Environmental Quality, Climate Change, Hazards, and Energy

Planning efforts, like the processes undertaken by the Old Colony Planning Council, make mitigation a proactive process in the OCPC region. Pre-disaster planning emphasizes actions that can be taken before a natural disaster occurs. Future property damage and loss of life can be reduced or prevented by a mitigation program that addresses the unique geography, demography, economy, and land use of a region within the context of each of the specific potential natural hazards that may threaten a community.

The MPO continually works with federal, state, and local environmental partners to determine how to systematically reduce or eliminate the loss of life and property damage resulting from natural hazards such as floods, earthquakes, and hurricanes. Hazard mitigation means permanently reduce alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, programs, projects, and other activities.

Working with our communities to prepare local natural hazard mitigation and climate adaptation plans before a disaster occurs can save the community money and facilitate post-disaster funding. Costly repairs or replacement of buildings and infrastructure, as well as the high cost of providing emergency services and rescue/recovery operations, can be avoided, or significantly lessened if the region implements the mitigation measures detailed in the plan. The integrated nature of this type of plan provides the opportunity to identify climate change impacts, describe the effect climate change is anticipated to have on natural hazards, and prepare an integrated strategy to understand and mitigate risks.

Climate Change has brought about uncertainties in accepted and widely used data regarding historically based floods, precipitation, and natural hazards. The current practice in modeling infrastructure lifecycle, although based on historic meteorological data, does not consider the potential future impacts of Climate Change especially the severity and frequency of flooding on local infrastructure.[1] A better understanding of the potential risks and impacts of Climate Change on the transportation system leads to more informed decision-making in the capital investments in infrastructure in the region.

Along with population change, we also face economic and demographic changes that force us to reevaluate past practices. The rising cost of infrastructure, energy, and public services demands that we find more efficient ways to grow; environmental expectations require us to respect our natural systems more fully; and an older more diverse population will demand more housing and mobility choices. Climate change and the challenges and environmental sustainability pose a serious threat to our future.

Issues Facing the Environment in the OCPC Region.

The topography of the region is relatively flat, apart from the Pine Hills near the coast in Plymouth. Areas of relatively higher elevation exist in the northern communities of Stoughton, Avon, and Abington, ranging up to approximately 250 feet. The lowest elevations are found where the Taunton River exits the region. Although more than 20 miles from the ocean, the elevation is only 15 feet above sea level. The region's rivers and streams do not experience great or rapid drops in elevation and generally flow slowly. Many of the rivers are broad and meandering with shallow depths and a wide riparian zone of wetlands along the banks. The Old Colony region's terrain consists of generally low and gently rolling glaciated land with many hills, ridges, and other features created by the late glacial ages, as well as a generally north-south drainage system and extensive wetlands including the Hockomock Swamp in parts of Bridgewater, Easton, and West Bridgewater and the Great Cedar Swamp in Halifax and Hanson. Three of the region's municipalities are coastal communities including Duxbury, Kingston, and Plymouth. Plymouth has the largest land area of any municipality in Massachusetts with 134 square miles and over 20 miles of coastline.

Antiquated transportation facilities cause traffic congestion which contributes to air pollution. Older roadways\, bridges, and intersections that cannot accommodate the current traffic demand cause traffic congestion. Automobile emissions resulting from traffic congestion are one of the primary contributors to air pollution.

The transportation sector continues to be one of the highest contributors to Greenhouse Gas emissions. Fossil fuels are the largest source of greenhouse gas emissions, a leading cause of global warming and climate change. The transportation sector continues to be reliant on fossil fuels and the vehicle miles traveled continue to rise.

Fossil fuel-powered vehicles are still the most common type of motorized transportation. Despite the emergence of alternative fuel vehicles, the infrastructure needed to accommodate these types of vehicles remains insufficient.

Challenges

According to the *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, Climate Change in Massachusetts is already exacerbating natural hazards and extreme weather and it is leading to new impacts affecting the state. Massachusetts is expected to experience intensification in four areas, precipitation, sea level rise, rising temperatures, and extreme weather events.

Changes in Precipitation

The changes in precipitation are expected to bring inland flooding as well as drought during the summers. Annual precipitation increases of up to 16 percent or plus 7.3 inches are expected. The days with rainfall accumulation of more than one inch are expected to increase by 57 percent. Conversely, the summers are expected to see a decrease in precipitation with an increase in consecutive dry days leading to more droughts during the summer with an increase in the potential for landslides.

Severe and frequent rainfall may exceed the capacity of existing stormwater systems, as Brockton and many of the OCPC communities experienced in March of 2010. Fire stations, police stations, and schools are vulnerable as coastal and riverine flooding may overflood bridges, roads, and public transit infrastructure. Flooding, as well as coastal storm surge, which will be more severe due to sea level rise, can interrupt first responders and emergency operations. Flooded roads or damaged ports could have significant negative impacts on local economies and disrupted transportation networks may impede the mobility of emergency services. In addition, combined sewer overflow events may precipitate public health crises.

Floods are one of the most common natural hazards in the OCPC region, they can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines, and multiple counties or states). A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood.

Inland flooding is the result of moderate precipitation over several days, intense precipitation over a short period, or melting snowpack. In addition, developed areas that have impervious areas can contribute to inland flooding.

Several local factors determine the severity of a flooding event, including stream and river basin topography, precipitation and weather patterns, recent soil moisture conditions, amount of impervious surface area, and degree of vegetative clearing. Flooding can also be influenced by more extensive, global climate events. Global warming and climate change are shifting rainfall and storm patterns, resulting in increased precipitation and the frequency of flooding in the region.

Flash flooding typically occurs within minutes or hours after heavy precipitation, after a dam or levee failure, or from a sudden release of water from an ice jam. Most often, flash flooding is the result of a slow-moving thunderstorm or the heavy rains from a hurricane. In rural areas, flash flooding often occurs when small streams spill over their banks. However, in urbanized areas, flash flooding is often the result of clogged storm drains (leaves and other debris) and a higher amount of impervious surface areas (roadways, parking lots, rooftops).

General flooding events may last for several days. Excessive precipitation within a watershed of a stream or river can result in flooding particularly when development in the floodplain has obstructed the natural flow of the water and/or decreased the natural ability of the groundcover to absorb and retain surface water runoff (e.g., the loss of wetlands and the higher amounts of impervious surface area in urban areas).

Sea Level Rise

Sea level rise projections for the year 2100 are estimated to have an average range of one to four feet. The impact of sea level rise can vary because it is dependent on the local ocean current, wind pattern, shoreline contour, land topology, and natural-based protection features; however, four feet of water can pose a serious threat to coastal communities and local infrastructure. More extreme average sea level rise scenarios are possible if greenhouse gas emissions and further destabilization of the Antarctic ice sheet remain unchecked.

Sea level rise is expected to bring on coastal flooding and coastal erosion. Three towns in the region will be directly impacted by coastal flooding and erosion, these include Plymouth, Kingston, and Duxbury. Sea level rise poses specific problems for roadways in that it can accelerate roadway deterioration and reduce the life cycle of pavements. In addition, sea level rise can impact ports and harbors as well as coastal development. The impact of sea level rise is dependent on the local ocean current, wind pattern, shoreline contour, land topology, and natural-based protection features. It can impact different roads along the coastline more severely in some areas than others.

Rising Temperatures

Massachusetts has a humid continental climate type with warm, humid summers and cold, snowy winters. This type of climate is found over large areas of land masses in the temperate regions of the mid-latitudes where there is a zone of conflict between polar and tropical air masses. The state is prone to extreme weather, with influences from the polar region as well as tropical weather from the south. In addition, the state's proximity to the ocean makes it susceptible to winds and weather from the Atlantic. The hottest month is July, with an average high of 82 °F (28 °C) and an average low of 66 °F (18 °C), with conditions usually humid. Periods exceeding 90 °F (32 °C) in summer and below 10 °F (−12 °C) in winter are not uncommon. The record high temperature is 104 °F (40 °C), recorded July 4, 1911. The record low temperature is -18 °F (-28 °C), recorded on February 9, 1934.

A heat wave is a period of abnormally and uncomfortably hot and usually humid weather. The World Meteorological Organization is specific in its definition by stating that a heat wave is when the daily maximum temperature for more than five consecutive days exceeds the average maximum temperature by 9 degrees. The National Weather Service reported the longest heat wave in Greater Boston lasted 9 days and took place between July 3 and July 11, 1912, a span during which temperatures ranged from daytime lows of 90 degrees to a high of 98 degrees.

According to the *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, Climate Change is expected to bring average annual temperature increases to 23 percent (plus 10.8 degrees Fahrenheit). It is expected to decrease up to 42 percent the number of days with the minimum temperature below freezing as winter temperatures are expected to increase at a greater rate than spring, summer, or fall. Long-term average minimum winter temperatures are expected to increase up to 66 percent (+11.4 degrees Fahrenheit). The number of days per year with daily maximum temperatures over 90 degrees Fahrenheit is expected to increase to over 64 days per year.

Climate Change is expected to bring, along with the extreme temperatures, more wildfires, and invasive species to Massachusetts. Although New England is generally considered to be a moist region with ample precipitation, droughts are not uncommon. Widespread drought has occurred across New England several times since climate records have been kept. More frequent and severe droughts are expected as climate change continues to increase temperatures, raise evaporation rates, and soils dry out, despite heavier rainfall events. Seasonal or short-term droughts that last less than six months are most common in New England. The greatest risk for seasonal drought may be in the summer and early fall because of higher temperatures that lead to greater evaporation and earlier snowmelt.

Extreme Weather Events

Hurricanes

According to the *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, the frequency and magnitude of hurricanes are expected to increase in Massachusetts due to Climate Change. The Gulf Stream, which traditionally brings warm water from the Gulf of Mexico and the southern portion of the North Atlantic northward along the eastern seaboard and across the ocean from west to east is disrupted in the north due to the melting of the polar ice cap. This in turn stalls warm water in the Gulf of Mexico, the Caribbean, and the southern portion of the North Atlantic Ocean from moving north, making warmer water available with more energy to fuel more frequent and higher-intensity storms.

Hurricanes are also known as Tropical Cyclones. Tropical Cyclone is a general term for low-pressure systems such as tropical storms and hurricanes, as these systems usually form over the tropics, and have a distinctive rotation. These storms are among the most powerful and destructive meteorological systems on earth. The destruction is mainly caused due to high winds, heavy rain, lightning, tornadoes, and storm surge. As these storms move inland, they can cause severe flooding, downed trees, and power lines, and structural damage. The National Hurricane Center (NHC) describes four types of classifications for tropical cyclones, including Tropical Depressions, (with maximum sustained winds of 38 mph or less, Tropical Storms, (with maximum sustained winds of 39 to 73 mph), Hurricanes, tropical cyclones with maximum sustained winds of 74 mph or higher, and Major Hurricanes, a tropical cyclone with maximum sustained winds of 111 mph or higher.

