11-5 below displays major roadways and railroad lines proximity to 100 year and 500 year flood zones. A 100 year flood zone began in the 1960s when "the United States government decided to use the 1-percent annual exceedance probability (AEP) flood as the basis for the national flood insurance. The 1-percent AEP flood has a 1 in 100 chance of being equaled or exceeded in any 1 year, and has an average recurrence interval of 100 years, it is often referred to as the 100-year flood. The 500 year flood corresponds to an AEP of 0.2 percent, which means a flood of that size or greater has a 0.2 percent chance (or 1 in 500 chance) of occurring in a given year[11]." While the likelihood of a flood of either magnitude is minimal, these events would require numerous roadway closures. This would detour many transportation services onto surrounding roadways. While many of the major roadways in the region are affected by these flood zones the areas identified in this report highlight the roadways and areas that move large volumes of population and goods.

[11] U.S. Department of the Interior, *General Information Packet 106*, April 2010

Figure 11-5 – 100 and 500 Year Flood Areas

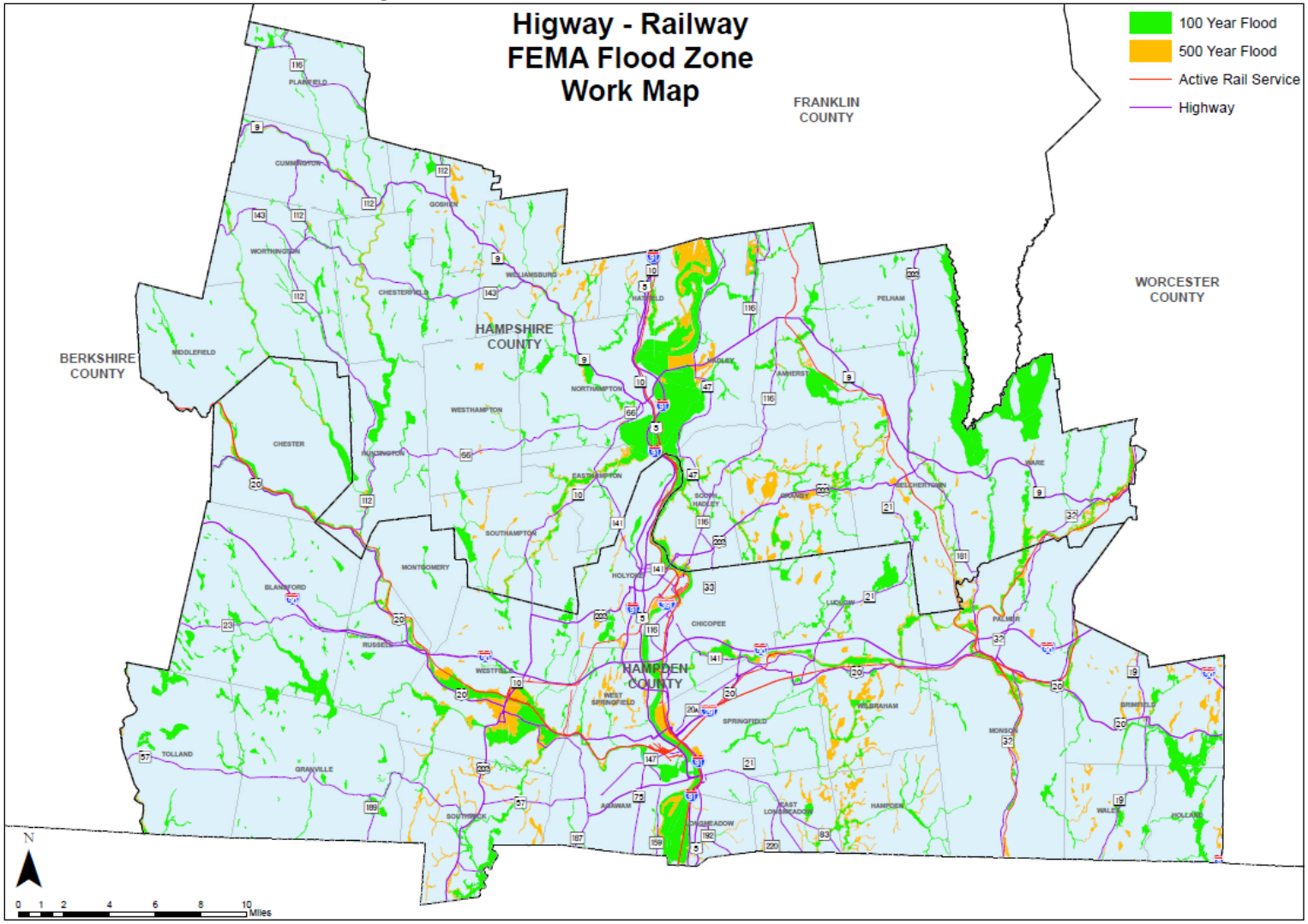
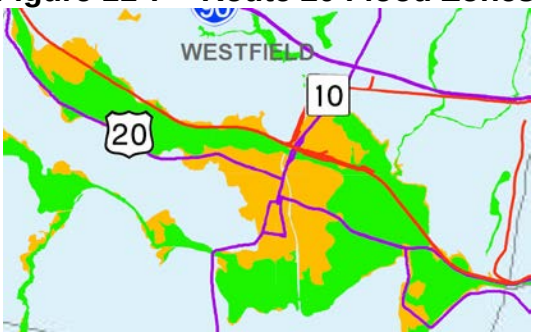


