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March 27, 2015

The President
The White House
1600 Pennsylvania Avenue, N.W.
Washington, D. C. 20500

Through: Paul F. Ford, Acting Regional Administrator
Federal Emergency Management Agency, Region I
99 High Street, 6th Floor
Boston, MA 02110

Dear Mr. President:

As you are aware, the Commonwealth of Massachusetts recently experienced an unprecedented and disastrous pattern[1] of severe winter weather with record-breaking snowfall and persistent cold temperatures. Over a 28-day period we not only experienced ongoing significant snowfall resulting in nearly 9-feet of snow, but we also faced consistently sub-freezing temperatures across central and eastern Massachusetts. Despite our experience in dealing with harsh winter conditions, this severe winter pattern brought the Commonwealth to a virtual standstill for days at a time. Twenty-five people died. Hundreds more were injured. Our public transit system collapsed, and private sector commerce, government services and healthcare suffered severe disruptions. We acted quickly and decisively throughout the extended period, but the efforts required overwhelmed state and local capabilities. We estimate the total costs to state and local government from this year's

[1] As cited in the FEMA Disaster Operations Legal Reference, Version 2.0, July 2013, page 3-38, the National Weather Service defines a weather pattern as a broad meteorological phenomenon that can result in multiple weather systems over a long period of time, extending from days to weeks.

severe winter weather pattern to be near $400 million, which depleted snow removal budgets and left the state and its municipalities with huge unanticipated costs.

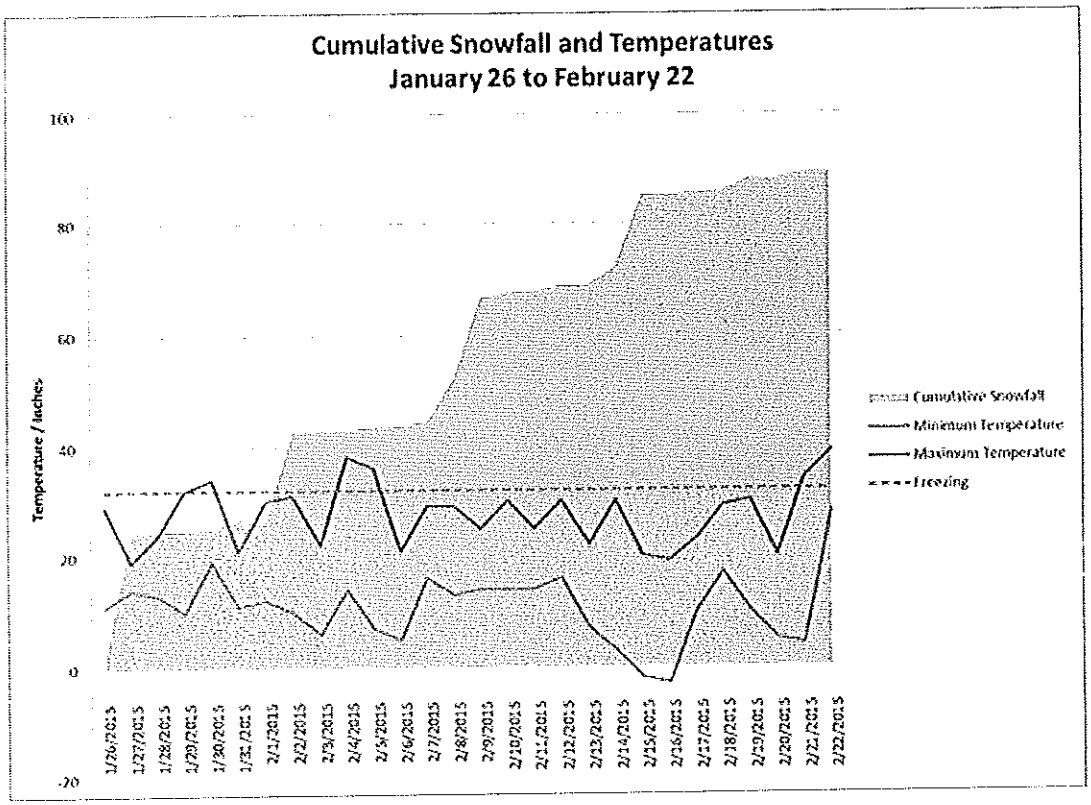
Notwithstanding the standard interpretation of FEMA policy to limit snow assistance to 48 or 72-hours after an individual storm, the Stafford Act and federal regulations allow you to determine the duration of major disaster based on the circumstances of an event and authorize snow assistance for a longer duration of time. I am confident that after reading the report that follows, you will agree that this unusual severe weather pattern which the University of Oklahoma determined to be a once-in-26,000-year event (See Attachment A) merits being treated as a single disaster of 28-days, and warrants the authorization of snow assistance for the entire incident period.

Overview

The persistent severe winter weather pattern that caused such severe impacts began with a blizzard in late January 2015 that brought record-breaking snowfall to much of Massachusetts. Even as the initial snow clearing and removal operations were underway, the severe weather pattern brought relentless storms over four weeks that included a second, and then a third, and then a fourth period of heavy snowfall. Overall, Boston received measurable snowfall on more than half of the days in February (a record) while the National Weather Service (NWS) Taunton Office recorded measurable snowfall on 24 of 33 days between January 24 and February 25, 2015.

Under normal circumstances, some of the snow may have been melted by the sun and warming temperatures. However, extreme cold temperatures were another component of the weather pattern. In February, the average mean temperature in Boston was just 19 degrees—second only to the February of 1934—and the maximum temperature remained under 32 degrees for a record 22 of 28 days, 15 of which were in a row. These unusually cold temperatures prevented any melting between periods of significant accumulation, and the burdens from the snow increased day-after-day throughout the duration of the severe winter weather pattern.

Graph 1: Cumulative Snow and Temperature



We engaged in proactive and decisive actions to best position Massachusetts to recover as quickly as possible from the virtually endless snow and cold temperatures. I declared successive states of emergency, instituted a travel ban for 24 hours, and deployed the National Guard. State offices and schools were closed on a number of days; some schools were closed for as many as five consecutive days. Nevertheless, the resources necessary to respond to the impacts of this weather pattern were well beyond the capabilities of the Commonwealth, requiring us to seek out-of-state and private-sector resources from as far away as Pennsylvania and New Jersey. It has taken us many weeks to recover from this severe winter weather pattern, and in fact, our commuter rail system is not set for full service until next Monday, March 30, 2015.

Accordingly, under the provisions of Section 401 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C. §§ 5121-5207 (Stafford Act), implemented by 44 CFR § 206.36 (major disaster declaration requests), and in accordance with 44 CFR §206.227 (snow assistance), as a result of cumulative impacts from this historic winter weather pattern, I respectfully request you take the following actions:

1. Issue a Major Disaster Declaration for Public Assistance for 10 counties (Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk and Worcester) that have verified Public Assistance costs that exceed their countywide per capita indicators. In addition,

include Snow Assistance for nine (9) counties: seven (7) (Barnstable, Bristol, Dukes, Middlesex, Plymouth, Suffolk and Worcester) which met record historical snowfall totals as maintained by the National Climactic Data Center (NCDC) and two (2) (Essex and Norfolk counties) which met FEMA's "contiguous county" criteria related to snowfall. This Major Disaster Declaration request is based on the record and near-record snowfalls during the blizzard of January 26-28 that initiated the month-long persistent weather pattern, the associated damage to public infrastructure and the costs of emergency protective measures, including snow removal. This should include authorization of the FEMA post-disaster Hazard Mitigation Grant Program (HMGP) on a statewide basis.

2. Define the incident period for this Major Disaster Declaration as January 26, 2015 through February 22, 2015 as a result of the near-catastrophic snowfall associated with the unprecedented, historic and unrelenting month-long weather pattern. As demonstrated in this letter and its enclosures, the Commonwealth experienced a severe, persistent weather pattern that triggered a four-week period of unrelenting snow and cold temperatures. The impacts of this severe winter weather pattern required extensive emergency protective measures - including snow removal operations - to protect life, health and property, and critical services for a period of time extending from January 26 through February 22. As discussed later in this letter, federal law and regulation allows you, as President, to establish an incident period that mirrors the length of the prolonged weather pattern. While we acknowledge that disaster declarations relating to snow storms are most often limited in duration—what Massachusetts experienced this winter was not merely a big blizzard at the end of January. This was, instead, a month-long weather pattern the likes of which has never before impacted our state. It was an extraordinary 28 days of mounting snow, freezing cold and massive impacts on the citizens of our state and on the public and private sectors of the Commonwealth.

3. Include as eligible costs all Category B Emergency Protective Measures – including but not limited to all costs of snow removal operations - conducted throughout the defined incident period. Because of the unprecedented impacts of the successive major snowfalls, including $350 million in snow removal costs, I am requesting that snow removal costs incurred between January 26 through February 22 be considered eligible emergency protective measures, and as such, be reimbursed at the rate of at least 75 percent. As detailed later in this letter, federal law and regulation allows you, as President, to authorize reimbursement to the Commonwealth of at least 75 percent of all snow removal costs incurred during the entire incident period.

Below I provide more details about both the severe winter pattern itself, as well as the initial blizzard and the cumulative effects on the Commonwealth over the duration of the severe winter pattern. Additional details can be found in the Enclosures and Attachment A attached hereto and incorporated herein.

I. Persistent and Severe Weather Pattern

Between January 26, 2015 and February 22, 2015, the Commonwealth of Massachusetts experienced an extraordinarily rare, severe winter weather pattern, which, as defined by NWS, is a meteorological phenomenon that results in multiple weather systems over a long period of time which may extend from days to weeks.[2] For Massachusetts, the 28-day severe weather pattern brought both periods of significant snowfall and record cold temperatures. The combined conditions resulted in snowfall amounts nearing ***nine feet*** in the majority of the affected areas and no natural melting. Please see Enclosure D-3 for additional details related to snow accumulations between January 26, 2015 and February 22, 2015.

During this severe weather pattern, the Commonwealth experienced four weeks of significant snow accumulation—including two blizzards.

- **Week 1:** The January 26-28 blizzard resulted in record snowfall totals of 36 inches and brought high winds, coastal flooding and whiteout blizzard conditions for multiple hours.
- **Week 2:** The Commonwealth received an additional 20-24 inches in the impacted areas.
- **Week 3:** The Commonwealth received an additional 29 inches of snow in the impacted areas.
- **Week 4:** The Commonwealth received an additional 20-28 in the impacted areas, with periods of strong winds and blizzard conditions.