Tornados

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. These events are spawned by thunderstorms and occasionally by hurricanes and may occur singularly or in multiples. They develop when cool air overrides a layer of warm air, causing the warm air to rise rapidly. Most vortices remain suspended in the atmosphere. Should they touch down, they become a force of destruction. Some ingredients for tornado formation include:

- Very strong winds in the mid and upper levels of the atmosphere
- Clockwise turning of the wind with height (from the southeast at the surface to west aloft)
- Increasing wind speed with altitude in the lowest 10,000 feet of the atmosphere (i.e., 20 mph at the surface and 50 mph at 7,000 feet)
- Very warm, moist air near the ground with unusually cooler air aloft
- A forcing mechanism such as a cold front or leftover weather boundary from the previous shower or thunderstorm activity.

On average there are six tornados that touchdown somewhere in the Northeast region every year. On average, (between 1950 and 2008), more than two tornadoes per year strike the state of Massachusetts alone, with New England as a whole recording more than 8. Most tornadoes reported in the region are "weak", rated EF0 or EF1 on the Enhanced Fujita Scale. Around 30 percent are "significant" tornadoes (rated EF2 or greater), and only one percent are violent (rated EF4 or EF5, the highest damage rating). Weak tornadoes occur in all areas of New England, but EF3 or greater tornadoes have been reported. There have been 34 killer tornadoes in New England's recorded history.

Nor'easter

A nor'easter is an extratropical cyclone in the western North Atlantic Ocean. The name derives from the direction of the winds that blow from the northeast. The original use of the term in North America is associated with storms that impact the upper north Atlantic coast of the United States and the Atlantic Provinces of Canada.

These storms originate as a low-pressure area that forms within 100 miles of the shore between North Carolina and Massachusetts. The precipitation pattern is like that of other extratropical storms. Nor'easters are usually accompanied by very heavy rain or snow and can cause severe coastal flooding, coastal erosion, hurricane-force winds, (more than 74 miles per hour), or blizzard conditions. Nor'easters are usually most intense during winter in New England and Atlantic Canada. They are fueled by converging air masses that include the cold polar air mass and the warmer air over the water. They can be more severe in the winter when the difference in temperature between air masses is greater.

Nor'easters tend to develop most often and most powerfully between the months of October and April, although they can (much less commonly) develop during other parts of the year as well.

Federal Response to Climate Change

Executive Order

The federal government issued several executive orders in response to Climate Change. Executive Order 13653, "Preparing the US for the Impacts of Climate Change", was issued in 2013. It built on a previous 2009 executive order, which supported scientific research, observational capabilities, and assessments to improve understanding and response to climate change and its impacts on the country. The 2013 executive order promoted federal agencies to engage in strong partnerships and information sharing at all levels of government, utilize risk-informed decision-making and the tools to facilitate it, and utilize adaptive learning, in which experiences serve as opportunities to inform and adjust future actions and promote preparedness planning.

In 2014, the Federal Highway Administration (FHWA) created a policy in response to executive Order 13653 via directive. The FHWA stated that it will, "Integrate the consideration of the risks of climate change and extreme weather event impacts and adaptation responses, into the delivery and stewardship of the Federal-aid and Federal Lands Highway programs, including encouraging State

DOTs, MPOs, tribal governments, and others to develop cost-effective strategies to minimize climate and extreme weather risks.” Specifically, the FHWA developed the *Climate Change Adaptation Guide for Transportation Systems Management, Operations, and Maintenance*, in response to the need for action due to Climate Change.

The FHWA guide focuses on two transportation functions, transportation systems management, and operations and maintenance of transportation infrastructure. Both of these involve the day-to-day activities that maximize the use of transportation infrastructure. The FHWA anticipates several operational impacts due to Climate Change including:

- Increase in traffic incident management activities.
- Road and lane closures.
- Reduced (and variable) speed limits.
- Disruption of transit service.
- Road and transit diversions.
- Truck restrictions.
- Work zone management (to accommodate additional lane closures).

To ensure that infrastructure is resilient against Climate Change, maintenance practices have to be proactive to anticipate changes to the system (e.g., inspection, frequency of repairs, need for “quick maintenance” patrols).

Transportation systems management and operations include Traffic Management, Freight Management, Work Zone Management, Traffic Incident Management, Planned Special Event management, Traveler Information Services, Road Weather Management, Traffic Signal Coordination, Active Transportation & Demand Management, and Transit Priority and Integration. Maintenance includes Pavement Management, Shoulder Maintenance, Bridge Inspection, Vegetation Management, Road Weather Management, and Asset Management.

State Response to Climate Change

Global Warming Solutions Act

Massachusetts approved the Global Warming Solutions Act (GWSA) on August 7, 2008, as a comprehensive response to the impacts of global climate change. The GWSA requires the Executive Office of Energy and Environmental Affairs (EOEEA), in consultation with other state agencies, as well as the public, to set economy-wide greenhouse gas (GHG) emission reduction goals for the state. The GWSA approved (in consultation with the state executive office of administration and finance), the use of market-based compliance mechanisms to address climate change concerns and for setting and reaching reduction goals. In addition, it allowed the state to work with other states to develop a plan to expand market-based compliance mechanisms such as the regional greenhouse gas initiative to other sources and sectors necessary or desirable to facilitate the achievement of the greenhouse gas emission. This includes those states who have in the past participated in the regional greenhouse gas initiative and includes other interested states and Canadian Provinces.

The GWSA set the following priorities:

- Establish 1990 as a baseline assessment of statewide GHG emissions used to measure goal progress (1990 is the base year of the Kyoto Protocol).
- Establish target emission reductions for 2020 and a plan for achieving them.
- Analyze strategies via advisory committee and make recommendations for adapting to climate change, the committee reports to the Legislature by December 31, 2009.
- Reduce between 10 percent and 25 percent below statewide 1990 GHG emission levels in the state by 2020.
- Reduce to at least 80 percent below statewide 1990 GHG emission levels by 2050.
- Establish regulations requiring reporting of GHG emissions by the Commonwealth's largest sources by January 1, 2009, providing data about the types and levels of GHG.
- Develop a projection of the statewide GHG emissions for 2020 (a "business as usual" scenario as if no government action is implemented for reductions).

EOEEA established two advisory committees to provide input on the implementation of the GWSA 1.) The Climate Protection and Green Economy Advisory Committee to advise the Executive Office of Energy and Environmental Affairs on measures to reduce greenhouse gas emissions under the GWSA, 2.) The Climate Change Adaptation Advisory Committee to study and make recommendations on strategies for adapting to climate change.

The Transportation Climate Initiative

According to the Massachusetts Department of Environmental Protection, the Transportation Climate Initiative (TCI) is a regional collaboration of Northeast and Mid-Atlantic jurisdictions, working together since 2010 to improve transportation, develop a clean energy economy, and reduce emissions from vehicles and fuels. Twelve northeast and mid-Atlantic states plus Washington, D.C., are involved in the discussions to join the TCI, these include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia.

TCI is a “Cap-and-Trade” system, whereby a cap is set on the total amount of carbon dioxide that can be released from vehicles using transportation fuels (lowered as time goes on) in each jurisdiction. Transportation fuel suppliers must then buy allowances for every ton of carbon dioxide their fuel will produce, the total number of allowances is limited, based on the cap. An auction is held in which fuel suppliers can bid to buy fuel allowances in which the price of those allowances depends on the market, as allowances can be traded.

The states and jurisdictions get money from the sale of the allowances and would be required to invest that money into projects that reduce carbon emissions from transportation. This system is expected to incentivize the development of fuel-efficient technologies and incentivize people to use less pollution-emitting fuel. It is also expected that the system will raise money for state investments in new technologies, such as electric vehicles.

According to the Transportation Climate Initiative, the Memorandum of Understanding was signed in December 2020 by Massachusetts, Connecticut, Rhode Island, and the District of Columbia and includes a commitment to dedicate a minimum of 35 percent of each jurisdiction’s proceeds, (which can amount to nearly $100 million each year in the inaugural jurisdictions combined), to ensure that communities underserved by the transportation system and overburdened by pollution will benefit equitably from clean transportation projects and programs. Each jurisdiction will designate an advisory body to identify underserved and overburdened communities, guide investments, and define goals and metrics for measuring progress. A majority of the members of each advisory body will be people from or representing underserved and overburdened communities.

It was expected that each signatory jurisdiction will work with communities and with its Equity Advisory Body to assess the equity impacts of the program on an ongoing basis, including by monitoring air quality in communities overburdened by air pollution to ensure the effectiveness of policies and investments, and will ensure transparency by annually reviewing and reporting on program progress. The Signatory Jurisdictions agreed to work together to encourage other jurisdictions to participate in TCI to expand the program. Any jurisdiction may withdraw at any time; however, they must not interfere with the integrity of the program. The jurisdictions also commit to continue to work individually and together on additional policies that reduce pollution from transportation and advance shared goals of equity and environmental justice.

On Nov. 15, 2021, Connecticut and Massachusetts pulled out of the 12-state TCI Agreement. The governor of Massachusetts cited a lack of support for TCI from the other partners as a reason to pull out of the agreement. The governor's spokesperson cited that the administration maintained that Massachusetts would only move forward with TCI if multiple states committed and if that was not possible, then TCI would no longer be the best solution for the Commonwealth's transportation and environmental needs.

Massachusetts 2050 Decarbonization Roadmap

The *Massachusetts 2050 Decarbonization Roadmap* report was released in January 2021 by the Executive Office of Energy and Environmental Affairs. The main goal of the report was to identify and document cost-effective and equitable strategies for achieving net zero greenhouse gas (GHG) emissions by the year 2050. The study created a planning process that included stakeholder engagement, science-based analysis, and the inclusion of the business community to maintain the economy while addressing the impacts of Climate Change and reducing greenhouse gas emissions improving air quality and public health.

The approach toward achieving decarbonization goals explores what the report calls "multiple pathways". These include policies that reduce carbon but support maintaining equity and a thriving economy. According to the Executive Office of Energy and Environmental Affairs, the study seeks to understand interdependencies in the current system and from there create actions and policies that transition energy use to the goal of net zero carbon emissions in Massachusetts. The study process involves modeling future scenarios as well as producing data that can guide the policy and program design.

The policies to achieve the study's 2050 net zero goals include:

Transportation – Emissions-free cars, trucks, and buses by utilizing zero-carbon fuels, which will include electric and hydrogen-powered vehicles. In addition, create a healthy public transit system in concert with transit-oriented development, bike lanes, and sidewalks.