Figure 11-6 – Route 9 Flood Zones

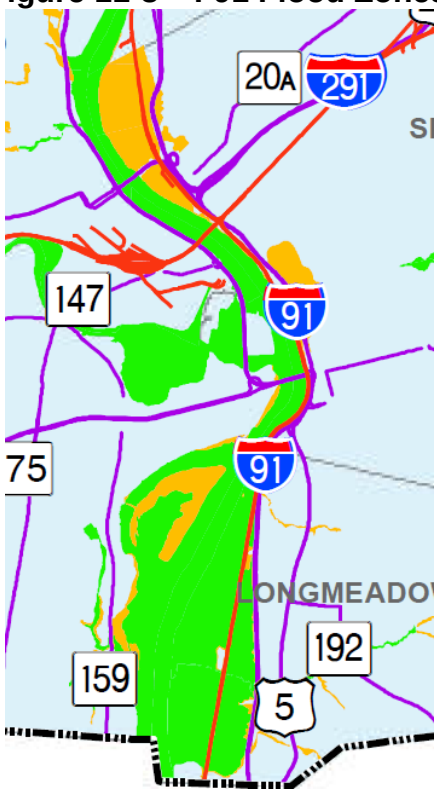
Hadley/Northampton-The western border of Hadley and the eastern border of Northampton possess a 100 year flood zone. During flood events road closures could potentially occur on Routes 5, 9, and 47. The Connecticut River would be the source of the flooding event.

Figure 11-7 – Route 20 Flood Zones



Westfield-The commercial and industrial areas along Route 20 and Union Street respectively are within the 100 year flood zone. During a 100 year flood Route 20 and Union Street could potentially be closed. The CSX rail line could also be potentially flooded at its lower elevation points through Westfield. Downtown Westfield is within the 500 year flood zone. If a flood of that magnitude occurs the area potentially could have Routes 10, 20, and 202 as well as other local road closures. The CSX line could potentially be flooded during this event as well. The Westfield River would be the source of the flooding event.

Figure 11-8 – I-91 Flood Zones



I-91 Ramps - I-91 is expected to be accessible during a flood event due to the higher elevation. However, many ramps in near downtown Springfield are at a lower elevation and at risk of flooding.

Knowledge Corridor-The proposed realignment under the "Knowledge Corridor" plan utilizes rail lines that are in close proximity to the Connecticut River. The rail line runs north through Chicopee and across the river to Holyoke. The rail line travels on the western side of the Connecticut River through Easthampton and parts of Northampton. Portions of the rail line through Easthampton and Northampton are within the 100 year flood zone.