Official NWS observation sites at Boston's Logan Airport, Blue Hills Observatory in Milton, NWS Office in Taunton, and Worcester all recorded their snowiest February and snowiest thirty-day period on record. Between January 26, 2015 and February 22, 2015, the City of Boston received 94.4 inches of snow, 38% more than its prior 30-day record of 58.8 inches which included the infamous Blizzard of 1978. As of mid-March, Boston has recorded its snowiest winter season ever; Blue Hills Observatory was less than half an inch shy of its snowiest season on record. These comparisons are particularly significant given that the records for Boston and Blue Hills go back to 1875 and 1885, respectively.[3] Similarly, Worcester received 94.6 inches of snow during a 30-day period, exceeding its prior monthly record (66.2 inches) by nearly 43%.

During the month of February, Boston received measurable snowfall on a record number of 16 days, including three separate days with more than 12 inches of snow. In the 33-day stretch from January 24, 2015 through February 25, 2015, the NWS Taunton Office recorded measurable snowfall on 24 days.

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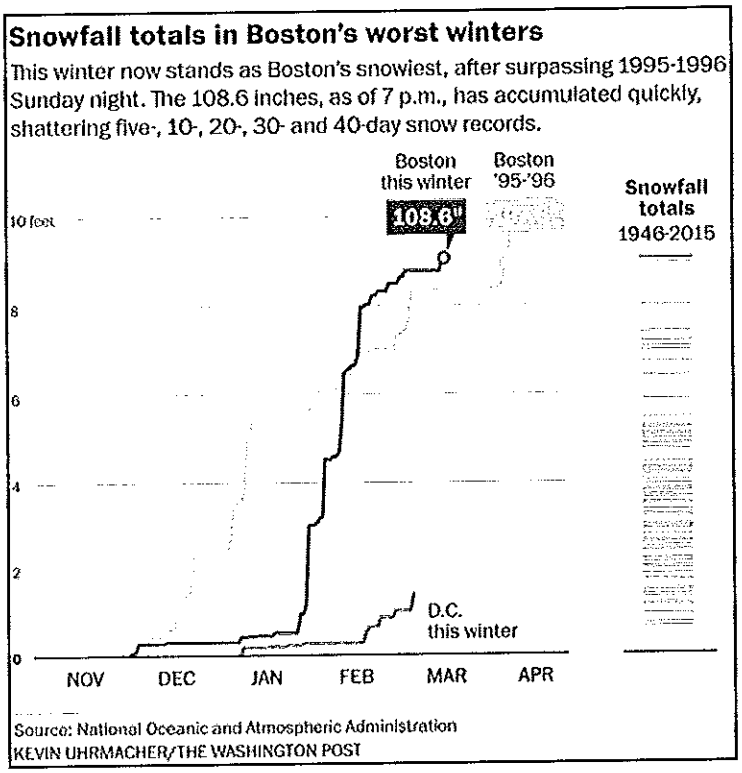
[2] FEMA Disaster Operations Legal Reference, Version 2.0, July 2013, page 3-38

[3] See March 17, 2015 letter attached hereto from Robert Thompson, Meteorologist-in-Charge, NWS, Taunton, MA (Enclosure D-4).

Graph 2: Boston Snowfall Totals



Notably, the snowfall was accompanied by sustained cold temperatures throughout this period. The average mean temperature for Boston during February was 19 degrees, in second place behind the all-time record cold monthly average temperature of 17.5 degrees set in 1934. A record 22 days—15 of which were consecutive—featured *maximum* temperatures below 32 degrees.

The rarity of this severe winter weather pattern has been the subject of professional and academic analysis and studies. The NWS Taunton Office stated that this weather pattern is unprecedented and historical. A statistical analysis completed by the University of Oklahoma defines the weather pattern as anomalous and so rare that is it unlikely to be repeated for another 26,000 years.

II. January 26-28, 2015 Blizzard

The initial snowfall from the persistent weather pattern was the January 26-28, 2015 blizzard, bringing 36 inches of snow to two counties and more than 30 inches of snow to seven counties, crushing snowfall records.

In addition, strong to damaging winds accompanied the snowfall, including sustained winds of 50 to 60 mph along the coast, with some areas experiencing hurricane force wind gusts of more than 75 mph. Nantucket experienced sustained winds of 59 mph, with gusts recorded of almost 80 mph. Each of the impacted counties experienced blizzard conditions for extended periods of time, with blowing and drifting snow and whiteout conditions. Winds also contributed to 100% of the island of Nantucket being without power for a 24-hour period of time during freezing temperatures.

This period of significant snowfall was also accompanied by areas of moderate, and pockets of major, coastal flooding along the east coast of the Commonwealth. This flooding damaged dozens of homes in coastal areas and rendered many coastal roads impassable. Across the southeastern Massachusetts coast, there was also extensive beach and dune erosion in numerous communities as well as damage to publicly-owned seawalls and other coastal infrastructure. On Nantucket, a town-owned pier with more than 100 boat slips was severely damaged. This pier is one of the busiest on the east coast of the United States during the summer and serves both commercial and recreational users. Preliminary damage estimates collected during FEMA's Preliminary Damage Assessment (PDA) process indicate that the cost of repair to the pier and associated pump-out facilities is approximately $1.2 million dollars.

The Massachusetts Bay Transportation Authority (MBTA) was forced to suspend all services on January 27 including its subway, buses, ferry and commuter rail service. In addition, Amtrak and most regional transit systems also suspended service, and Logan Airport saw more than 1,400 flights into, and out of, the airport cancelled. The Steamship Authority suspended all ferry service to Martha's Vineyard and Nantucket on January 27 and cancelled 20 additional round trips the following day because of storm conditions. Portions of the MBTA system reopened on January 28, but operated with significant delays. Many parts of the subway system had to be replaced with bus service, contributing to significant delays across the mass transit system.

State Actions

In response to the extreme threat posed by these conditions, I undertook appropriate action under state law, including the following:

- Activating the State Emergency Operations Center to Level III (Full Activation);
- Declaring a statewide emergency on January 26, 2015;
- Directing the execution of the State Emergency Operations Plan in support of the statewide emergency declaration in accordance with Section 401 of the Stafford Act;
- Directing non-emergency state employees not to report to work for two days and closing state offices;
- Ordering a statewide travel ban, prohibiting non-emergency travel on all roads in the Commonwealth;
- Calling up the Massachusetts National Guard, placing 278 soldiers on active duty to support missions related to public safety and emergency protective measures;
- Issuing a waiver of certain staffing requirements for emergency medical services to allow an increased number of ambulances to operate at the paramedic level, and a waiver to authorize transport to alternate care facilities such as shelters;
- Prepositioning emergency response capabilities in critical areas across the Commonwealth, including staging high water/high access rescue vehicles in coastal communities to assist with evacuations from flood prone areas or communities experiencing flooding;

- Prepositioning high access rescue vehicles at State Police barracks throughout the Commonwealth to assist state and local law enforcement with emergency response through heavy snow and rescuing stranded motorists;
- Committing all available state resources to support state and local emergency protective measures, including snow removal;
- Issuing an Emergency Management Assistance Compact request for heavy equipment;[4] and
- Hiring private sector resources to support emergency protective measures, including snow removal, when state assets were overwhelmed.

Without these preventative actions and on-going responses it seems clear that the risks to health and public safety would have been much higher. We expect the likelihood of a higher incident of accidents and deaths would have followed.

Local Actions

Approximately 122 cities and towns declared a local state of emergency, with 87 of those activating their local Emergency Operations Centers (EOCs). Many local jurisdictions, including the City of Boston, closed government offices. Thirty-six shelters were opened, many supported by American Red Cross volunteers. The extensive and varied impacts suffered by many of our communities are described in greater detail in the statement of impacts attached to this request.

Preliminary Damage Assessment Estimates

Initial cost estimates for damage and snow removal costs related to the blizzard that began the month-long persistent weather pattern were provided to MEMA by state agencies and local communities and exceeded $87 million. The Commonwealth partnered with FEMA to conduct follow-on, joint Preliminary Damage Assessments (PDAs) which verified and validated over $35 million worth of eligible PDA and snow assistance costs, more than triple the FEMA statewide PDA cost threshold of approximately $9.2 million.[5]

Joint FEMA/State preliminary damage assessments were conducted in all ten counties included in this declaration request. More than 87 percent ($30.7 million) of the verified PDA costs were for Category B Emergency Protective measures. The majority of these costs are directly related to snow removal. Additionally, 11 percent ($3.9 million) of PDA estimates were for Category G (Parks, Recreation and Other) damages, which include verified damage estimates for coastal infrastructure such as seawalls and piers. Additional cost estimates were verified for damages in PDA Categories C (Roads and Bridges), Category E (Buildings and Equipment) and Category F (Utilities) as detailed in Enclosure B (Estimated Stafford Act Requirements for Public Assistance).

Detailed PDA documents are included as Enclosures B, C and D. In addition, a more comprehensive statement of impacts is attached hereto and incorporated herein (see Attachment A).

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[4] This request was subsequently cancelled when private sector assets were available to address the resource needs.

[5] FEMA stopped validating and verifying reported costs once the Commonwealth was satisfied that state and county PA cost thresholds were met or exceeded. The actual total eligible costs are expected to be significantly more than the $35 million validated through the PDA process.

I have determined that this incident was of such severity and magnitude that effective response was beyond the capabilities of the Commonwealth and affected local governments, and that supplementary federal assistance is necessary.

III. Compounding Impacts Resulting from Weather Pattern and Associated Ensuing Significant Snowfall Accumulations

The weather pattern continued beyond January 28, bringing significant snow accumulation and cold temperatures that impacted the Commonwealth through February 22. The Commonwealth and our communities were faced with increasing challenges each week of this ongoing severe weather pattern, receiving 36 inches of total accumulation in the first week, nearly 60 inches by the second week, nearly 85 inches by the third week and approaching more than 100 inches by the fourth week.

In response to the extreme threat posed by the disaster conditions brought on by this severe weather pattern, I once again undertook appropriate action under state law, including the following:

- Activating the State Emergency Operations Center to Level III (Full Activation) which continued through February 22.
- Declaring a statewide emergency on February 9 and continuing until February 25.
- Directing the execution of the State Emergency Operations Plan in support of the statewide emergency declaration in accordance with Section 401 of the Stafford Act.
- Directing non-emergency state employees to not report to work, closing state offices.
- Ordering a call up of the Massachusetts National Guard and placing 576 soldiers on active duty to support missions related to public safety and emergency protective measures.
- Committing all available state resources to support state and local emergency protective measures, including snow removal.
- Issuing a waiver of certain staffing requirements for emergency medical services to allow an increased number of ambulances to operate at the paramedic level.
- Issuing an Emergency Management Assistance Compact request for heavy equipment.
- Issuing an Emergency Management Assistance Compact request for additional personnel to work in the State Emergency Operations Center.
- Hiring private sector resources to support emergency protective measures, including snow removal, when state assets were overwhelmed.
- Issuing waivers for hours of service to ensure prompt delivery of critical fuel commodities, including gasoline, diesel, home heating oil and propane.