Buildings – Build structures with higher-performing heat pumps that can provide energy-saving heat and air conditioning as more energy-efficient buildings and electric appliances help reduce energy bills for families and small businesses.

Energy Supply – Widely utilize wind and solar power to decarbonize the grid and meet the growing demand for clean electricity, but also employ a diverse mix of energy resources for year-round reliability. Make improvements to the transmission and distribution systems to increase access to diverse low-cost energy resources and allow offshore wind to power New England.

Non-Energy – Increase composting and recycling of plastics to minimize waste generation. Manage and reduce emissions in agriculture and industry.

The Clean Energy and Climate Plan for 2030 (2030 CECP)

The Executive Office of Energy and Environmental Affairs (EOEEA) developed the Clean Energy and Climate Plan for 2030 (2030 CECP) to ensure that the 2030 emissions limits that have been set for Massachusetts will be met. This plan provides details on the actions Massachusetts will undertake through the 2020s to ensure the emissions limit is met. The 2030 CECP was prepared in coordination with the development of the 2050 Decarbonization Roadmap so that the strategies, policies, and actions in the 2030 CECP align with the net zero greenhouse gas emissions by 2050.

The CECP for 2030 outlines a plan to achieve emissions reductions of at least 45% below the 1990 level for 2030. The plan outlined several priorities for the EOEEA:

- Protect Natural and Working Lands - Create programs with incentives to achieve no net loss in forest or farmland. Protect and restore inland and coastal wetlands.
- Manage Ecosystem Health and Enhanced Carbon Sequestration - Implement best management practices identified in the Healthy Soils Action Plan and the Resilient Lands Initiative. Commission additional forest carbon sequestration research, building upon the land use analysis in the 2050 Roadmap, to assess the long-term impacts of sustainable forest management practices.
- Incentivize Regional Manufacture and Use of Durable Wood Products - Explore opportunities to incentivize the regional use of harvested wood in long-lived products, such as cross-laminated timber and wood-based building insulation.
- Develop Sequestration Accounting and Market Frameworks - Work with states and stakeholders in the Northeast to develop the measurement, accounting, and market frameworks necessary to support the development of a regional carbon sequestration offset market by the end of 2025 (Transportation Climate Initiative, TCI). Convene an inter-agency Carbon Sequestration Task Force beginning in 2021. MassDEP will update the statewide biogenic emissions inventory as needed to support and track verified carbon sequestration.

In April of 2021, Governor Baker signed comprehensive climate change legislation (*Senate Bill 9 - An Act Creating a Next Generation Roadmap for Massachusetts Climate Policy*) codifying Massachusetts' commitment to achieving Net Zero emissions by 2050. This new law establishes new interim goals for emissions reductions, significantly increases protections for Environmental Justice communities across Massachusetts, authorizes the implementation of a new, voluntary energy-efficient building code for municipalities, and allows the Commonwealth to procure an additional 2,400 Megawatts (MW) of clean, reliable offshore wind energy by 2027. This legislation updates the greenhouse gas emissions limits related to the 2008 Global Warming Solutions Act, commits Massachusetts to achieve Net Zero emissions in 2050, and authorizes the Secretary of Energy and Environmental Affairs (EEA) to establish an emissions limit of no less than 50% for 2030, and no less than 75 percent for 2040. The legislation also authorizes EEA to establish emissions limits every five years and sub-limits for at least six sectors of the Massachusetts economy - electric power; transportation; commercial and industrial heating and cooling; residential heating and cooling; industrial processes; and natural gas distribution and service.

The OCPC Transportation System and Potential Risk

Climate change will only increase both the intensity and severity which natural hazards affecting the region. While occasionally flooding, late summer hurricanes, winter storms, and small wildfires are all part of life in the region, they are for the most part, at a manageable level. Other threats, such as tornadoes, earthquakes, and landslides are far less common. Each of these events, which will only intensify in frequency and severity with climate change, can have disastrous impacts across the region and has the potential to wreak havoc on the entire transportation system. Two of the most common means of traveling in the Old Colony region (road and rail) are particularly susceptible to climate change and its resulting increases in precipitation, storm activity, and temperature.

Rail

Commuter rail is a common form of transportation in the region. The primary rail system in the region is the MBTA Old Colony Commuter Rail, with most of its 14 stations in the region located in low-lying sites. Some stations and rail lines are in or near mapped floodplains, as is the case in the Town of Whitman, where the station is adjacent to a 100-Year Flood zone and the track in the southern portion of the town crosses a mapped floodplain. These facilities, however, were designed for their sites and are unlikely to be affected by local flooding. Other concerns with rail lines include extreme heat that may cause the track to buckle and cause derailments and storms that can knock down signs and potentially cause safety issues.

The interruption of rail traffic is likely to become more common with more frequent flooding. Likely impacts include track inundation, erosion of the track subgrade, and the rooting of wooden crossties. Erosion of the subgrade can wash away ballast and weaken the foundation, making the track unstable for the passage of heavy locomotives and railcars. Wind may impact the railroad signs, signals, and grade crossings, which has the potential to increase rail accidents at grade crossings.

Roads and Bridges

The highway network is the most vital part of the transportation system in the Old Colony region, as it is used daily by almost all of the region's 393,249 residents who rely on it to get to their jobs, shopping, and social activities. The roads and bridges in the Old Colony region are some of the oldest in the country and when combined with severe weather events, this infrastructure is susceptible to major damage.

The most immediate impact of more intense precipitation is increased flooding of roadways, especially those located within the 100 and 500-Year Flood Zones as well as those areas along the coastline. While potential changes in average annual precipitation are likely to have little impact, an increase in the intensity of individual extreme rainfall events may have significant implications. An increase in the frequency of extreme precipitation events will result in more frequent short-term flooding and bridge scour, as well as more culvert washouts that exceed the capacity of the current stormwater management infrastructure.

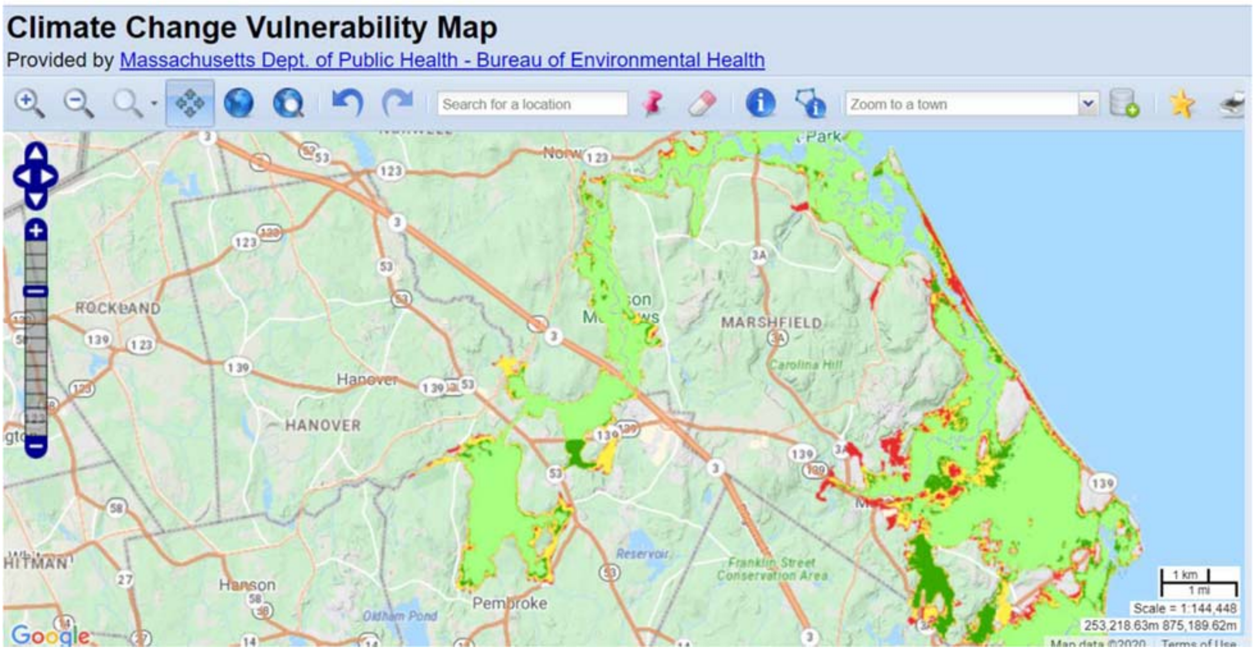
While most of the Old Colony region is located inland, the coastal communities of Duxbury, Kingston, and Plymouth must also deal with the potential rise in sea levels. According to the Transportation Research Board (TRB), expected sea level rise will aggravate flooding because storm surges will build on a higher base, reaching farther inland. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report on North America identifies coastal flooding from expected sea level rise and storm surge, especially along the Gulf and Atlantic coasts, as one of the most serious effects of climate change.

Higher sea levels and storm surges can also erode road bases and undermine bridge supports. The loss of coastal wetlands and barrier islands will lead to further coastal erosion due to the loss of natural protection from wave action. Additionally, strong winds from storms can also damage highway signs, traffic signals, and luminaries throughout the area. More significant safety and operational impacts are likely to be caused by debris blown onto roadways and from crashes precipitated by debris or severe winds.

The roadways and bridges in the Old Colony region are also exposed to a wide range of temperatures, from the extreme heat and humidity of the summer months to the cold and snow of the winter. According to the U.S. Global Change Research Program, impacts related to projected changes in average temperatures appear to have only moderate implications for bridges and highways, while increases in extreme heat may be significant. Longer periods of extreme heat may compromise pavement integrity, such as softening asphalt and increasing rutting, the buckling of pavement (especially older, jointed concrete), and flushing or bleeding of asphalt from older or poorly constructed pavements. In addition, an increase in the freeze–thaw may occur, creating frost heaves and potholes on roads resulting in load restrictions on certain bridges and roads to minimize damage. Extreme heat can also cause the thermal expansion of bridge joints, which adversely affects bridge operation. This will generally lead to increased maintenance costs wherever pavement thermal tolerances are exceeded. Extreme heat during the summer is also likely to increase the number of wildfires, threatening communities and infrastructure directly and bringing about bridge and road closures in affected areas.

Hurricane Surge Zones

Maps from the Massachusetts Department of Public Health show the impact of the Hurricane surge zone on several OCPC coastal communities including Duxbury, Kingston, and Plymouth as well as those communities of Hanover and Pembroke near the coast, (including the non-OCPC communities just north and east, Marshfield and Norwell). The following figures, Figure 4 to Figure 6 show the inundation zones from Hurricane surges from Category 1 through 4 Hurricanes and how they impact the OCPC transportation system.