In addition to flood zones, in the Pioneer Valley, severe storms are causing an increasing number of washouts of culverts and bridge structures. In 2011, Tropical Storm Irene caused more than $25 million of roadway damage in the region, including many culvert wash outs. There are 2,885 culverts and 678 bridges in the region. Culverts and bridges are structures usually built to carry a road, rail line or path over a stream or river. Culverts and bridges are usually located at points where the banks narrow, either naturally or as a result of man-made earthworks. In either case, the effect is to create a potential "choke point" in the downstream water flow.

All culverts in the region are mapped on Figure 11-9 and summarized by municipality. The top 5% deemed most ecologically vulnerable or sensitive to extreme weather and heavy rain are shown in red. Additional information on the

potential increase in habitat connectivity that can result from improving a road-stream crossing is presented in Chapter 17 on Figure 17-8.

Figure 11-9 – Culverts for Roadway Crossings in the Pioneer Valley

TOWN	Total	in top 5%	TOWN	Total	in top 5%	TOWN	Total	in top 5%
Agawam	100		Hadley	61	1	Plainfield	34	3
Amherst	87		Hampden	47	4	Russell	37	
Belchertown	146		Hatfield	32	1	South Hadley	46	
Blandford	74	10	Holland	35	2	Southampton	54	4
Brimfield	119	10	Holyoke	86		Southwick	72	
Chester	65	13	Huntington	41	3	Springfield	146	
Chesterfield	25		Longmeadow	35		Tolland	38	7
Chicopee	60		Ludlow	117	4	Wales	60	4
Cummington	44	8	Middlefield	29	5	Ware	95	
E. Longmeadow	45		Monson	124	4	W. Springfield	90	
Easthampton	45		Montgomery	32	2	Westfield	130	4
Goshen	27	3	Northampton	109		Westhampton	43	8
Granby	71	1	Palmer	92	3	Wilbraham	82	1
Granville	72	13	Pelham	36	16	Williamsburg	53	6
						Worthington	49	4
						TOTAL:	**2,885**	**145**

B. EXISTING POLICIES

EPA and the National Highway Traffic Safety Administration (NHTSA) have set GHG emissions standards and fuel efficiency standards for light-duty vehicles for model years 2012-2016. California is expected to propose stricter standards for model years 2017-2020, and Massachusetts law requires the state to adopt the California standards. Both EPA and NHTSA have proposed GHG emissions standards and fuel efficiency standards for medium- and heavy-duty vehicles for model years 2014-2018.

The federal renewable fuel standard requires an increase in the volume of renewable fuels used in the U.S. Additionally, Massachusetts' Biofuels Act, passed in 2008, instructs the state to pursue the development of a regional low-carbon fuel standard (LCFS). An LCFS would include targets and timelines for reducing the average carbon content of vehicle fuels. The Massachusetts' Sustainable Development Principles, last updated in 2007, are aimed at promoting clean energy to reduce GHG emissions and encouraging reductions in VMT through the creation of "pedestrian-friendly" neighborhoods.

1. Expanded Policy

It will be important to implement additional smart growth policies to make it easier for households and businesses to decrease VMT. The Plan suggests that such policies focus on influencing infrastructure investments by state agencies and planning decisions made by local governments.

C. NEW POLICIES

In 2006 the Pioneer Valley region was selected by ICLEI, Local Governments for Sustainability to participate in a pilot effort to reduce GHG emissions from transportation by promoting smart growth. Since 2007 we have partnered with the Massachusetts Department of Environmental Protection to remove old polluting vehicles from the road through our "voluntary vehicle recycling" initiative. The Pioneer Valley Planning Commission has long been recognized by MassDOT as a leader in encouraging bicycling as evidenced by our 12 years of success in facilitating Pioneer Valley Bike Commute week, a collaboration between our region and MassBike, the state bicycling advocacy program, that has now been replicated by MassDOT and MassBike at the statewide level. Thanks to diligent and ongoing education and advocacy efforts, we have many miles of on and off road bicycle ways and work to encourage sidewalks in all new developments. We have been working for 15 years to bring commuter rail back to the I-91 corridor; we have facilitated region-wide idling reduction programs and have a robust regional transit system through the Pioneer Valley Transit Authority.