Some specific impacts are described below, and a more comprehensive statement of impacts is attached hereto and incorporated herein (see Attachment A).

Deaths and Injuries

There were 25 deaths related to this weather pattern. Eight resulted from cardiac episodes related to shoveling and similar activities, and 17 resulted from blunt force trauma ranging from pedestrians struck by motor vehicles to falls from roofs or stairs while clearing snow to slips on the ice.

In addition, more than 1,500 individuals were transported by ambulance to hospitals with storm-related injuries and illnesses.

Resource Deployment

The compounding effects of this continuous weather pattern and its weeks of successive snowfalls exponentially expanded the extent of emergency protective measures that were necessary to mitigate the resulting health and safety impacts. By mid-February, as the snow continued to fall without any real rise in the temperature, the Commonwealth had exhausted its resources and needed to supplement in order to effectively implement emergency protective measures.

The State Emergency Operations Center was inundated with requests from more than 150 cities and towns for resources to support clearing snow and opening roads and critical transportation routes. With essentially all in-state heavy equipment resources already engaged in snow removal operations, the Commonwealth was required to issue a request for resources through the Emergency Management Assistance Compact (EMAC). As a result of this EMAC request, five states deployed a total of 151 pieces of heavy equipment from eight agencies to Massachusetts. Assistance was received from the following:

- Maine National Guard
- New Jersey Department of Transportation
- New York City Department of Sanitation
- New York State Department of Transportation
- New York Thruway
- Pennsylvania Department of Transportation
- Pennsylvania Turnpike
- Vermont National Guard

Additionally, the Massachusetts Emergency Management Agency (MEMA) contracted with private vendors in two states to supply nearly 100 additional pieces of heavy equipment for emergency snow removal operations. The Massachusetts National Guard (MANG) also deployed heavy equipment and soldiers to support snow removal operations.[6]

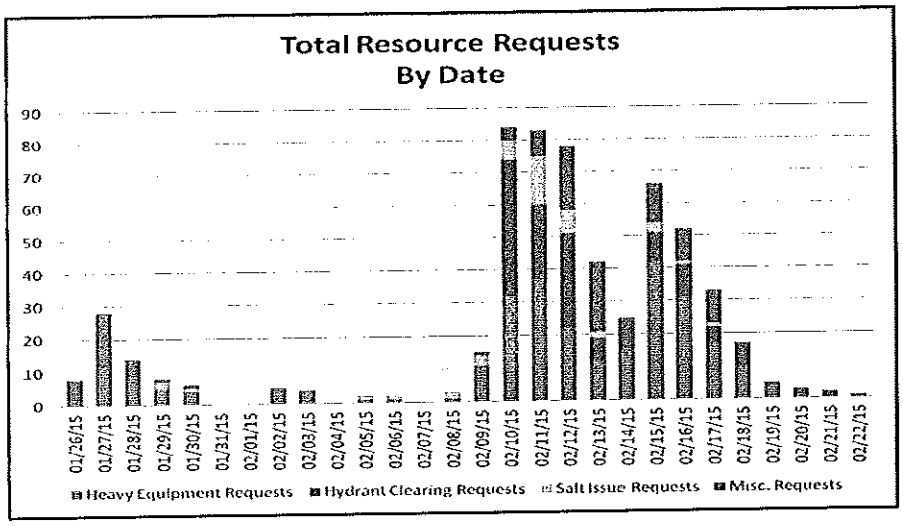
To manage the influx of heavy equipment resources into the Commonwealth, MEMA, in collaboration with the MANG, the Massachusetts Port Authority and the Massachusetts Department of Fire Services, stood up a state staging area that operated on a 24/7 basis from

[6] By February 22, the MANG removed more than 120,000 yards and 3,000 truckloads of snow, clearing 52 Bus stops, 174 miles of road, and over 4 miles of MBTA track.

February 11-22. This required a vast amount of support resources, including a Type III Incident Management Team, two mobile command posts, and numerous personnel to ensure the effective and timely deployment of equipment to the most heavily impacted areas of the Commonwealth.

There was no opportunity for the Commonwealth or its communities to recover from any period of heavy snow accumulation and be in a position to effectively respond to subsequent snowfall. As depicted in Graph 5 below, requests for state resources (heavy equipment, hydrant clearing and salt) increased significantly in response to these weeks of successive snowfalls.

Graph 3: Total Resource Requests January 26, 2015 through February 22, 2015



The light and fluffy consistency of the snow combined with strong winds exacerbated response and snow removal operations throughout the weather pattern as the snow was constantly blowing and drifting. In many cases this blowing and drifting of snow required areas to be repeatedly cleared by crews that struggled to maintain roads in a safe, passable condition.

The sheer volume of accumulated snow left no community with an available place to push snow; large volumes of snow were required to be lifted and hauled away—not merely pushed and plowed—as an emergency protective measure to provide emergency access and open roads, and to maintain public safety. Communities hauled snow in trucks to snow dumping locations ("snow farms") in parks, vacant lots, and other open areas. As snow farms grew to enormous heights and exceeded capacity, many communities were forced to look to open water disposal of snow. Dumping snow in waterways is considered the last alternative for snow disposal and is very rarely invoked. Yet the conditions imposed upon the Commonwealth by the weather pattern required that this option be exercised to bring relief to communities. The Massachusetts Department of Environmental Protection (MassDEP) coordinated emergency requests for open water disposal of snow. These requests also needed concurrence from the local conservation commissions, and coordination with the US Environmental Protection Agency. MassDEP continues to perform

ongoing inspections with local officials at snow dumping locations to assess any residual impacts from the disposal.

Roadways and Pedestrian Routes

The unrelenting snow and non-existent melting created dangerously high snowbanks along roadways and pedestrian routes that greatly inhibited line of sight and afforded little to no room for snow to be plowed from roadways. Each significant snow accumulation further narrowed streets and roadways, rendering many of them impassable or nearly impassible for days at a time. Many urban areas were forced to convert streets narrowed by snow from two-way traffic to one-way travel.

Sidewalks and pedestrian walkways remained unplowed for days and even weeks on end, creating significant life-safety issues by forcing pedestrians to walk the narrowed roadways, and requiring them to share this space with moving cars, plows and emergency response vehicles. In fact, six pedestrians were struck and killed by snow plows or moving vehicles during this time period.

The narrowed roadways also greatly impacted the flow of traffic; indeed, the narrowed streets in the City of Boston resulted in hours-long gridlock during morning and evening commutes in the days after significant snowfall accumulations. These gridlock conditions created public safety issues as emergency vehicles were incapable of quickly navigating through traffic. In addition, there was a great impact on the economy as the workforce was not able to commute to their places of business in a timely manner. Commutes for many were increased by 400 percent, turning a typical 30-minute commute to a two-three hour process.

On-street parking was banned in many urban areas for weeks, and in areas where parking was permitted, streets were typically so narrow that parking was not feasible, as parked vehicles would block traffic. The unavailability of parking had costly impacts to local businesses and restaurants which saw a drastic decrease in business in part due to the lack of parking options for their customers.[7]

Government Offices and Schools

State offices were closed for multiple days during this severe winter weather pattern. The City of Boston also closed city offices during the severe weather pattern, and kept them closed for multiple days.

The majority of school districts in the affected areas closed schools during the severe winter weather pattern, with many schools remaining closed for multiple days. Some school districts missed more than 10 days of classes as result of weather related closures. This number would have been greatly increased had it not been for the February school vacation week that fell in the middle of this prolonged weather pattern. The consequences of school closings are ongoing as school

[7] A survey conducted by the Retailers Association of Massachusetts of more than 1,600 small businesses measured weather-related lost sales between January 26 and February 22, 2015. Retail and restaurant employers reported a 49% drop in sales and 14% drop in payroll costs over this time period.

districts struggle with meeting the state-mandated 180-day school year requirement as a result of having missed so many days of school.

Public Health and Medical Services

The severe weather pattern significantly impacted the region's emergency medical services, including the ability to swiftly transport patients to hospitals. The Massachusetts Ambulance Trip Recovery Information System (MATRIS) includes reports of over 950 delayed emergency transports as a result of road and weather conditions.

This severe weather pattern also posed exceptional challenges for the Commonwealth's healthcare infrastructure. Healthcare service must operate on a 24/7 basis, and hospitals across the region expended significant amounts of money clearing snow. Although facilities did not experience a high number of power outages, difficulties with maintaining staffing levels (due to reduced transportation access), snow removal and facility damage combined for serious harm to the healthcare system.

In particular, ensuring staff - both direct clinical care givers and support staff – could travel to work was extraordinarily challenging throughout this weather pattern. The MBTA's suspended and reduced services as well as the narrowing of roads contributed to the daily commute difficulties.

In response to these challenges, hospitals, nursing homes and long-term care facilities had to take extraordinary measures to accommodate staff and meet their clinical responsibilities. These included multiple clinical shifts with associated overtime, providing taxi vouchers and other means to get into work, and on a number of occasions, finding hotel rooms for staff unable to get home.

In addition, ongoing snow removal and facility damage (e.g. broken pipes and roof damage) greatly impacted healthcare facilities. Through the use of private contractors, these facilities were able to maintain access in and out of their institutions but at great cost.

As one example, Brigham and Women's Hospital, a major teaching hospital in Boston, expended $400,000 clearing snow and ice and saw overtime increases of $700,000 due to the inability to bring in personnel for regular shifts. Another Boston hospital, Faulkner Hospital, spent more than $560,000 clearing snow and ice between January 26 and February 22.

Transportation

The Massachusetts Bay Transportation Authority (MBTA), the country's fifth largest mass transit system, provides public transit service to 176 cities and towns with a total population of nearly 5 million. The MBTA system includes a number of transit modes, including three rapid transit lines and five light rail lines, four trackless trolley lines, 13 commuter rail lines, 183 bus routes, paratransit service, and ferry service. The MBTA has a large ridership, including healthcare professionals, who rely on its services to get to and from work each day. Average weekday ridership for the entire MBTA system is approximately 1.3 million passengers.