Based on this data, Figure 4 shows that a Category 1 Hurricane is expected to cause a storm surge that will impact the North River causing flooding inland through Marshfield, Norwell, Hanover, and Pembroke. A Category One hurricane has the potential to flood out Route 3 at the Pembroke/Norwell Town Line as well as other arterials important to travel on the road network in Hanover and Pembroke including Route 139, Route 53, and Route 14, as well as Elm Street and West Elm Street in Pembroke. This map also shows significant flooding impacts to Route 3A in the northern part of Duxbury at the Marshfield line with flood inundation from a Category 2 and 3 Hurricane.

I highlighted the figure # as it will change when you format this into the final report. I thought it would be easier to locate them if I highlight them.

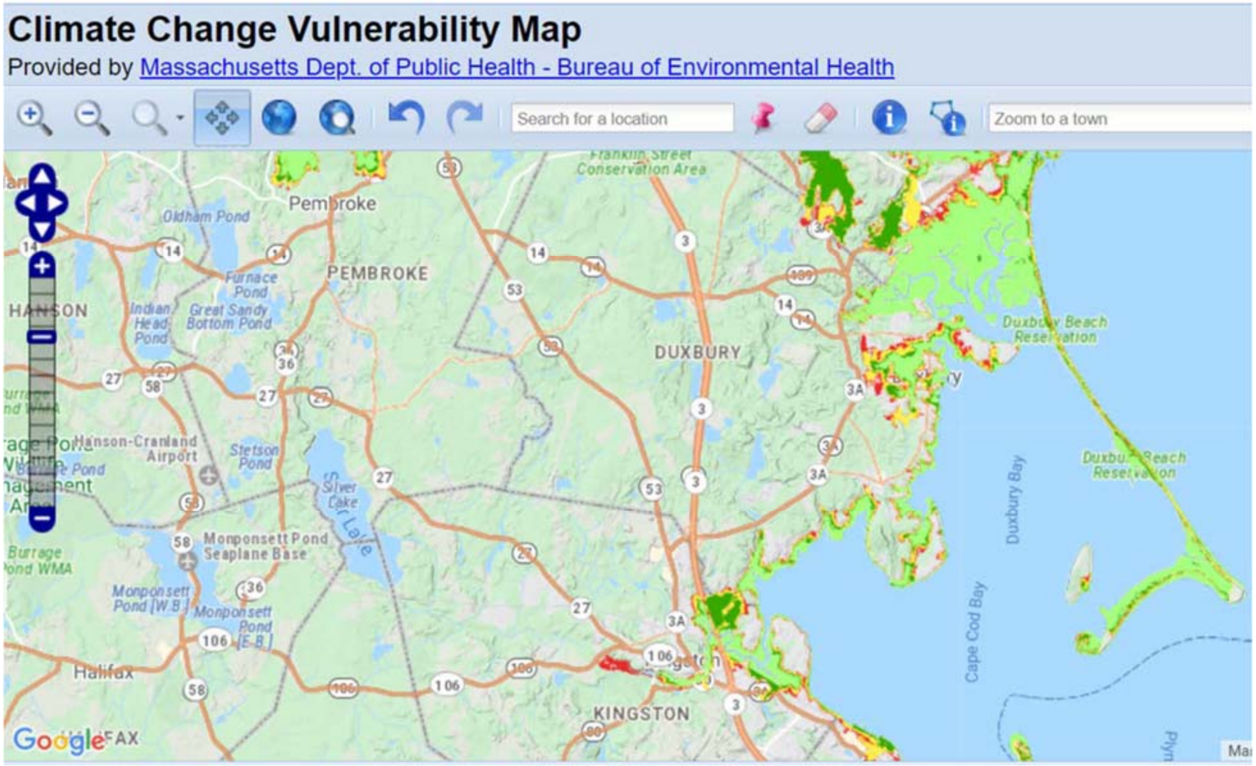


Figure 5 shows that a potential storm surge from a Category 1 and 2 Hurricane will impact Route 3A in Duxbury as well as Route 139 in Marshfield just north of the Duxbury line, St. George Street, and Washington Street. A storm surge from a Category 1 or 2 Hurricane is expected to impact Kingston significantly with flood impacts to Route 3 and Main Street (Route 3A). The Hurricane storm surge is also expected to flood the passenger rail lane to North Plymouth, which runs parallel to Main Street (Route 3A) in Kingston, to Kingston center where it then crosses Main Street and runs west at Evergreen Street.

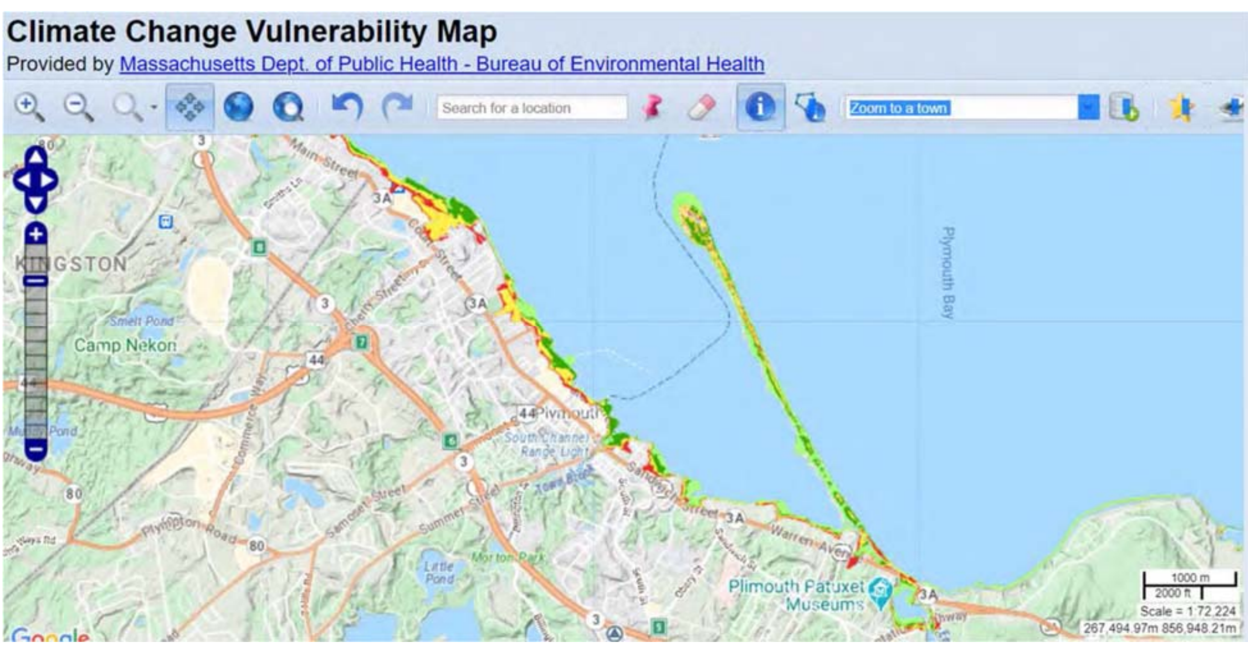


Figure 6 shows that Cordage Park, Route 3A at Cordage Park, and the MBTA T Cordage Passenger Rail Station in Plymouth are expected to be flooded during the storm surge from a Category 3 or higher Hurricane. Much of the coastline from Eel Brook north through the Plymouth Center to the Holmes Reservation in the north is expected to be impacted by a Category 1 and higher Hurricane in Plymouth. The most significant impacts to the transportation network in Plymouth occur on Route 3A over the Eel River and also at the Town Brook at Summer Street and Route 3A, where Route 3A in Plymouth is likely to be flooded from a Category 1 or higher Hurricane.

National Flood Insurance Program (NFIP)

According to the Federal Emergency Management Administration (FEMA), the National Flood Insurance Program (NFIP) is a federal program that aims to reduce the impact of flooding on private and public structures. It provides affordable insurance to property owners, renters, and businesses and encourages communities to adopt and enforce floodplain management regulations. The program is intended to reduce the socioeconomic impacts of disasters by promoting the purchase and retention of general risk insurance, specifically, flood insurance.

FEMA has defined flood zones within geographic areas according to varying levels of flood risk. These zones are shown on a community's official Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map. Each zone reflects the severity or type of flooding in the area. According to FEMA, The Flood Insurance Rate Map (FIRM) is the official map of a community on which FEMA has delineated Special Flood Hazard Areas (SFHA) for floods and the risk premium zones applicable to parcels in a specific community. The one percent annual chance flood is also referred to as the base flood or 100-year flood. The FEMA flood zones are defined as follows (a more detailed description is included in the appendix to this report):

Zone A

The flood insurance rate zone that corresponds to the 100-year floodplains no Base Flood Elevations or depths are shown within this zone.

Zones AE and A1-A30

The flood insurance rate zones that correspond to the 100-year floodplains are determined by detailed methods. Base Flood Elevations are shown at selected intervals within this zone.

Zone AH

The flood insurance rate zone corresponds to the areas of 100-year shallow flooding with a constant water-surface elevation (usually areas of ponding) where average depths are between 1 and 3 feet.

Zone AO

The flood insurance rate zone corresponds to the areas of 100-year shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average flood depths derived from the detailed hydraulic analyses are shown within this zone.

Zone D

The designation on NFIP maps is used for areas where there are possible but undetermined flood hazards. In areas designated as Zone D, no analysis of flood hazards has been conducted.