In December, 2010 the Commonwealth of Massachusetts released their Clean Energy and Climate Plan for 2020 that sets out an ambitious state-wide GHG

emissions reduction target and lays out a framework for how the state will achieve that target. In January, 2008 the PVPC released our Clean Energy (and Climate Action) Plan (CEP) which set out our regions' emissions reduction targets and laid out a framework for how we would achieve those targets. The Commonwealth's Plan was released in compliance with the state's Global Warming Solutions Act of 2008 (GWSA), a legislative initiative adopted in June of 2008, six months after the release of our regional CEP. The GWSA mandates an 80 percent reduction in state-wide GHG emissions from 1990 levels by 2050. This goal is consistent with the Pioneer Valley Clean Energy Plan. In addition to a goal for 2050, GWSA required the Secretary of Energy and Environmental Affairs to establish an interim GHG emissions reduction target of between 10 and 25 percent below 1990 levels for 2020, and to issue a plan for achieving those reductions.

Both the Pioneer Valley Clean Energy Plan and the Massachusetts Clean Energy and Climate Plan include a mix of existing, expanded and recommended new policies to address climate change, including energy efficiency requirements, advanced building codes, a renewable portfolio standard (RPS), fuel efficiency standards, incentives for purchasing more efficient vehicles and reducing vehicle miles traveled (VMT), and smart growth policies. The Commonwealth's Plan portfolio of policies is broken down into five categories: buildings; electricity supply; transportation; non-energy related sources of emissions; and cross-cutting policies.

In order to meet the established interim GHG emissions reduction targets, it will be important to establish new policies that encourage a change in existing driving habits. Together, these policies and programs are estimated to reduce state-wide GHG emissions 7.6% by 2020. Below is a brief summary of the policies and programs that pertain to transportation.

- Provide incentives for consumers to shift their vehicle purchases to more fuel-efficient models, including varying the rates on new car sales taxes, annual auto excise taxes, and registration fees.
- Implement a pilot "pay-as-you-drive" (PAYD) vehicle insurance program. Under PAYD, car insurance rates would increase the more miles a person drives, creating an incentive to reduce discretionary driving.
- Implement GreenDOT, a sustainability program recently announced by the Massachusetts Department of Transportation. The program focuses on reducing GHG emissions in the transportation sector; promoting bicycling, transit and walking; and supporting smart growth development of the state's transportation systems.

In the Pioneer Valley we are committed to doing all that we can to further these policies. Our region is eager to serve as the pilot site for the PAYD vehicle insurance program and is also an established leader in understanding the connection between land use planning and transportation particularly when it comes to reducing GHG

emissions. Both our regional smart growth plan and our regional clean energy plan have been recognized through national planning awards.

D. PIONEER VALLEY CLEAN ENERGY PLAN

The Pioneer Valley Clean Energy Plan, first published in 2009 and updated in 2014 as part of the regional Climate Action and Clean Energy Plan, sets the following goals:

- Reduce regional energy use 15% by 2020 (over the 2000 baseline year) through improved energy efficiency.
- Replace non-renewable energy with clean and renewable energy that is generated locally, including sources such as wind, solar, landfill gas co-generation, hydropower, solar electric photovoltaic, solar hot water, biomass and biofuels.
- Increase the installed capacity of renewable energy production in the region to a total 754 million kWh/year by 2020; as of 2012, installed renewable capacity in the region was 281 million kWh per year, or 28% of the way toward the goal).
- Create local jobs in the clean and renewable energy sector.