The MBTA was forced to suspend services system-wide on three occasions as a result of this persistent weather pattern and its record cold temperatures and repeated significant snowfall.

Even when some modes of transit were able to come back online, they ran far below normal service levels for weeks while the MBTA worked to recover from the impacts of the snow and cold. Railyards were snowed in, reducing the ability to get additional rail cars in service. Switches were frozen and rendered inoperable. Roads were too narrow for buses to maneuver. Bus stops were piled with snow forcing passengers to wait on narrowed, active streets. The resources of the MBTA for clearing snow and ice from tracks, railbeds, platforms, maintenance yards, bus stops and commuter lots were significantly overwhelmed. The specialized equipment used for track clearing operations could not handle the large scale, system-wide impacts, leaving the MBTA with the need to hand shovel accumulated snow, ice and snowdrifts from more than 15 miles of track.[8]

In addition to accumulations of snow and ice, the record cold temperatures brought about significant equipment failures. This resulted in fewer cars on the rail lines, and failures of equipment while they were mid-service, creating public safety issues and requiring the evacuation of disabled rail cars.

The weeks of shutdowns and prolonged service reductions had significant impacts on public safety, including forcing mass transit riders into vehicles and increasing congestion on narrowed, gridlocked and often snow-covered roads, and inhibiting the ability of critical healthcare workers to travel to hospitals, nursing homes and long-term care facilities.

Attachment A details some of the delays on the various modes of transport.

To date, the MBTA has identified approximately $40 million in projected storm costs that include labor, equipment, materials, police and supplemental bus services. Of this amount, approximately $4.7 million is attributed to revenue loss. The full costs of the weather impacts and recovery is likely to exceed these amounts.

In addition to the impacts on the MBTA, other essential transit services were affected throughout the severe winter weather pattern. Amtrak and most regional transit systems also suspended service multiples times, and an additional 1,800 flights in and out of Logan International Airport were cancelled. The Steamship Authority, which provides ferry services to the islands of Martha's Vineyard and Nantucket, was forced to cancel nearly 50% of all scheduled routes between January 26 and February 22 (142 route cancellations of 291 scheduled routes) because of severe weather conditions.

Essential Services

Plum Island Sewer System: In addition to coastal infrastructure damages, and substantial snow removal costs, the combination of extreme cold and deep snowpack also contributed to the failure of the City of Newburyport's sewer system on Plum Island. The City's air-vacuum sewer system serves hundreds of local residents. This system experienced frozen valve pits, and feet of accumulated snow blocked air vents which keep the system operational. The results were sewer

[8] It took several days and more than 850 personnel and hired laborers, 325 soldiers and 140 inmates to hand-shovel the tracks and right of way.

back-ups into dozens of homes and a prohibition on the use of water for basic household needs. Residents were urged to refrain from using water, including flushing toilets, doing laundry and taking showers until the system function was restored. The system was impacted for approximately four weeks and prompted the City to place approximately 60 households into local hotels for approximately two weeks. To assist impacted residents, an information center was established and staffed by City officials as well as representatives from the American Red Cross, Massachusetts Division of Insurance, state and local public health officials, Massachusetts Department of Housing and Community Development and the Massachusetts Emergency Management Agency.

Fuel Delivery: The ability to deliver gasoline, diesel, propane and home heating oil also was impacted by this weather pattern because of road conditions and extreme cold temperatures. To ensure continued capability and capacity to deliver these critical commodities, I issued waivers to allow extended hours of service for delivery of gasoline, diesel, home heating oil and propane. These waivers were initially issued from February 8-21, 2015, but were expanded through March 7, 2015 to address the ongoing need.

Fire Systems: Numerous communities experienced a significant public safety threat when fire hydrants were repeatedly buried by snowfall and plowed snow banks. Municipalities did not have adequate resources to continually clear hydrants from snow. To mitigate any threat of untimely response to fires, the Commonwealth deployed Massachusetts National Guard soldiers into communities to clear snow from nearly 7,400 hydrants.

Building Collapses

As snow continued to fall, many structures across the impacted area began to fail under the weight of the snow. The Commonwealth has seen 268 structural collapses since February 9. The impacted facilities include homes, schools, businesses, recreational facilities and agricultural facilities such as barns.

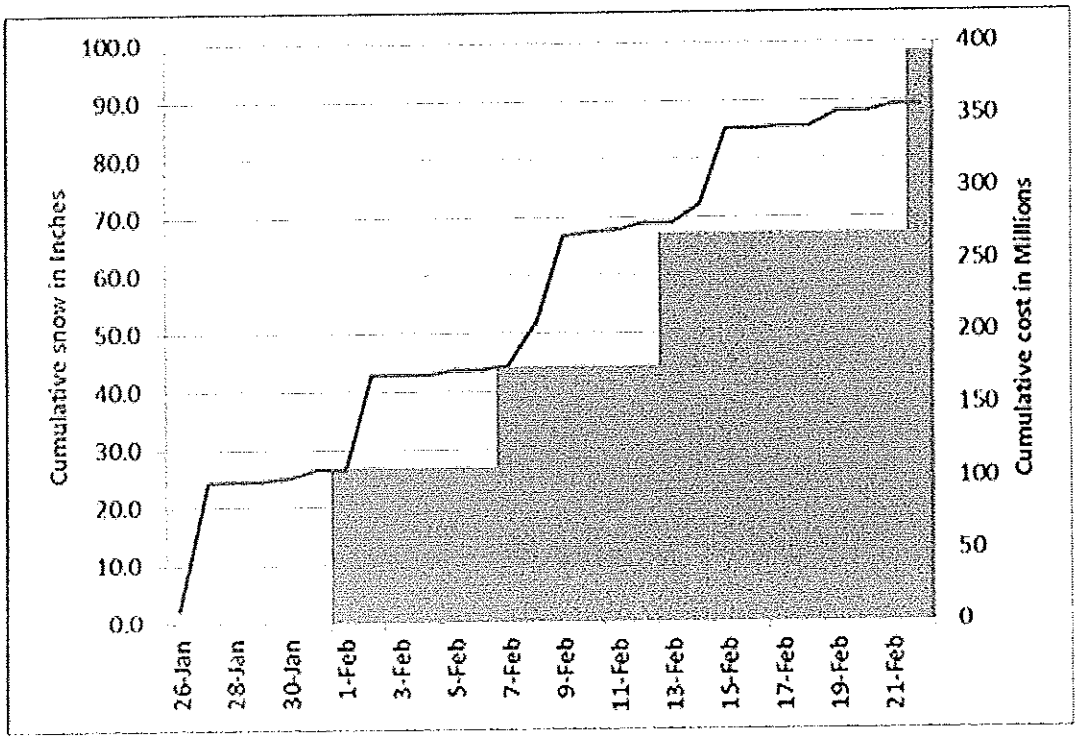
Emergency Dune Restoration

We continue to work with impacted coastal communities to determine the need for emergency dune restoration, but at this time have not been able to ascertain or quantify the level of damage to dunes. However, we request the option of emergency dune restoration as part of this declaration request to enable communities to obtain placement of temporary berms for the purposes of eliminating or lessening the threat of additional damage from a five-year event. We have confirmed that preliminary damage assessment costs captured to date and included in Enclosure B do not include any beaches that might fall under the authority of the United States Army Corps of Engineers or other federal authorities.

Economic Impacts

The financial impacts of this severe winter weather can be measured in both the additional costs associated with protecting lives and property along with the economic losses associated with the service disruptions to industry, retail and commercial businesses.

Graph 4: Cumulative State and Local Snow Removal Costs



The Massachusetts Municipal Association (MMA) recently conducted a survey of local snow and ice budgets versus expenditures for this winter season. 142 communities in central and eastern Massachusetts responded to the survey, reporting that they had budgeted approximately $66 million for this winter season. These same communities reported that they had expended more than $153 million on snow removal to date this year.

The Massachusetts Department of Transportation (MassDOT) Highway Division had budgeted $56 million for snow and ice operation for the entire winter season. To date, MassDOT has expended more than $164 million on snow and ice removal, hired equipment, and vehicle repairs.

On a statewide basis, cost estimates for damage to public property and emergency protective measures (including snow removal) related to the severe winter weather pattern from January 26 through February 22 were provided to MEMA by state agencies and local communities. These initial costs estimates are calculated to be nearly $400 million.

A more comprehensive statement of impacts is attached hereto and incorporated herein (see Attachment A).

IV. Governor's Request for a Major Disaster Declaration

Given the vast extent and unprecedented nature of impacts to the Commonwealth as a result of this significant, long-duration weather pattern, I submit to you the following three-part request.

1. ***Issue a Major Disaster Declaration for the Commonwealth Based Upon the Record and Near-Record Snowfall and Impacts Resulting from the January 26-28, 2015 Blizzard.***

Under the provisions of Section 401 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C. §§ 5121-5207 (Stafford Act), and implemented by 44 CFR § 206.36 (major disaster declaration requests), and in accordance with 44 CFR §206.227 (snow assistance), as a result of cumulative impacts from winter storms and snowstorms, I request that you issue a major disaster declaration for the Commonwealth of Massachusetts on the basis of the record snowfall and its impacts during the January 26-28, 2015 blizzard.

Specifically, I am requesting Public Assistance (PA), Categories A through G, for the following ten Massachusetts counties that have verified Public Assistance costs that exceed their countywide per capita indicators:

- Barnstable
- Bristol
- Dukes
- Essex
- Middlesex
- Nantucket
- Norfolk
- Plymouth
- Suffolk
- Worcester

This would include authorizing at least 75 percent reimbursement for all ten counties for emergency protective measures, as well public infrastructure that was damaged or destroyed.

I am also requesting Snow Assistance for the following nine counties that have met record historical snowfall totals as maintained by the National Climactic Data Center (NCDC) or have met FEMA's "contiguous county" criteria as defined in DAP 9523.1 related to snowfall:

- Barnstable (core with 2-day record snowfall)
- Bristol (core with 1-day record snowfall)
- Dukes (core with 2-day record snowfall)
- Essex (contiguous with Suffolk County)
- Middlesex (core with 2-day record snowfall)
- Norfolk (contiguous with Suffolk and Plymouth counties)
- Plymouth (core with 2-day record snowfall)
- Suffolk (core with 2-day record snowfall)
- Worcester (core with 2-day record snowfall)

This would include authorizing at least 75 percent reimbursement of snow removal costs incurred as emergency protective measures.