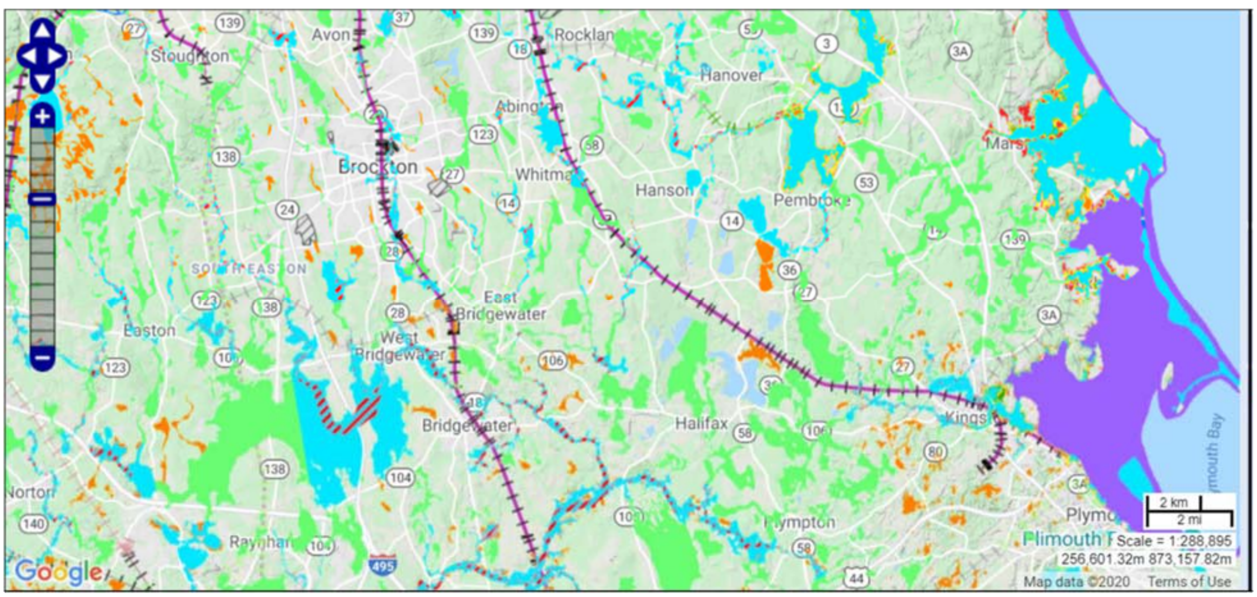
Zone V and VE

The flood insurance rate zone corresponds to the 100-year coastal flood plains that have additional hazards associated with storm waves.

Zones B, C, and X

The flood insurance rate zones that correspond to areas outside the 100-year floodplains, areas of 100-year sheet flow flooding where average depths are less than 1 foot, areas of 100-year stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 100-year flood by levees.

Figures 7 through 9 show a series of maps that show the FEMA flood zones in the OCPC region and their impact on the transportation infrastructure. Figure 7 shows the Plymouth/Kingston passenger rail line is impacted by Zone A through Kingston center as well as in Plymouth at Cordage Park. The Marlborough passenger rail line was impacted by Zone A in Bridgewater and East Bridgewater. Figure 7 also shows the Zone A flood impacts on Route 3A in Kingston Center and Route 106 in Kingston as well as Route 3A in Duxbury. In addition, the Kingston-Plymouth passenger rail is expected to be impacted in Whitman.



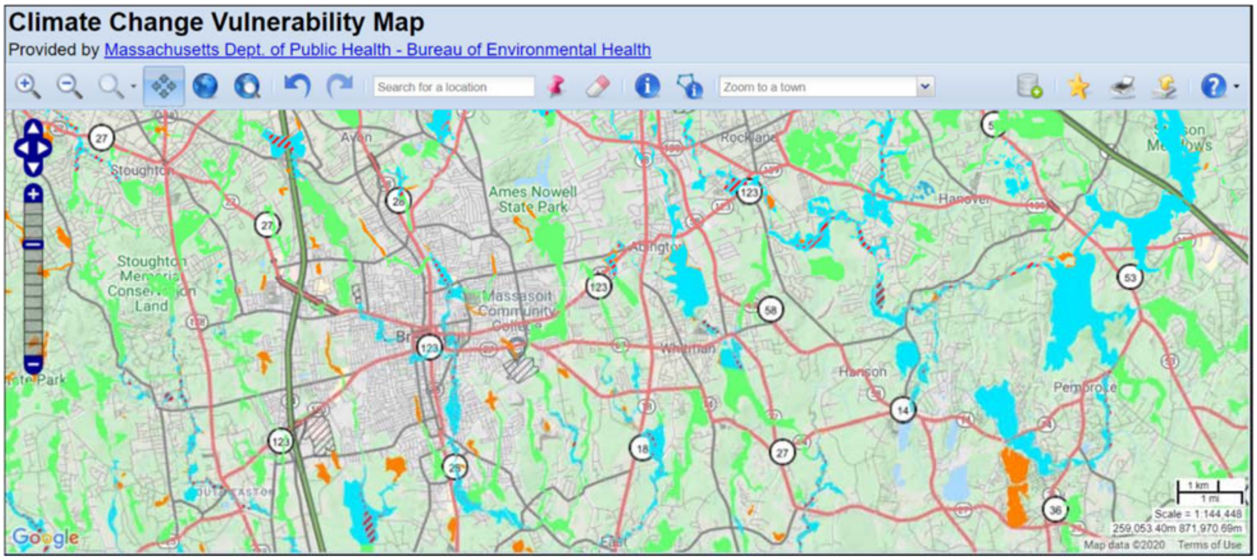


Figure 8 shows the impact of the FEMA flood zones on the regional highway network with impact flooding (Zone A) on Route 53 and Route 139 in Hanover, Route 14 in Pembroke, Route 14 in Hanson and Halifax, Route 123 and Route 139 in Abington, Route 18/28 in Bridgewater, Route 18 and Route 28 in West Bridgewater, and Route 28 in the south of Brockton. In addition, Figure 8 shows potential Zone A flooding impacts to the two limited access highways in the region, Route 24 in the north at the Avon/Stoughton line, and Route 3 in Pembroke.

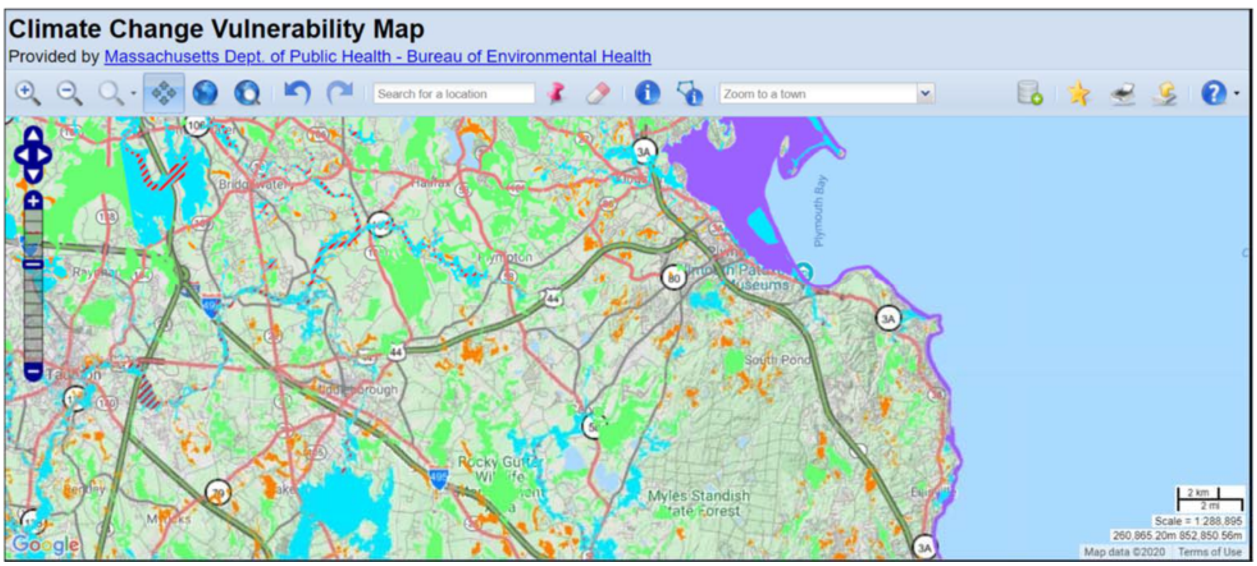


Figure 9 shows the flood zone map impacts on Route 138 in Easton, just north of Raynham, as well as the impacts on Route 24 in Bridgewater, Route I-495, just south of the OCPC region, and Route 44. Figure 9 also shows flood zone map impacts on Route 105 in Bridgewater and Halifax, Route 36 in Halifax, Route 106 in Halifax, and Kingston, as well as the impacts to Route 3A in Kingston center and along the coast in Duxbury and Plymouth.

Climate Change Projects in the OCPC Region

The *2015 Natural Hazard Mitigation Plan for the Old Colony Region* lists several projects for each of the OCPC communities that are designed to specifically address the impacts of Climate Change.

The purpose of the 2015 plan was to develop an inclusive, comprehensive, and long-term plan to prepare for disasters before they occur. The 2015 plan supports communities in their response to The Federal Disaster Management Act of 2000 (DMA 2000), which established a national program for regional mitigation and the administration of disaster relief. The Federal DMA 2000 mandates that all localities must review and revise their local natural hazard mitigation plans every five years to reflect changes in development, progress in mitigation efforts, and changes in priorities. Table 6 includes Climate Change projects by the town in the region, originally compiled in the 2015 plan and updated to include projects since the completion of that study.

Table 6

Community	Project/Action	Source
Abington	Removed and replaced several "blocked" drain lines in various locations throughout town, including Nash Memorial Drive, Jennings Drive, Spruce Street, West Street, and Central Street.	2015 Plan (before 2015)
Abington	Cleared and cleaned pipe inverts in the following areas: Island Grove Pond, Central Street, Centre Avenue, North Avenue, Lincoln Street, Colonel Hunt Drive, Shaw Avenue, and others.	2015 Plan (before 2015)
Abington	Conducted regular maintenance of storm drains utilizing a catch basin digger.	2015 Plan (before 2015)
Abington	Replace the superstructure of Central Street over the Shumatuscacant River to rehabilitate and replace a structurally deficient bridge (MassDOT Project #607346).	Old Colony TIP in design
Avon	Cleaned pipes and outlets on Route 24 during the Resurfacing and Related Work on Route 24 Project (MassDOT Project ID# 605238).	Old Colony TIP
Avon	Replaced the Ladge Street culvert over Trout Brook with a new larger culvert after it collapsed due to heavy rains during March 2010 floods.	2015 Plan (before 2015)
Avon	Improved drainage on the following roadways with the addition of culvert enlargements, larger pipes, and additional catch basins: o East High Street o East Spring Street o Page Street o Pond Street o Brentwood Subdivision Avenue Subdivision (partially completed)	2015 Plan (before 2015)
Avon	Completed drainage improvements in the Nichols Avenue, Johnson Road, Howard Lane, and Lawson Street neighborhoods.	2015 Plan (before 2015)
Avon	Cleared brooks and streams of trash and vegetation throughout town to allow for the free flow of water and to mitigate flooding.	2015 Plan (before 2015)
Bridgewater	At Halifax line bridge replacement Cherry Street over the Taunton River (MassDOT Project # 601280)	Old Colony TIP completed 2002)
Bridgewater	Installed catch basins and built-up aprons to control drainage on Bedford Street (Routes 18/28) during the Resurfacing and Related Work on Routes 18 & 28 Project from the Bridgewater to the Middleboro Rotary (MassDOT Project ID# 601104).	Old Colony TIP
Bridgewater	Replaced the Bedford Street (Route 18) Bridge over the Taunton River with a reinforced concrete drainpipe and catch basins during the Bedford Street Bridge Replacement Project (MassDOT Project ID# 603385).	Old Colony TIP Complete 2008
Bridgewater	Installed catch basins with curb inlets and reinforced concrete drainpipes at the intersection of Bedford Street (Routes 18/28) at Winter Street during the Signalization & Improvement Project (MassDOT Project ID# 603568).	Old Colony TIP
Bridgewater	Replaced the Summer Street Bridge over the Taunton River during the Summer Street Bridge Replacement Project (MassDOT Project ID 04415).	Old Colony TIP Complete