The Massachusetts Global Warming Solutions Act of 2008 created statewide green house gas (GHG) emission reduction requirements of 25% by 2020 and 80% by 2050 from the 1990 baseline year. To achieve its “fair share” proportional GHG reductions to be consistent with this statewide goal, the Pioneer Valley plan identifies reductions in various sectors of energy use. In our region, transportation sources account for 31.8% of all GHG emissions (total 9.2 million tons of carbon dioxide equivalent). This means that reductions to come from the transportation sector through reduced driving, use of lighter-weight vehicles with improved aerodynamics and more energy efficient propulsion systems, as well as greater use of public transit.

Specific action recommendations to address climate change via transportation-related solutions in the Pioneer Valley Clean Energy Plan are summarized below.

a) The plan offers information and strategies intended to make it possible for people to use cars more efficiently, or not at all, including:

- Cars emit as much carbon dioxide as a typical single family home. Everything we can do to improve the fuel efficiency of cars will have an enormous impact on climate change. The Commonwealth has already committed to statewide policies requiring the most fuel efficient vehicles available, and the Green Communities program requires as one of its five criteria that municipalities commit to purchasing only fuel efficient vehicles. PVPC assists its member municipalities in obtaining Green Communities certification. In addition, we

support community-based efforts to educate drivers about fuel efficiency so they can operate their vehicles as efficiently as possible.

- PVPC promotes and encourages the use of buses, passenger rail, bicycling, walking, ride-sharing, vanpools, car-sharing and tele-commuting, tele-conferencing and webinars. We also work to create compact, mixed use communities, neighborhoods and village centers so people do not necessarily need cars to get to work, school, recreation or shopping, and we educate drivers to obey the speed limit, stop idling, and to buy fuel efficient vehicles when they can.

b) Provide financing and funding to promote fuel efficiency from the Clean Energy Plan include:

- Support redirecting fuel taxes to renewable energy, green planning, and mass transit.
- Work toward tax and regulatory policies that reflect the true cost to society of energy production and manufacturing processes based on a life-cycle "cradle to grave" analysis.
- Support an excise tax based on miles driven with funds to be used to support green transportation projects.
- Support use of fuel taxes for clean energy and green development projects.
- Support the use of congestion pricing on appropriate regional roadways.
- Work with financial institutions to promote location-efficient mortgages.
- Encourage the state to add a fee to vehicle-inspection charges to fund transportation-option education.
- Investigate a region-wide parking permit and/or state-wide registration fee based on a vehicle's greenhouse gas emissions. Revenue will be used to reduce use of single-occupancy vehicles.
- Work with the state to provide loans and other financial incentives to promote the purchase of vehicles with fuel efficiency by business, government, and individuals.

c) Specific actions that the Clean Energy Plan encourages for businesses, municipalities, and individuals:

- Provide transit passes for all residents funded through a household levy or business tax.
- Encourage the Pioneer Valley Transit Authority (PVTA) and the Franklin Regional Transit Authority (FRTA) to consider additional van pools to make connections between existing routes.
- Enhance transportation management associations (TMAs) and encourage the development of TMAs in all regional centers to make more efficient use of existing transportation resources.
- Work with the PVTA and the FRTA to improve access to transit service.
- Ensure prompt snow removal and clearing of pedestrian paths at bus stops and around traffic signal poles with crosswalk push buttons, to maintain safe access for transit riders and pedestrians.

- Encourage shared parking opportunities such as movie theaters with primary parking needs in evenings and churches or other facilities with weekend-only parking needs.
- Support park-and-ride lots to encourage car pooling.
- Provide additional services such as secure, covered bicycle parking, coffee and newspapers during peak hours, and other amenities.
- Continue and expand projects that increase pedestrian accessibility to transit stops, neighborhood shopping areas, schools, churches, and parks.
- Help transit riders to show their neighbors, friends, and co-workers how easy it is to take transit.
- Encourage citizens to commute to goods and services by bicycle or foot.
- Promote the Pioneer Valley Bicycling map and the new Franklin County Bikeway Map.
- Provide secure, covered bicycle parking at schools, in commercial districts, and at other destinations.
- Promote growth through redevelopment and infill that maintains or improves the quality of life for existing neighborhoods.
- Promote proximate commuting (i.e., living near a workplace).

d) Support continued use of transportation demand management strategies.