In addition, I am requesting that post-disaster Hazard Mitigation Grant Program (HMGP) funding be made available on a statewide basis.

I have determined that this incident was of such severity and magnitude that effective response was beyond the capabilities of the Commonwealth and affected local governments and that supplementary federal assistance is necessary.

2. ***Define the Incident Period for this Major Disaster Declaration as January 26, 2015 through February 22, 2015.***

In Title I, § 101(a)(2) of the Stafford Act, *as Amended,* Congress declared that "because disasters often disrupt the normal functioning of governments and communities, and adversely affect individuals and families with great severity; special measures, designed to assist the efforts of the affected States in expediting the rendering of aid, assistance, and emergency services ... are necessary." Congress further stated its intent "by this Act, to provide an orderly and continuing means of assistance by the Federal Government to State and local governments in carrying out their responsibilities to alleviate the suffering and damage which result from such disasters by – (1) revising and broadening the scope of existing disaster relief programs; ... and (6) providing Federal assistance programs for both public and private losses sustained in disasters." Stafford Act, § 101(b)(1),(6)

Because of the catastrophic impacts suffered by the Commonwealth as a result of a pattern of severe winter weather, I request that you grant a major disaster declaration with an incident period from January 26 through February 22, 2015. As demonstrated in Sections I and III of this letter and its enclosures, the Commonwealth experienced a severe, persistent weather pattern that triggered a 4-week period of unrelenting, and seemingly unending snow, in what one researcher has determined was a 1-in-26,000-year event. The snowfall accumulation, compounded by freezing temperatures which did not allow for any melting of snow, required extensive emergency protective measures—including snow removal operations—to protect life, health and property, and critical services. The implementation of emergency protective measures began on January 26 and continued through at least February 22, when the Commonwealth determined conditions allowed for the dismissal of all EMAC assets.

As President you have sole authority under the Stafford Act to issue major disaster declarations. This extended incident period is also consistent with federal regulations regarding snow assistance which state that "federal assistance will be provided for all costs eligible under 44 CFR 206.225 **for a specified period of time which will be determined by the circumstances of the event.**" 44 CFR § 206.227 (emphasis added). My request for disaster relief for the entire disaster period does not conflict with FEMA Policy (DAP 9523.1 - Snow Assistance and Severe Winter Storm Policy) which recognizes the criteria within the policy are "solely for use by FEMA in making recommendations to the President and in no manner restricts the ability of the President, in his discretion, to declare . . . major disasters pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended." The circumstances surrounding this weather event as described in this request provide ample grounds for the requested incident/snow assistance period even if FEMA considers itself bound to recommend to you a shorter period under its policy.

3. ***Include as Eligible Costs All Category B Emergency Protective Measures – Including but Not Limited to All Snow Removal Operations - Conducted throughout the Defined Incident Period.***

Federal law and regulation allows the President to establish an incident period that mirrors the length of the prolonged weather pattern, and to authorize reimbursement to the Commonwealth of at least 75 percent of all snow removal costs incurred during the entire incident period. Because of the unprecedented impacts of the successive major snowfalls, I am requesting that the $350 million in snow removal costs incurred during the entire incident period be considered eligible emergency protective measures, and as such, be reimbursed at the rate of at least 75 percent.

More specifically, I am requesting that eligible Category B emergency protective measure work include activities related to snow removal, establishment and operation of snow dumps/snow farms, de-icing, salting and sanding of roads and other facilities essential to eliminate or lessen immediate threats to life, public health, and safety. I am also requesting that other prudent actions and activities undertaken by the Commonwealth and local government to eliminate or reduce an immediate threat of significant damage to improved public (or private) property through cost-effective measures be considered eligible. This would include the cost of removing accumulated snow from roofs of applicant-owned and eligible facilities to eliminate or reduce the immediate threat to life, public health and safety, and costs associated with sheltering of residents, search and rescue operations and other snow related public safety operations such as snow clearing of fire hydrants.

The Commonwealth understands the intention of FEMA's Snow Assistance and Severe Winter Storm Disaster Assistance Policy (DAP) 9523.1 which establishes a 48 hour period (with an opportunity for expansion to 72 hours) for snow assistance. In typical severe winter storms, even with record-breaking snowfall amounts, states and their municipalities can and should reasonably be expected to complete snow removal operations and open their roadways within 48 hours, even when state and local capacity is overwhelmed. In fact, Massachusetts was issued two major disaster declarations with snow assistance for record breaking snow events, one in 2011 and one in 2013. For these events, the application of a 48-hour period for snow removal operations was appropriate and reasonable. However, this event is unlike those previous incidents or any other. It is quite different, distinct and unique. This unique and unprecedented event, which included record cold temperatures and persistent, significant snow accumulation that dumped ***nine feet*** of snow, severely crippled essential services, including transportation networks, for many weeks. With each significant snow accumulation, extensive emergency protective measures, including snow removal, had to be implemented. Simply plowing and pushing the snow was not an option. The Commonwealth's response was forward-leaning, aggressive and extremely costly, and requires a broader, more comprehensive response from the federal government than is contemplated in FEMA's Snow Assistance Policy. Quite simply, allowing only a 48-hour, or 72-hour period of snow

assistance for an event that involved 4-weeks of record-setting accumulating snow would not begin to provide the extent of federal disaster assistance this Commonwealth requires.[9]

Moreover, as noted above, the policy provides that its criteria are "solely for use by FEMA in making recommendations to the President and in no manner restricts the ability of the President, in his discretion, to declare . . . major disasters pursuant to the Stafford Disaster Relief and Emergency Assistance Act, as amended." Given the unprecedented and historic nature of this weather pattern and its impacts on the Commonwealth—this was an event that will happen approximately once every 26,000 years—the requested assistance, including reimbursement for at least 75% of all snow removal costs during the 4-week incident period, is reasonable, appropriate, and necessary under these extraordinary circumstances.

As detailed in this letter, our snow removal efforts were necessary to save lives and protect the public health and safety. Accordingly, they qualify as emergency protective measures. Emergency protective measures are defined as the work necessary to meet an immediate threat to life and property and essential to saving lives and protecting public health and safety, and to lessen or avert the threat of catastrophe. In fact, 44 CFR § 206.225(a)(1) specifically states "emergency protective measures to save lives, protect public health and safety, and to protect improved property are eligible." 44 CFR § 206.225(a)(3) goes on further to state that, "In order to be eligible, emergency protective measures must: (i) eliminate or lessen immediate threats to live, public health or safety; or (ii) eliminate or lessen immediate threats of significant additional damage to improved public or private property through measures which are cost effective." Through this severe weather pattern, which brought a record-breaking snow period unlike any the Commonwealth has experienced in the past, or expects to experience again in the future, emergency protective measures in the form of snow removal and hauling were critically necessary to eliminate or lessen the immediate public safety threats occasioned by the compounded snowfall accumulations and cold temperatures. These emergency protective measures could not be effectively completed in a 48- or even 72-hour period of time, as the impacts were so severe that recovery between significant snow accumulations was nonexistent.

V. Commonwealth's Ability to Respond to and Recover From Damages Caused by Severe Winter Weather

While the Commonwealth has been fortunate that no major disasters have occurred in the past 12 months, on-going disaster recovery efforts at the local and State level continue for a significant number of open and active federal disaster declarations. Since January 1, 2011 the following federal major disasters and emergencies have been declared in Massachusetts:

[9] It is also worth noting that FEMA is actively working with the National Emergency Management Association (NEMA) to review and potentially revise its current Snow Assistance Policy (FEMA DAP 9523.1) which was published in 2009. These discussions between FEMA and NEMA were initiated last fall and, may be moving towards policy revisions and a pilot program next winter.

- FEMA-1959-DR designated Berkshire, Essex, Hampshire, Middlesex, Norfolk, and Suffolk Counties for the Public Assistance Program, Categories A and B. These counties suffered over $34.5 million dollars in damage as a result of a severe winter storm.
- FEMA-1994-DR designated Hampden County and the Towns of Sturbridge and Southbridge for the Public Assistance Program as a result of damage from tornadoes. These counties suffered over $49.2 million dollars in damages.
- FEMA-4028-DR designated Barnstable, Berkshire, Bristol, Dukes, Franklin, Hampden, Hampshire, Norfolk and Plymouth Counties for the Public Assistance Program, Categories A-G. These counties suffered over $35.6 million dollars in damage as a result of Tropical Storm Irene.
- FEMA-4051-DR designated Berkshire, Franklin, Hampden, Hampshire, Middlesex and Worcester Counties for the Public Assistance Program. These counties suffered over $94.9 million dollars in damage as a result of a severe winter storm in October 2011.
- FEMA-4097-DR designated Barnstable, Bristol, Dukes, Nantucket, Plymouth and Suffolk Counties for the Public Assistance Program. These counties suffered over $12.4 million dollars in damages as a result of the devastation caused by Hurricane Sandy in October 2012. As a result of an on-going FEMA internal review of projects from this disaster, approximately $2.5 million in awarded funds are awaiting reimbursement. This internal review impacts approximately 58 local communities and agencies.
- FEMA-3362-EM designated Suffolk, Middlesex, Norfolk and Bristol Counties for emergency work costs as part of the Public Assistance Program. Communities and State agencies in these counties suffered more than $8.3M in emergency costs associated with the 2013 Boston Marathon bombings.
- FEMA-4110-DR designated all fourteen (14) counties in Massachusetts for the Public Assistance Program. These counties suffered more than $54.8 million in damages as a result of the severe winter storm, snowstorm and flooding in the February 2013 Blizzard. As a result of an on-going FEMA internal review of projects from this disaster, approximately $10.1 million in awarded funds are awaiting reimbursement. This internal review impacts approximately 98 local communities and agencies.

The State and local cost share for these seven declared disasters and emergencies since 2011 exceeds $72 million dollars, stretching state and local resources to the breaking point. Based upon the Commonwealth's experience responding to these past disasters and current budgetary constraints on state and local governments, I am of the opinion that without federal disaster assistance, Massachusetts does not have the resources required to adequately respond to and recover from the impacts of this severe winter weather.

In further support of this opinion, on February 3, 2015 Secretary Kristen Lepore of the Commonwealth's Executive Office for Administration and Finance identified a significant budget shortfall of $768 million for Fiscal Year 2015, which ends on June 30, 2015. At my direction, she

implemented certain enhanced fiscal controls to close the budget gap, including a hiring freeze for Executive Branch agencies, a reduction in administrative expenses and one-time use of capital gains revenues that were scheduled to deposit into our stabilization fund. Secretary Lepore also identified a projected $1.8 billion budget shortfall for Fiscal Year 2016, beginning July 1, 2015, which we addressed in a budget proposal filed on March 4, 2015. Against this backdrop, I respectfully request that you exercise your discretion and decision making authority to declare a major disaster for the Commonwealth of Massachusetts that includes an extended incident period and FEMA snow assistance.