Community	Project/Action	Source
Bridgewater	Installed a closed drainage system to convey stormwater from North Street during the Reconstruction of North Street, from Pleasant Street (Route 104) to Village Gate Drive Project (MassDOT Project #604958).	Old Colony TIP
Bridgewater	Replaced the Bridge Street Bridge over the Town River after it partially collapsed during the March 2010 floods.	2015 Plan (before 2015)
Bridgewater	Replaced the Hayward Street Bridge over the Town River after it partially collapsed during the March 2010 floods.	2015 Plan (before 2015)
Bridgewater	Repaired the Northfield Drive culvert.	2015 Plan (before 2015)
Bridgewater	Repaired damage to Bridge Street at the approach to the bridge after damage due to March 2010 floods.	Town project
Brockton	Brockton- intersection improvements at Lyman Street/grove street/summer street & replacement of grove street bridge, b-25-005, over the Salisbury Plain River	Old Colony TIP (in Design)
Brockton	Bridge replacement on Allen Street over Salisbury Brook (MassDOT project #600649).	TIP completed 2002
Brockton	Installed catch basins, with curb inlets and drainage manholes, and reinforced concrete drainpipes as part of the reconstruction of West Chestnut Street from Pearl Street to Burke Drive (MassDOT Project ID# 601339).	Old Colony TIP
Brockton	Installed catch basins with curb inlets, drainage manholes, and reinforced concrete drainpipes as part of the Reconstruction of Winter Street from Howard Street to North Cary Street (MassDOT Project ID #601347).	Old Colony TIP
Brockton	Replaced the Bartlett Street Bridge over the Salisbury Brook during the Bartlett Street Bridge Replacement Project (MassDOT Project ID #601393).	Old Colony TIP complete
Brockton	Installed catch basins with curb inlets, drainage manholes, and reinforced concrete drainpipes as part of the Signal & Intersection Improvements Project at Montello Street (Route 28) and Howard Street (Route 37) (MassDOT Project ID #602557).	Old Colony TIP
Brockton	Installed catch basins, catch basins with curb inlets, gutter inlets, and reinforced concrete drainpipes as part of the Signal & Intersection Improvements Project at Pleasant Street (Route 27) and Belair Street and Moraine Street (MassDOT Project ID #604595).	Old Colony TIP
Brockton	Replaced the White Avenue Bridge over the Salisbury Brook during the White Avenue Bridge Replacement Project (MassDOT Project ID #604419).	Old Colony TIP Complete
	Brockton- Bridge Replacement, Br# B-25-059 Spring Street Over Salisbury Brook (602539)	Old Colony TIP complete
Brockton	Installed catch basins, new drainage manholes, and reinforced concrete drainpipes as part of the Reconstruction of Pleasant Street (Route 27) at West Street and Westgate Mall Drive (MassDOT Project ID# 604741).	Old Colony TIP
Brockton	Completed Emergency Action Plans (EAP) for city-owned dams: Ellis Brett Pond Dam, Thirty Acre Pond Dam, and Waldo Lake Dam.	2015 Plan (before 2015)
Brockton	Installed a Bandalong Litter Trap in the Salisbury Plain River to capture and remove floating litter preventing trash dams, and impairing the free flow of water.	2015 Plan (before 2015)
Brockton	The city completed over $110 million in wastewater, sewer, and clean water infrastructure improvements throughout the city.	2015 Plan (before 2015)
Brockton	$1.6 million in upgrades for the booster station.	2015 Plan (before 2015)
Brockton	Infrastructure improvements to the earthen Brockton Reservoir Dam in Avon, including replacing the wooden spillways with newer concrete spillways, as well as high and low-level outlet control valves.	2015 Plan (before 2015)
East Bridgewater	Repairs at the Forge Pond Dam, which is rated in “Poor” condition.	2015 Plan (before 2015)

East Bridgewater	Reduced streamside risks by removing selected structures from floodways and reconfiguring banks for storage and safe dry weather open space/habitat use.	2015 Plan (before 2015)
East Bridgewater	Adopted stormwater treatment and retention requirements for new developments.	2015 Plan (before 2015)
East Bridgewater	Replaced and elevated the Department of Public Works office building to prevent flooding from heavy rains.	2015 Plan (before 2015)
East Bridgewater	Placed snow fencing in snowdrift-prone areas throughout town.	2015 Plan (before 2015)

Community	Project/Action	Source
Easton	Replaced the Central Street Bridge over the Queset Brook during the Central Street Bridge Replacement Project (MassDOT Project ID #602836).	Old Colony TIP complete
Easton	Installed catch basins, catch basins with curb inlets and drainage manholes, and reinforced concrete drainpipes as part of the Reconstruction of the Intersection of Routes 106 & 123 (Five Corners) (MassDOT Project ID# 604658).	Old Colony TIP
Easton	Installed catch basins, catch basins with curb inlets, drainage manholes, gutter inlets, leaching basins, and reinforced concrete drainpipes as part of the Reconstruction of Foundry Street (Route 123) from Route 106 to the Norton Town Line (MassDOT Project ID# 601332).	Old Colony TIP
Easton	Made improvements to dams in town: Ames Long Pond Dam, Langwater Pond Dam, and Shovelshop Pond Dam.	2015 Plan (before 2015)
Duxbury	Bridge Replacement (48H & 48J), Route 3 (PILGRIM HIGHWAY) NB/SB over Franklin Street (MassDOT Project ID 605294).	Old Colony TIP (under Design)
Duxbury	Bridge Replacement D-14-003 (438), Powder Point Avenue over Duxbury Bay (MassDOT Project ID 612006).	Old Colony TIP (under Design)
Halifax	Replaced the riprap around the culvert on Plymouth Street (Route 106) across from the Police Station.	2015 Plan (before 2015)
Hanover	Hanover- Pembroke- Bridge Rehabilitation, Br# H-06-005=P-05-005 Route 53 (Washington Street) Over The North River	Old Colony TIP project complete
Hanson	Installed drainage manholes, reinforced concrete drainpipes, and catch basins with curb inlets during the Reconstruction of Franklin Street (Route 27) (MassDOT Project ID# 600397).	Old Colony TIP
Hanson	Replaced smaller drainage pipes with larger ones on Maquan Street across from Maquan Pond.	2015 Plan (before 2015)
Hanson	Purchased a new jet rodder for $44,000 to flush drains throughout town. The new more powerful and efficient jet rodder replaces an aging 1961 rod that was used to flush drains.	2015 Plan (before 2015)
Hanson	Completed a drainage project on Crescent Street to alleviate flooding issues.	2015 Plan (before 2015)
Kingston	Bridge repair and concrete work systematic bridge preservation Route 3 over the Jones River (MassDOT Project # (609376).	Old Colony TIP
Kingston	Improvements to a structurally deficient bridge Route 3 over the Jones River by replacing the superstructure (MassDOT project #607268).	Old Colony TIP (in design)
Kingston	Replaced the Elm Street Bridge over the Jones River during the Elm Street Bridge Replacement Project (MassDOT Project ID #24090).	Old Colony TIP project complete
Kingston	Installed drainage manholes, reinforced concrete drainpipes, catch basins and catch basins with curb inlets, drop inlets, leaching basins, and gutter inlets during the Reconstruction of Pembroke Street (Route 27) (MassDOT Project ID# 600413).	Old Colony TIP
Kingston	Acquired property on Elder Avenue to mitigate flooding.	2015 Plan (before 2015)
Kingston	Acquired the Halfway Preserve property off Route 106 to mitigate flooding.	2015 Plan (before 2015)
Kingston	Replaced the Brookdale Street culvert that washed away during the March 2010 floods.	2015 Plan (before 2015)
Kingston	Purchased a Vactor sewer cleaning truck to clean catch basins as needed.	2015 Plan (before 2015)

Kingston	Embarked on a program to reduce the amount of road salt being used when treating roadways in inclement weather.	2015 Plan (before 2015)
Kingston	Implemented a Reverse 911 public safety communications system to notify residents via telephone of emergencies in town.	2015 Plan (before 2015)
Pembroke	Installed drainage manholes, catch basins, and catch basins with curb inlets and gutter inlets with gutter mouths during the Corridor Improvements on Route 139 (Plain Street) Project (MassDOT Project ID# 604915).	Old Colony TIP
Pembroke	Replaced backup diesel fuel engine with a Natural Gas backup generator and automatic transfer switch at Drinking Water Pumping Station #2.	2015 Plan (before 2015)

Community	**Project/Action**	**Source**
Pembroke	Replaced angle drive natural gas engine and replaced it with a Natural Gas backup generator and automatic transfer switch at Drinking Water pumping Station #3.	2015 Plan (before 2015)
	Norwell- Pembroke- Bridge Replacement, N-24-004=P-05-008, Route 3 (Nb & Sb) Over North River. This project is intended to replace a structurally deficient bridge on Route 3 in Norwell and Pembroke over the North River.	Old Colony TIP (in design)
Pembroke	Replaced failed leach basins and paved roadway at 14 Glenwood Road.	2015 Plan (before 2015)
Pembroke	Replaced failed box culvert with 24" RCP and tied it into existing headwalls at Monroe Street.	2015 Plan (before 2015)
Pembroke	Drainage project improvement to reroute stormwater runoff to alleviate flooding in the McKenzie Orchard subdivision as well as on Oldham Street.	2015 Plan (before 2015)
Plymouth	Plymouth- Bridge Replacement, Br# P-13-012 River Street Over Eel River (602591)	Old Colony TIP complete 2004
Plymouth	Installed gutter inlets, catch basins, catch basins with curb inlets, reinforced concrete pipes, and leaching basins at the Intersection of Route 3A, Manomet Point Road, and Strand Avenue (MassDOT Project ID# 603468).	Old Colony TIP
Plymouth	Installed catch basins and reinforced concrete drainpipes during the Resurfacing and Related Work Project on Route 3 (MassDOT Project ID #604223).	Old Colony TIP
Plymouth	Plymouth DPW project improvements to existing stormwater outfalls for the Billington Sea 319 Stormwater Project. Improving capacities and treatment of sediments, nutrients, and bacteria discharged to the coastal seabed.	2015 Plan (before 2015)
Plymouth	Plymouth DPW improvements to Samoset Street 319 Stormwater Project focusing on improvements to drainage, stormwater treatment, and water quality in Plymouth Harbor.	2015 Plan (before 2015)
Plymouth	Water management and modeling software were installed to improve simulations that assess hydraulic and aquifer performance, determine firefighting capabilities, and facilitate environmental impacts and design.	2015 Plan (before 2015)
Plymouth	Improvements to the recreational boating pump-out facility within the Town of Plymouth.	2015 Plan (before 2015)
Plymouth	Town-wide DPW drainage projects (95 total) for the reconstruction of swales and conventional drainage systems, and the design and installation of stormwater mitigation areas and culverts.	2015 Plan (before 2015)
Plymouth	Town-wide DPW Catch Basin Maintenance and Repair Operations (3,600) to improve stormwater capacity and limit localized problem flooding areas.	2015 Plan (before 2015)