As noted previously, the Pioneer Valley is one of 35 regions in the country selected to receive federal funding to enhance sustainability in our region. With this federal funding we will be updating our existing regional plans, and developing a new Climate Action plan to further our region's initiatives to address climate change.

E. MERRICK AND MEMORIAL PHASE II

Merrick and Memorial Phase II Transportation and Community System Preservation study for the Merrick and Memorial Neighborhoods of West Springfield, Massachusetts. This study is a multidisciplinary effort of the Pioneer Valley Planning Commission (PVPC) and the City of West Springfield to look at how transportation and redevelopment can work together to improve the quality of life for residents and the economic vitality of businesses in these two neighborhoods.

Phase I of this study was completed in 2004 with the issuance of a Redevelopment Plan. This plan targeted several areas for economic development in the Merrick Neighborhood, including properties along Union Street, and recommended several transportation and infrastructure improvements to improve access to the CSX railyard and preserve the quality of life in surrounding residential areas.

Now complete, Phase II of the study addresses the entire study area (both Merrick and Memorial Neighborhoods). It offers recommendations that are geared to improve the efficiency of the regional transportation system, increase employment and business activity, and encourage new development and redevelopment that will enhance the livability and the quality of life for people who live and work in the Merrick and Memorial Neighborhoods.

The study specifically identified focus areas based on their potential to spur future redevelopment through Complete Streets improvements. Conceptual improvements were developed to provide concepts for discussion under various redevelopment scenarios that could be advanced in conjunction with proposed transportation enhancements. An Executive Summary and the Final Report can be downloaded on the Merrick and Memorial Neighborhood Study webpage at: http://www.pvpc.org/projects/merrick-and-memorial-neighborhood-study.

F. GREEN HOUSE GAS EMISSIONS ON I-91

The Pioneer Valley Planning Commission staff collected air samples to measure the levels of carbon dioxide along the I-91 corridor as part of its Interstate Route I-91 Corridor Planning Study Existing Conditions Report completed in November 2014. Specific points in the vicinity of highway exits were measured to identify green house gas (GHG) emissions from automobiles.

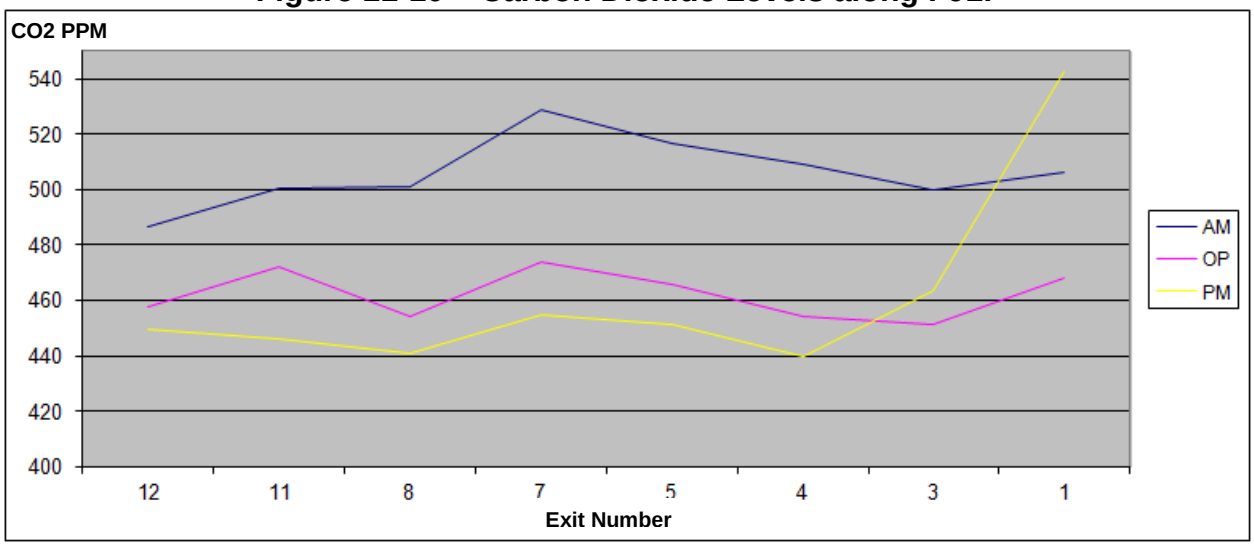
As traffic congestion increases Carbon Dioxide also increases. Carbon Dioxide emissions are sensitive to the type of driving occurring. Traveling at a steady speed will result in much lower emissions than stop and go driving patterns. For example, on a highway when travel speeds are reduced due to congestion vehicles experience frequent acceleration and deceleration events over a short travel distance, which in turn correlates with higher grams per mile emission rates. And when vehicles travel at higher speeds they experience higher engine loads which result in higher emissions rates. However, a steady velocity of 45 to 50 mph produces the minimum grams per mile of CO2 emissions.