I have designated Kurt N. Schwartz as the State Coordinating Officer for this request. He will work with the Federal Emergency Management Agency in continued damage assessments and write-ups and may provide further information or justification on my behalf.

I thank you for the support we have received from the Federal Emergency Management Agency throughout this challenging period, and for your consideration of this request for a Major Disaster Declaration.

Sincerely,

Charles D. Baker
Governor

cc: Daniel Bennett, Secretary, Massachusetts Executive Office of Public Safety and Security
Kurt N. Schwartz, Director, Massachusetts Emergency Management Agency

Enclosures:

FEMA Form 010-0-13, Request for Presidential Disaster Declaration
Enclosure B: Public Assistance, Final PDA Matrix
Enclosure C: Requirements for Other Federal Agency Programs
Enclosure D: Historic and Current Snowfall Data
Enclosure D-1: National Weather Service Taunton – Event Summary for Jan. 26-28 Blizzard
Enclosure D-2: National Climatic Data Center (NCDC) - Historic Snowfall Data for 1-, 2- & 3-Day Events
Enclosure D-3: Cumulative Snowfall Total Matrix January 26, 2015 – February 22, 2015
Enclosure D-4: National Weather Service Taunton Memo Regarding Severe Weather Pattern

Attachments:

Attachment A: 2015 Severe Winter Weather Pattern Impacts - Supplemental Information

ENCLOSURE B TO MAJOR DISASTER REQUEST

Estimated Stafford Act Requirements for Public Assistance

DAMAGE ASSESSMENT WORKSHEET

Massachusetts

State: $1.41

County: $3.56

Date: 3/19/2015	PUBLIC DAMAGE								GOAL			
Report #:	A	B	C	D	E	F	G	TOTAL	*POP. '10*	*$/CAP.*	*$3.56/CAP.*	*SHORT*
Barnstable County	$0	$1,787,192	$0	$0	$0	$0	$0	$1,787,192	215,888	$8.28	$768,561	$0
Bristol County	$0	$2,517,943	$0	$0	$0	$0	$0	$2,517,943	548,285	$4.59	$1,951,895	$0
Dukes County	$0	$104,022	$0	$0	$0	$0	$0	$104,022	16,535	$6.29	$58,865	$0
Essex County	$0	$4,149,796	$0	$0	$0	$60,310	$0	$4,210,106	743,159	$5.67	$2,645,646	$0
Middlesex County	$0	$6,916,469	$0	$0	$0	$0	$3,239	$6,919,708	1,503,085	$4.60	$5,350,983	$0
Nantucket County	$0	$0	$0	$0	$0	$144,166	$1,200,000	$1,344,166	10,172	$132.14	$36,212	$0
Norfolk County	$0	$3,370,742	$0	$0	$5,000	$0	$0	$3,375,742	670,850	$5.03	$2,388,226	$0
Plymouth County	$0	$2,905,082	$165,200	$0	$65,355	$0	$2,767,645	$5,903,282	494,919	$11.93	$1,761,912	$0
Suffolk County	$0	$5,347,398	$0	$0	$0	$0	$0	$5,347,398	722,023	$7.41	$2,570,402	$0
Worcester County	$0	$3,661,691	$0	$0	$0	$0	$0	$3,661,691	798,552	$4.59	$2,842,845	$0
Totals	$0	$30,760,335	$165,200	$0	$70,355	$204,476	$3,970,884	$35,171,250	6,547,629	$5.37	$9,232,157	$0
NOTES:	DEBRIS CLEARANCE	PROTECTIVE MEASURES	ROAD SYSTEM	WATER CONTROL	BUILDINGS & EQUIPMENT	PUBLIC UTILITY	PARKS & OTHER		6,547,629	State Population Check Sum		
Percentage	0.00%	87.46%	0.47%	0.00%	0.20%	0.58%	11.29%					

ENCLOSURE C TO MAJOR DISASTER REQUEST

Estimated Assistance from Other Federal Agency Programs

County/ Tribal Area	SBA Home Loans	SBA Business Loans (Economic Injury Disaster Loans)	FSA Loans	NRCS	FHWA	USACE	BIA	OTHER
Barnstable		**X**		**TBD**	**TBD**	**TBD**		**TBD**
Bristol		**X**		**TBD**	**TBD**	**TBD**		**TBD**
Dukes		**X**		**TBD**	**TBD**	**TBD**		**TBD**
Essex		**X**		**TBD**	**TBD**	**TBD**		**TBD**
Middlesex		**X**		**TBD**	**TBD**	**TBD**		**TBD**
Nantucket		**X**		**TBD**	**TBD**	**TBD**		**TBD**
Norfolk		**X**		**TBD**	**TBD**	**TBD**		**TBD**
Plymouth		**X**		**TBD**	**TBD**	**TBD**		**TBD**
Suffolk		**X**		**TBD**	**TBD**	**TBD**		**TBD**
Worcester		**X**		**TBD**	**TBD**	**TBD**		**TBD**
Totals		***TBD***						

Note: *Provide numbers and amounts, as appropriate.*

ENCLOSURE D TO MAJOR DISASTER REQUEST

Historic and Current Snowfall Data

County / Tribal Area	NWS Snowfall (inches)	Period (# of days)	NCDC Record Snowfall Data		Evaluation				
			Amount	Period	Record Exceeded	Near Record	Contiguous County	Core County	Comments
Barnstable	30.5	2	28.0	Ending 10 Feb 1987	X			X	
Bristol	26.0	1	21.5	Ending 6 Feb 1978	X			X	
Dukes	27.0	2	23.0	Ending 6 Feb 2005	X			X	
Essex	31.5	2	43.7	Ending 8 Feb 1978			X		Contiguous w/ Suffolk
Middlesex	36.0	2	32.0	Ending 2 Apr 1997	X			X	
Norfolk	31.0	2	36.1	Ending 8 Feb 1978			X		Contiguous w/ both Suffolk & Plymouth
Plymouth	30.7	2	30.0	Ending 23 Jan 2005	X			X	
Suffolk	31.0	2	27.6	Ending 18 Feb 2003	X			X	
Worcester	36.0	2	32.1	Ending 12 Dec 1992	X			X	

Note: Provide National Weather Service statement.

ENCLOSURE D-1

National Weather Service Taunton – Event Summary for Jan. 26-28 Blizzard

Memo For: CT, MA, RI State Emergency Management Agencies 2/4/15

From: Robert Thompson, MIC, National Weather Service – Taunton, MA
Glenn Field, WCM, National Weather Service – Taunton, MA
Joseph DelliCarpini, SOO, National Weather Service – Taunton, MA

Subject: Summary of Blizzard of 2015 that impacted southern New England

The following is a summary of the Blizzard of 2015 (Jan. 26-28, 2015) that impacted all of southern New England.

EVENT OVERVIEW

An historic winter storm brought heavy snow to southern New England with blizzard conditions to much of Rhode Island and eastern Massachusetts, beginning during the day on Monday, January 26 and lasting into the afternoon hours of Tuesday, January 27 in western portions and into the pre-dawn hours of Wednesday, January 28th in easternmost areas. The highest snowfall totals, averaging two to three feet, extended from extreme northeast Connecticut and northwest Rhode Island into much of central and northeast Massachusetts, including greater Boston. Some of the highest totals reported include Hudson, MA (36 inches), Acton, MA (34 inches), Thompson, CT (33.5 inches), and Methuen, MA (31.5 inches). Much of southeast Massachusetts and the rest of Rhode Island received one to two feet of snow. Totals dropped off dramatically west of the Connecticut River Valley where totals of 4 to 11 inches were observed.

The storm was well-forecast, with Blizzard Watches and Winter Storm Watches issued 2 days before the snow began. Low pressure tracked northeast from the Carolinas and strengthened rapidly as it slowly passed southeast of Nantucket on Monday evening, January 26. All of the precipitation fell as snow with this storm. At its peak, snowfall rates of 2 to 3 inches per hour were common. In Massachusetts, blizzard conditions were officially reported in Marshfield (14 hours), Hyannis (13 hours), Nantucket (11 hours), Boston (9 hours), Chatham (9 hours), Worcester (7 hours), and Beverly (3 hours). In Rhode Island, blizzard conditions were officially reported in Westerly (5 hours), Newport (4 hours), and at T.F. Green State Airport in Warwick (3 hours). Several other locations in the Taunton area of responsibility fell just short of the required criteria (3 consecutive hours of blizzard conditions) including Fitchburg, New Bedford, Falmouth, and Martha's Vineyard in Massachusetts and Smithfield in Rhode Island. The NWS Forecast Office in Upton, NY is working on the determination of any blizzard conditions for southern Connecticut...please refer to a separate report from their office for that.

Daily snowfall records were set for January 27 in Boston (22.1 inches, previous record 8.8 inches in 2011), Worcester (31.9 inches, previous record 11.0 in 2011), and Providence (16.0 inches, previous record 6.7 inches in 2011). In Worcester, the snowfall total of 34.5 inches was the greatest on record (dating back to 1892), breaking the previous record of 33.0 inches on March 31 to April 1, 1997. In Providence, the total of 19.1 inches was the fourth highest on record (dating back to 1904), while in Boston the total of 24.6 inches was the sixth highest on record (dating back to 1872).

The Blizzard of 2015 produced very strong winds late Monday into Tuesday near the Massachusetts and Rhode Island coasts where gusts of 50 to 65 mph were common. Gusts reached hurricane force at a few locations in Massachusetts including Nantucket (78 mph), Chatham (75 mph), Humarock (74 mph), and Aquinnah (74 mph).

Significant coastal flooding occurred along the Massachusetts east coast, mainly south of Boston. Due to a north-northeast wind around the time of the early morning high tide, Boston's north shore was spared much in way of significant impacts while north facing coastlines of Cape Cod and Nantucket received a higher storm surge. More specifically, the reach of coastline from Hull to Plymouth experienced significant damage as did the north side of Cape Cod and Nantucket Harbor.

BLIZZARD OF 2015 SNOWFALL TOTALS – HIGHEST BY COUNTY

** Please note that the following reports were taken from our Final Public Information Statements. The values listed have been vetted by our forecast staff and are believed to be reasonable and accurate based on radar trends and other reports in the area. For those listed as "amateur radio," that is the means by which the report was received. Most actively reporting amateur radio operators are trained Skywarn spotters, too, and some are local emergency managers, but they choose to report via the air waves instead of by phone or internet.