Plymouth	Plymouth's Environmental Management Division obtained 11 grant awards for the design and execution of the Eel River Headwaters Mitigation Project.	2015 Plan (before 2015)
Plymouth	Plymouth DPW completed the phase 1 inspection of 12 municipally owned dams and initiated dam removal projects with private/public owners.	2015 Plan (before 2015)
Plymouth	Plymouth DPW and Planning Departments completed extensive GIS improvements to map stormwater drainage systems, coastal erosion, and flooding areas affecting Plymouth Bay and the Buzzards Bay Watershed Areas.	2015 Plan (before 2015)
Plymouth	Plymouth- Reconstruction Of Taylor Avenue, From White Horse Road To Manomet Point Road, Includes Bridge Replacement OF P-13- 010 Work on this project will consist of roadway reconstruction, sidewalk installation, and reconstruction, installation of a closed drainage system, and replacement of the bridge carrying Taylor Avenue over Bridge Dam Brook. The work will improve roadway functionality, pedestrian bicycle mobility, and existing drainage issues in the Taylor Avenue corridor. (Project # 605038)	Old Colony TIP Complete
Plympton	Installed catch basins and catch basins with curb inlets, gutter inlets with gutter mouths, and gutter inlets during the Reconstruction of Main Street and Palmer Road (Route 58) (MassDOT Project ID# 602337).	Old Colony TIP

Plympton	Completed Phase 1 of the Dam Management Plan for the Winnetuxet Road Pond Dam.	2015 Plan (before 2015)
Plympton	Removed and cleared debris from culverts throughout town.	2015 Plan (before 2015)
Plympton	Worked with NSTAR to proactively trim trees around utility lines throughout town.	2015 Plan (before 2015)
Plympton	Plympton- Bridge Replacement, P-14-001 (445), Winnetuxet Road Over Winnetuxet River	Old Colony TIP (in Design)
Stoughton	Replaced a culvert on Bay Road in 2010.	2015 Plan (before 2015)
Stoughton	Installed Beehive drainage grates on Grove Street at Lincoln Street in 2010.	2015 Plan (before 2015)
Stoughton	Replaced a culvert on Lake Drive in 2011.	2015 Plan (before 2015)
Stoughton	Installed Beehive drainage grates at the Pratt Court Treatment Plant in 2011.	2015 Plan (before 2015)
Stoughton	Replaced a culvert on Pratt Court in 2012.	2015 Plan (before 2015)
Stoughton	Installed catch basins on Sharon Street.	2015 Plan (before 2015)
Stoughton	Installed Beehive drainage grates on Walker Road.	2015 Plan before 2015)

Community	Project/Action	Source
West Bridgewater	Replaced the South Street Bridge over the Town River during the South Street Bridge Replacement Project (MassDOT Project ID #130200).	Old Colony TIP complete
West Bridgewater	Installed catch basins, new drainage manholes, and reinforced concrete drainpipes as part of the Reconstruction of Manley Street from West Center Street (Route 106) to the Brockton City Line. (MassDOT Project ID# 601854).	Old Colony TIP
West Bridgewater	Replaced the Scotland Street Bridge over the Town River during the Scotland Street Bridge Replacement Project (MassDOT Project ID #603515).	Old Colony TIP Complete
West Bridgewater	Installed catch basins during the Park & Ride Upgrade Project (MassDOT Project ID# 604814).	Old Colony TIP
West Bridgewater	Cleaned existing pipes and outlets on Route 24 during the Resurfacing and Related Work on Route 24 Project (MassDOT Project ID# 605558).	Old Colony TIP
West Bridgewater	Updated FEMA Flood Maps were adopted by the town.	2015 Plan (before 2015)

West Bridgewater	Made repairs were made to both the Maple Street culvert and the Manley Street culvert.	2015 Plan (before 2015)
West Bridgewater	West Bridgewater- Bridge Replacement, W-18-012, Route 106 (West Center Street) Over the Hockomock River. The existing stone arch and reinforced concrete arch carrying West Center Street over the Hockomock River are anticipated to be replaced with a single-span superstructure of approximately 65 feet. The superstructure system of the first choice is a precast arch. (Project 605351)	Old Colony TIP Complete
Whitman	Rebuilt existing drainage structures during the Cold Planing and Resurfacing of Bedford Street (Route 18) Project (MassDOT Project ID# 604160).	Old Colony TIP
Whitman	Replaced the crumbling headwall of the Harding's Pond Dam with a newly poured concrete headwall.	2015 Plan (before 2015)
Whitman	Cleared trees and brush away from the river and stream banks throughout town every winter to allow for the free flow of water.	2015 Plan (before 2015)
Whitman	Used a sewer jet to clean drains of sediment and roots in various neighborhoods throughout Whitman as needed.	2015 Plan (before 2015)
Whitman	Dredged the following rivers and streams of sediment to reduce the risk of flooding: Unnamed stream at Route 18 and the Stop & Shop Driveway Unnamed stream at Route 58 between Simmons Avenue & Indian Trail Unnamed stream at Route 14 and Homeland Drive	2015 Plan (before 2015)

Stormwater Management

In Massachusetts, polluted stormwater runoff and discharges in urbanized areas cause serious water-quality problems. Polluted runoffs to waterbodies can negatively affect aquatic plant and animal life in streams and lakes. The effective management of stormwater is critical in protecting the quality of the natural environment adjacent to the roadway. Stormwater can become a transportation system for pollutants such as car antifreeze, motor oil, and salt and sand from de-icing operations, all of which can be deposited untreated into waterways.

Untreated runoff poses a major threat to water quality and is identified as a major source of nonpoint source pollution (NPS). Nonpoint source pollution or "polluted runoff" – which enters our water bodies from septic systems, agricultural uses, and runoff from roads, parking lots, construction sites, lawns, and other locations - is now the dominant cause of water quality problems in our lakes, rivers and coastal areas. Point sources still have significant impacts on certain water bodies, but across the state, nonpoint source pollution affects more total miles and acres of water. Although these pollution sources are lumped under the single heading of nonpoint sources there are a huge variety of nonpoint sources from farms to parking lots, which result from a similarly wide range of activities, from cars with leaking oil to the construction of new structures. It is easier and less costly to prevent problems from occurring than it is to fix them after they occur.

The pollution of the marine environment, because of roadway runoff, can impact coastal resources and economies. Protecting water resources is important for a better quality of life, economic development, recreational activities, wildlife and plant protection, and public/private water supplies.

The Impact of Salt Deicers

Salt applied to roadways for winter maintenance eventually percolates through roadside soils and enters aquifers with precipitation recharge in the early spring. There are varying opinions as to the proportion of road salt runoff that infiltrates groundwater; however, the actual amount of road salt runoff that infiltrates groundwater depends upon features such as permeability, vegetation cover, gradients, and roadside drainage techniques. Studies show that up to 35 percent of road salt spread for winter maintenance can end up in the groundwater. The current knowledge regarding the chemistry and physics of salt pollution indicates that groundwater contamination due to road salt for storm application can be problematic.[7] Increased sodium levels in drinking water can represent a health risk to people suffering from high blood pressure. Roadside vegetation is damaged by deicing salts through soil salt concentrations, which allow for salt absorption by roots, and by direct airborne salt spray on needles and branches.[8] Salt, which is sodium chloride, leaves residues of chloride ions on highway surfaces that not only contaminate surrounding groundwater resources but also corrode motor vehicles and bridge structures. Salt along the roadside may also be responsible for attracting deer to the side of the highways thereby contributing to accidents and injuries. The impacts of using salt for deicing include:

- Contamination of drinking water supplies
- Increased maintenance of roadside vegetation and removal of dead trees and shrubs
- Corrosive damage to bridge structures and vehicles.

The use of alternative deicers to salt is how agencies can reduce the amount of salt infiltration. Several alternatives have been in use including calcium magnesium acetate (CMA), calcium chloride, and magnesium chloride; however, calcium chloride and magnesium chloride, like salt, also leave residues of chloride ions on the road surface, which contaminate ground waters and corrode motor vehicles and bridge structures.[9]

These different deicing alternatives vary in effectiveness depending on the temperature. As the temperature drops, salt's effectiveness slows to the point that when it gets near 10 degrees and below, its effectiveness is greatly diminished. Calcium chloride is a hygroscopic material that attracts moisture from its surroundings, speeding the creation of brine to give melting action a fast start, and its lowest effective temperature is -25°F, which is below that of other common deicers. Magnesium chloride has an effective temperature of 0°F. CMA is typically used in blends with rock salt or other lower-cost materials. It has the lowest effective temperature roughly equivalent to rock salt.

CMA can be an effective deicing alternative to road salt if handled and used properly. CMA is made from limestone and acetic acid (commonly found in vinegar) and is biodegradable and non-toxic. Studies show it has little or no effect on vegetation and water sources and is low in mammalian toxicity. The same equipment that handles road salt can also be used to apply deicer alternatives. In addition, CMA and calcium chloride can be applied with abrasives (sand and mineral aggregates) for application. A wholesale switch from salt to alternative deicers can be expensive. CMA costs up to 20 times more per ton than road salt, and calcium chloride can cost up to 6 times more per ton than road salt. The drawback to using calcium chloride as a salt alternative is that it does not address the impact of chloride on the environment, although it does reduce the amount of sodium.

Energy

The nation's continued reliance on fossil fuels cannot be sustained, as these finite, non-renewable resources will eventually disappear. In addition to being finite resources, fossil fuels are the largest source of greenhouse gas emissions, a leading cause of global warming and climate change. To accommodate the ever-increasing demand for energy, while managing a depleting supply of fossil fuels, alternative forms of energy need to be developed. The best forms of alternative energy sources are ones that are sustainable, renewable and not a detriment to the environment.