For taking mobile observations of CO2 emissions along Interstate 91 a Picarro 2301 cavity ring-down spectrometer and mobile monitoring kit were utilized to collect samples at approximately 1 second intervals. The unit was secured in the rear of a compact car and fed the units inlet tube to the car's front bumper. The unit's mobile monitoring kit has a built in high precision GPS that records the exact location of where a sample was taken. This data was extracted from the unit and mapped using the provided latitude and longitude coordinates. A total of 3 observations were performed for this study during the morning rush hour 7:08-8:45 AM (6/5), off peak time, 2:36-3:39 PM (5/30), and afternoon rush hour 4:44-5:46 PM (5/17). Each field drive along I-91 followed the same loop passing through Longmeadow, Springfield and West Springfield from Exit 1 to Exit 13B.

The CO2 readings were charted for each of the three times of day by direction. Figure 11-10 shows the variation in CO2 readings taken on I-91 during various times of the day. The X axis lists I-91 exit numbers and the Y axis represents the level of CO2 in parts per million. Data points in this chart represent the average CO2 levels between exit locations. For example, the data point at Exit 4 represents the average CO2 emissions from Exit 3 to Exit 4. The intensity levels of CO2 along the highway

are depicted over an aerial map of the corridor area for the morning peak traffic period on Figure 11-11.

Figure 11-10 – Carbon Dioxide Levels along I-91.



AM: Morning Peak Hour, OP: Off Peak Hour, PM: Afternoon Peak Hour.

Travel speed observations and CO2 level measurements along the I-91 corridor study area show that congestion and the acceleration/deceleration events increase emissions between Interchanges 1 and 9. There are many on/off ramps between Interchanges 1 and 9 within a short distance from one another, including a connection to Interstate 291. Therefore, the volume of merging traffic from and to these ramps negatively impacts the ability of vehicles to maintain steady travel speeds, which results in higher emissions. Traffic moves more steadily between Interchanges 9 and 13 in both directions of the highway. Due to the steadier vehicular speeds, emissions are lower between Interchanges 9 and 13. Despite the fact that vehicular travel speeds are closer to the recommended 45 to 50 mph between Exits 1 and 9, acceleration/deceleration events prevent vehicles from maintaining a steady pace.

G. NORTHEAST RESILIENCE ANALYSIS

The Nature Conservancy's Northeast Resilience Project identifies those lands most likely to be resilient to climate change. By looking at the aspects that will not change (bedrock type, elevation, topographic gradient), this analysis identifies locations that should support the highest diversity of plants and animals (and ecosystem services like clean drinking water and carbon storage), even if the individual species found in a given location do change. More information is available at: https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/ne/Pages/default.aspx

Figure 11-11 – Carbon Dioxide Intensity on I-91 Northbound - Morning Peak Hour