Connecticut

Fairfield	Weston	14.0	Public
	New Canaan	12.3	CT DOT
Hartford	Marlborough	22.0	Trained Spotter
	Manchester	19.0	Trained Spotter
Litchfield	Watertown	11.5	Trained Spotter
Middlesex	Haddam	22.0	Trained Spotter
	Essex	20.5	Public
New Haven	Guilford	17.0	Trained Spotter
	Meriden	12.5	CT DOT
New London	Lisbon	26.0	Trained Spotter
	Colchester	25.0	CT DOT
	Norwich	24.0	CT DOT
	Groton	24.0	CT DOT
Tolland	Staffordville	23.0	Cooperative Observer
	Tolland	21.5	Trained Spotter
	Stafford Springs	19.0	Trained Spotter

Windham	Thompson	33.5	Media
	Putnam	33.0	CT DOT
	Moosup	25.0	Amateur Radio
	North Grosvenordale	25.0	Cooperative Observer

Massachusetts

Barnstable	West Harwich	30.5	Trained Spotter
	Hyannis	27.0	Amateur Radio
	East Falmouth	24.8	Trained Spotter
Berkshire	Lanesboro	8.0	TV weather spotter, but trained by NWS-Albany
Bristol	East Freetown	26.0	Amateur Radio
	Fall River	24.1	Amateur Radio
	Somerset	24.0	Amateur Radio
Dukes	Oak Bluffs	27.0	Amateur Radio
	Edgartown	20.0	Cooperative Observer
	West Tisbury	19.0	Amateur Radio
Essex	Methuen	31.5	Public
	Gloucester	31.0	Trained Spotter
	Swampscott	30.4	Public
	Newburyport	30.0	Cooperative Observer
	Peabody	28.5	Trained Spotter / Amateur Radio
	Ipswich	28.0	Trained Spotter
Franklin	Greenfield	10.8	Cooperative Observer
Hampden	Wales	16.0	Media
	Ludlow	14.0	Trained Spotter
	East Longmeadow	12.5	Amateur Radio
Hampshire	Amherst	6.8	Cooperative Observer
Middlesex	Hudson	36.0	Public
	North Billerica	34.0	Trained Spotter
	Littleton	34.0	Trained Spotter
	Acton	34.0	Public
	Chelmsford	33.8	Amateur Radio
	Framingham	33.5	Amateur Radio
	Dracut	33.1	Public
	Westford	33.0	Trained Spotter
	Maynard	33.0	Cooperative Observer
	Lowell	33.0	Trained Spotter
Nantucket	Nantucket	12.0	Trained Spotter / Amateur Radio

Norfolk	Sharon	31.0	Public
	Milton	30.8	Blue Hill Observatory/Cooperative Observer
	Braintree	26.0	Public
	Walpole	24.6	Trained Spotter / Amateur Radio
Plymouth	Plymouth	30.7	Public
	Norwell	28.0	Amateur Radio
	Kingston	28.0	Trained Spotter
	Marshfield	25.0	Trained Spotter
	Hanover	24.0	Public
Suffolk	South Boston	31.0	Trained Spotter
	Logan Int'l Airport	24.6	Trained Observer/Spotter
Worcester	Auburn	36.0	Trained Spotter
	Lunenburg	36.0	Trained Spotter
	Worcester Airport	34.5	Trained Observer
	Clinton	34.1	Public
	West Boylston	33.1	CoCoRaHS Observer
	Holden	32.0	Trained Spotter
	Upton	31.5	Trained Spotter
	Milford	31.0	Cooperative Observer

Rhode Island

Bristol	Barrington	18.0	TV Meteorologist
Kent	West Warwick	20.5	Trained Spotter
	Warwick (TF Green)	19.1	Trained Observer – Airport
	Greene	18.0	Trained Spotter
Newport	Tiverton	19.0	Amateur Radio
	Middletown	16.0	Trained Spotter
Providence	Burrillville	30.0	Emergency Manager
	Scituate	29.0	Emergency Manager
	West Glocester	25.6	Trained Spotter
	North Cumberland	24.0	Trained Spotter
	Glendale	23.5	Amateur Radio
Washington	Westerly	21.0	Trained Spotter
	Hope Valley	18.5	Trained Spotter
	North Kingstown	16.0	Trained Spotter

BLIZZARD OF 2015 SNOWFALL DURATION AT VARIOUS REPORTING SITES:

To determine the duration of "the storm" at any location, we felt that it was best to use visibilities of 2 miles or less as the basis, since that would generally equate to accumulating snow. (Snow that only reduces visibility to between 3 and 6 miles would be very light and not do much accumulating.) In general, although this event spanned parts of 2 and even 3 calendar days, it was primarily a one- to one-and-a-half-day event for most areas (duration-wise), as can be seen by the durations listed below. The event lasted from 13 to 20 hours in the westernmost portions of southern New England, 20 to 30 hours across eastern Connecticut, Rhode Island, and central Massachusetts...but lasted as much as 30 to 38 hours over east coastal Massachusetts.

Connecticut

Danbury (DXR)	20.1 hours
Windsor Locks (BDL)	20.0 hours
Bridgeport (BDR)	20.8 hours
Hartford (HFD)	23.5 hours
Meriden (MMK)	22.9 hours
New Haven (HVN)	22.8 hours
Groton (GON)	28.4 hours
Willimantic (IJD)	28.9 hours

Massachusetts

Pittsfield (PSF)	13.9 hours
Orange (ORE)	20.9 hours
Westfield (CEF)	13.0 hours
Worcester (ORH)	26.8 hours
Bedford (BED)	26.0 hours
Lawrence (LWM)	30.4 hours
Boston (BOS)	32.1 hours
Plymouth (PYM)	26.3 hours
Falmouth	36.0 hours (might be slightly overstated because of blowing snow)
Hyannis (HYA)	38.0 hours (might be slightly overstated because of blowing snow)
New Bedford (EWB)	20.7 hours
Martha's Vineyard (MVY)	32.3 hours
Nantucket (ACK)	36.1 hours (might be slightly overstated because of blowing snow)

Rhode Island

North Smithfield (SFZ)	27.0 hours
Warwick (PVD)	30.7 hours
Westerly (WST)	25.1 hours
Newport (UUU)	28.9 hours

HIGHEST WIND GUSTS (70+ mph)

Massachusetts

Nantucket	78 mph
Chatham	75 mph
Aquinnah	74 mph
Humarock	74 mph
Plymouth	72 mph
Centerville	72 mph
Sagamore	70 mph

COASTAL FLOODING

Fig. 1. Coastal Flooding following the January 27, 2015 AM High Tide in Scituate (Photo courtesy of Dave Laroche)

The January 26-27, 2015 blizzard produced significant coastal flooding along the Massachusetts east coast, mainly south of Boston. The Coastal Flood Watch/Warning issuances and Decision Support Services (DSS) information provided ample notice of the threat and overall communicated the right severity. Due to a shift in the wind from NE to more NNE by the time of the early morning high tide, Boston's north shore was spared much in way of significant impacts while north facing coastlines of Cape Cod and Nantucket received a higher storm surge and somewhat greater impact than anticipated. More specifically, the reach of coastline north of Boston received minor impacts, less than anticipated. The reach of coastline from Hull to Plymouth experienced widespread moderate with isolated major impacts, close to what was expected. Both the north side of Cape Cod and Nantucket Harbor received moderate to

major impacts and somewhat more than anticipated. The storm tide at Nantucket peaked about ¾ of a foot above what was forecast (7.2 feet MLLW observed versus 6.4 feet MLLW forecast). The Coastal Flood Warning was well-placed south of Boston. In retrospect, a Coastal Flood Advisory might have sufficed for the reach of coastline from Salisbury to Boston.

An interesting and challenging aspect of this coastal flood event was that the two storm tides of interest, early Tuesday morning and late Tuesday afternoon, occurred while the storm was rapidly ramping up and ramping down, respectively. Thus, coastal impacts were heavily dependent upon timing. Conditions were ramping up so quickly about the time of the Tuesday early morning high tide that the storm tide peaked a half hour or more after the scheduled astronomical high tide at many locations, and some locations such as along route 6A in Sandwich were still being impacted two to three hours after the time of the astronomical high tide. This temporal gradient in the storm's intensity and onshore wind flow/fetch inserted a level of uncertainty into the forecast process.

The storm surge at the time of the *early morning high tide* ranged generally between 3 and 4 feet from the Boston area south but peaked between 4.5 and a little over 5 feet in the vicinity of the *late morning low tide*. Similarly, seas just a few miles offshore had rapidly built to between 20 and 25 feet by the early morning high tide and were in the process of building rapidly before plateauing between 25 and 30 feet several hours after that high tide. Refer to Figures 2-4 for the observed tide trace at Boston, Scituate, and Nantucket Harbor, respectively. Refer to Figure 5 for a listing of wave heights at Boston Buoy (44013) during the height of the storm. The impact from this storm could have been substantially worse had it been about 4 to 6 hours faster. It is conjectured that this storm might have approached the level of impact of the December 1992 nor'easter or perhaps even the "Perfect Storm" of October 1991 in a number of locations south of Boston had the peak of storm surge and seas occurred just a few hours sooner. Had the peak surge occurred right at the 4:27 AM high tide of 10.5 feet MLLW in Boston, the Boston Harbor storm tide would have reached 15.3 feet MLLW or .2 feet above the record water level set during the February 1978 Blizzard (although with waves about 10 feet lower than those in 1978). And had this storm peaked out at the time of one of the spring high tides of the week before, we would have seen water levels in unchartered territory for Boston and areas south. Keeping an eye toward future preparedness, this storm should be remembered for not only what it was but what it could have been.