Alternative Fuels

The most recent Massachusetts Greenhouse Gas (GHG) Inventory shows that GHG emissions in 2018 were 22 percent below the 1990 baseline level, on track to meet the 25 percent reduction by 2020 required by the Global Warming Solutions Act (GSWA). Massachusetts's success in reducing GHG emissions comes despite a 14 percent growth in population and a 24 percent growth in vehicle miles traveled. Significant GHG emissions reduction from the electric sector since 2005 has been a major contributor to the drop in gross GHG emissions. Additionally, vehicle standards have lowered the carbon intensity of each vehicle mile traveled while the Commonwealth's nation-leading energy efficiency programs have helped to control energy demands in buildings despite economic growth and variable weather conditions. Over 65 percent of Massachusetts emissions come from our cars, trucks, homes, and offices, another 20 percent comes from the power plants that provide electricity for our lights, computers, and appliances.

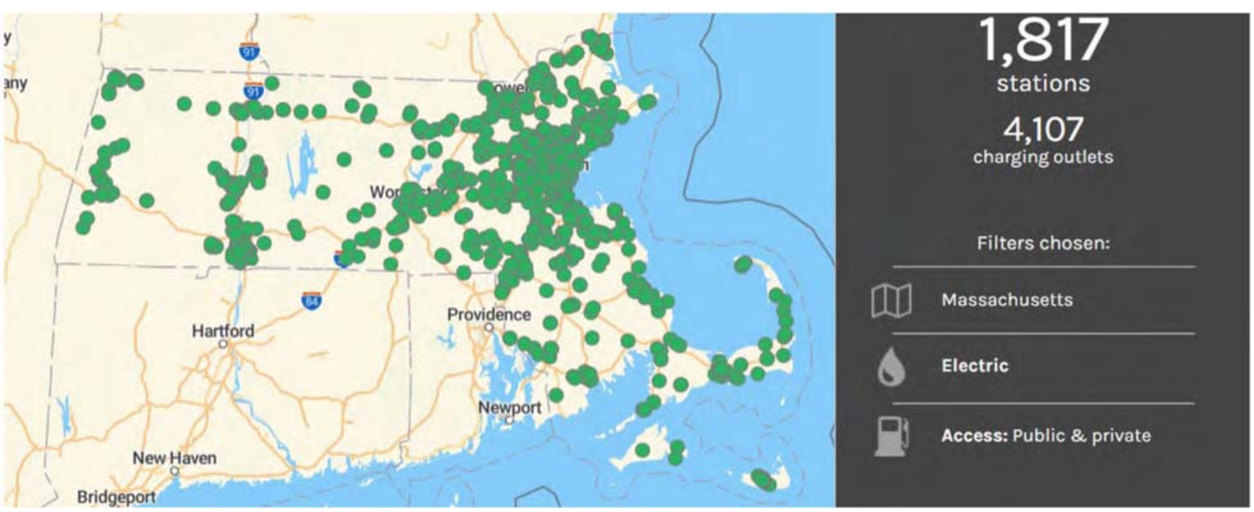
Vehicles that use alternative fuels, such as biodiesel, electricity, and natural gas help to reduce carbon emissions and increase our energy security. The Massachusetts Clean Cities Coalition promotes the adoption of alternative fuel vehicles (AFVs), supports the development of the infrastructure necessary to make AFVs viable transportation options, and aims to change our communities for the better.

Electric Vehicles in Massachusetts

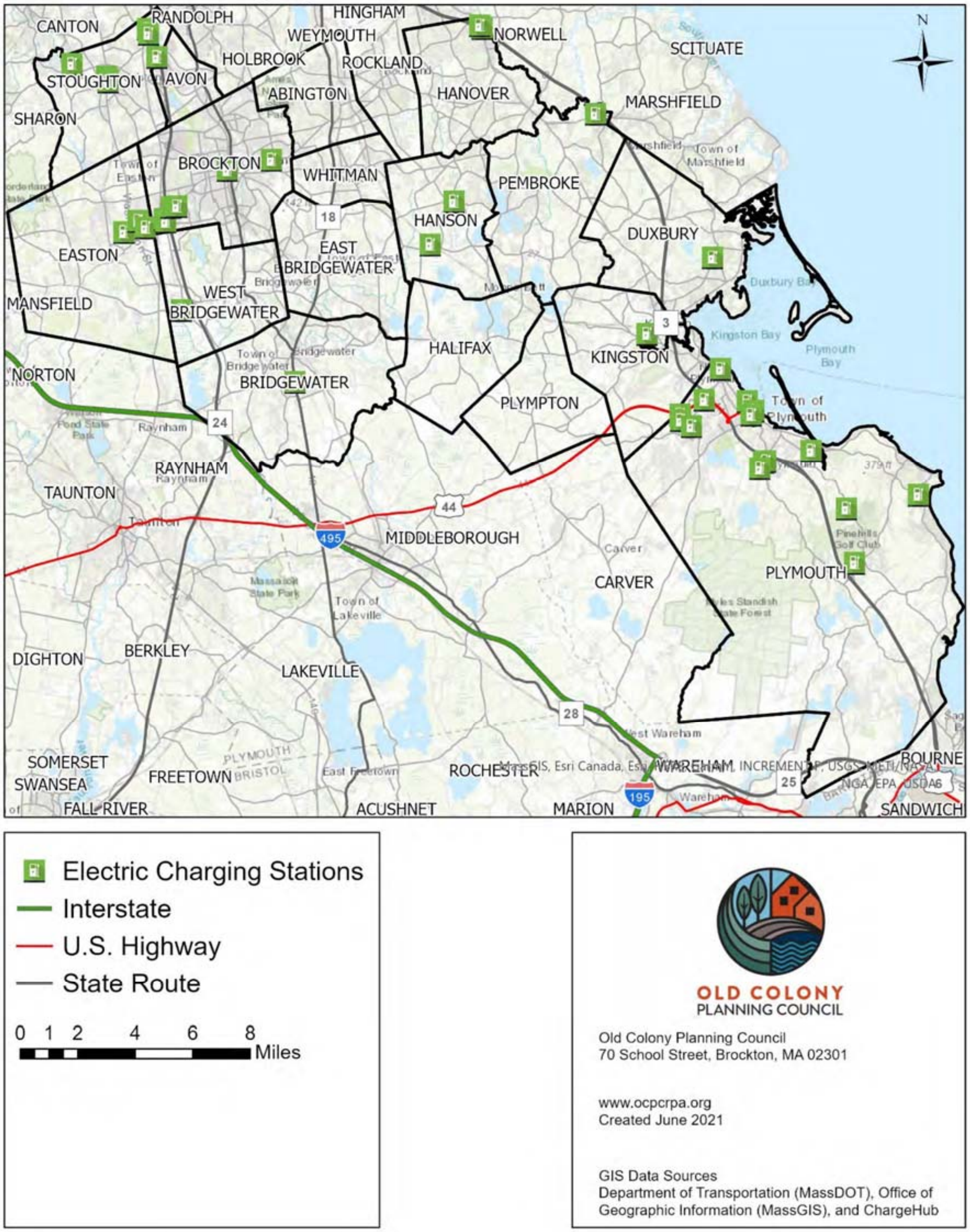
The global automobile industry decreased by sixteen percent due to the Covid-19 pandemic. Nevertheless, electric vehicle sales over the past year have been rising steadily. The International Energy Agency (IEA) states that the number of electric vehicles on the road worldwide is forecast to grow from 11 million this year to 145 million by the end of the decade. With electric vehicle sales expected to surge, this will decrease the oil demand, resulting in a decreased carbon footprint.

Massachusetts has joined the nine-state coalition, Transportation Climate Initiative, a regional collaboration of Northeast and Mid-Atlantic jurisdictions, working together since 2010 to improve transportation, develop the clean energy economy, and reduce emissions from vehicles and fuels. In addition, in the 2015 Massachusetts Zero Emission Vehicle Action Plan, there are 80 recommendations for automakers, dealers, utilities, charging and fueling companies, and other key partners to rapidly accelerate consumer adoption of zero-emission vehicles, including plug-in hybrid, battery electric, and hydrogen fuel cell vehicles. The state plans to dramatically cut greenhouse-gas emissions in the next decade and beyond through several changes, including mandating that all new cars sold in the state be electric by 2035. Massachusetts currently has about 30,000 electric vehicles on the roads, the goal by 2035 is to reach 750,000 electric vehicles.

With the number of electric vehicles on the road going up, the number of electric vehicle charging stations needs to increase as well. Many people might not be able to afford to install a charging station in their homes, so public charging station availability is crucial. Currently, Massachusetts has 1,817 public charging stations with 4,107 charging outlets. This number should increase to be able to handle the number of electric vehicles on the road by 2035. Figure 28 shows the number and locations of charging stations in Massachusetts. Figure 29 shows the location of electric vehicle charging stations in the OCPC Region.



Electric Car Charging Stations



The locations of the Electric Charging Stations in the OCPC region are as follows (by community:

Stoughton:

- 204 Tosca Drive, Stoughton, OHB Corporation

- 630 Washington Street, Stoughton, Sonic Drive-In
- 55 Monk Street, Stoughton
- 105 Porter Street, Stoughton
- 1 Hawes Way, Stoughton
- 1 Ikea Way, Stoughton
- 449 Page Street, Stoughton, Hampton Inn & Suites Boston/Stoughton

Easton

- 8 Island Court, Easton, Water Pointe
- 320 Washington Street, Easton, Stonehill College
- 99 Belmont Street, Easton, 99 Restaurant

Brockton

- 110 Liberty Street, Brockton
- 122 Liberty Street, Brockton, Copeland Volkswagen of Brockton
- 1016 Belmont Street, Brockton, Nissan 24
- 940 Belmont Street, Brockton, Veterans Affairs Boston Healthcare System
- 2-20 Crescent Street, Brockton, Brockton Parking Garage
- 680 Centre Street, Brockton, Signature Healthcare Brockton Hospital Emergency Room

West Bridgewater

- 726 West Center Street, West Bridgewater, National Grid

Bridgewater

- 545 Bedford Street, Bridgewater
- Bridgewater Town Hall, 66 Central Square Bridgewater
- Bridgewater State University Weygand Lot, 85 Burrill Ave, Bridgewater, MA

Hanson

- 1150 Main Street, Hanson
- 542 Liberty Street, Hanson

Hanover

- 1 Saturn Drive, Hanover, Coastal Volkswagen
- 2000 Washington Street, Jannell Ford of Hanover

Pembroke

- 146 Church Street, Pembroke

Recommendations