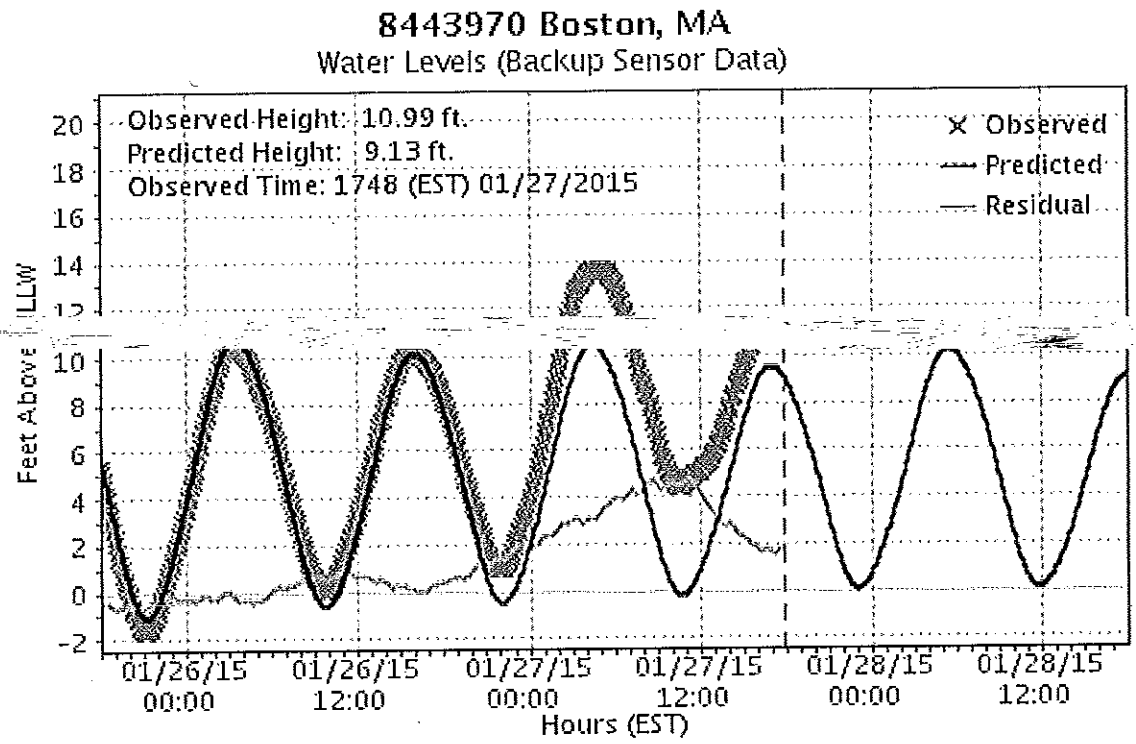


Figure 2. Observed Tide (MLLW datum) at Boston on January 27.

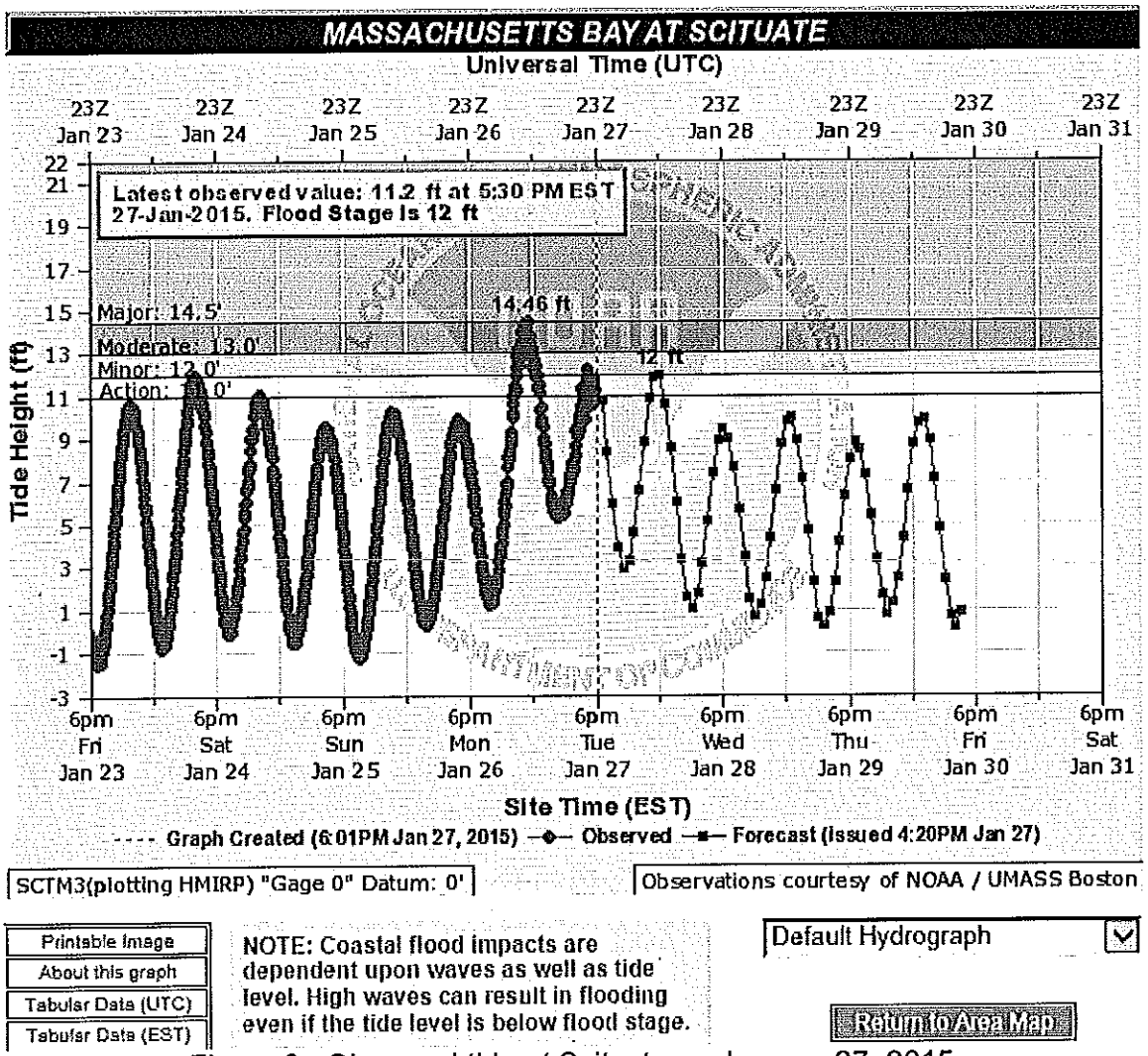


Figure 3. Observed tide at Scituate on January 27, 2015.

It is interesting to note that the storm tide at Scituate crested about 5 inches higher than the maximum water level for the February 2013 Blizzard (February 9 morning high tide). However, wave heights offshore were about 10 to 12 feet lower on January 27, 2015 compared with February 9, 2013. In Scituate the overall coastal impact from this storm appears to have been on par with the February 2013 event, but some portions of the shoreline fared better and others worse.

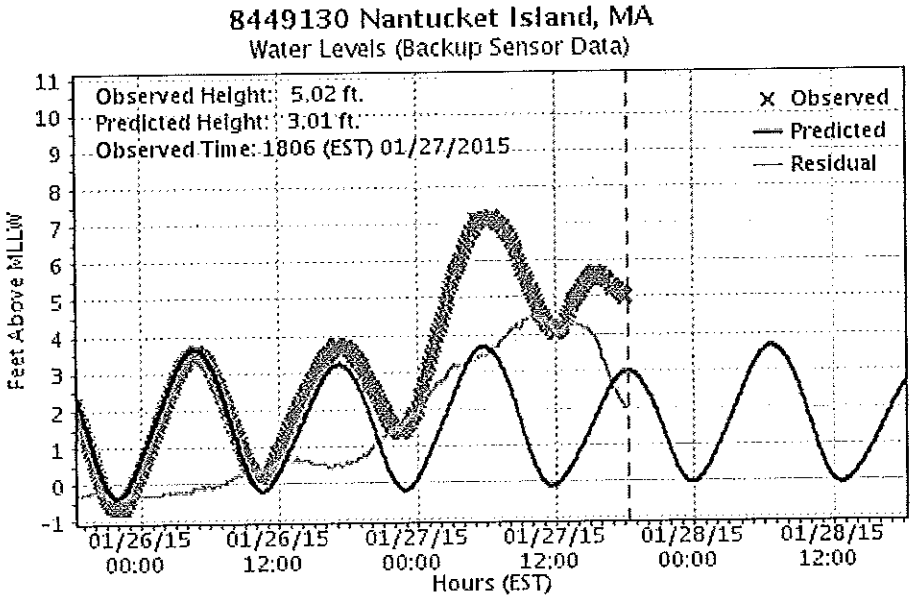


Figure 4. Observed tide at Nantucket Harbor on January 27, 2015.

The tide trace at Nantucket Harbor on January 27 illustrated a rapid increase in surge during the time of the morning high tide and a dramatic lowering of the surge in the 2 to 3 hours preceding the late afternoon high tide. Similar to Boston and Scituate, the storm surge peaked near or shortly before the late morning low tide.

Within a couple of hours of the late afternoon high tide, winds shifted to be from the northwest, and the storm surge rather quickly relaxed from above 4 feet to closer to 2 feet. Seas remained elevated between 24 and 28 feet, but the drop in surge combined with a lower amplitude astronomical high tide resulted in less impact compared with the early morning high tide in most locations. The impact is believed, however, to have only been slightly less along some of the Cape Cod Bay north facing shoreline as well as some locations along the Plymouth County coast where shoreline defenses had been compromised with the prior high tide.

Previous observations

MM	DD	TIME (EST)	WDIR	WSPD kts	GST kts	WVHT ft	DPD sec	APD sec	MWD	PRES in	PTDY in	ATMP °F	WTMP °F	DEWP °F	SAL psu	VIS nmi	TIDE ft
01	27	4:50 pm	N	36.9	44.7	23.9	14	9.6	ENE	29.41	+0.06	21.0	40.8	20.8	-	-	-
01	27	3:50 pm	N	35.0	40.8	25.9	14	9.8	NE	29.39	+0.04	21.4	40.8	21.4	-	-	-
01	27	2:50 pm	N	35.0	42.7	23.9	14	9.3	NE	29.38	+0.03	22.5	40.6	22.3	-	-	-
01	27	1:50 pm	N	40.8	48.6	26.6	14	9.5	ENE	29.35	-0.05	23.9	40.6	23.7	-	-	-
01	27	12:50 pm	NNE	40.8	50.5	25.9	14	9.6	ENE	29.35	-0.08	25.9	40.5	25.7	-	-	-
01	27	11:50 am	NNE	40.8	52.4	27.2	14	9.3	E	29.35	-0.09	25.9	40.5	25.7	-	-	-
01	27	10:50 am	NNE	38.9	46.6	25.6	12	9.4	NE	29.41	-0.06	25.7	40.5	25.7	-	-	-
01	27	9:50 am	N	40.8	52.4	23.9	11	9.2	NE	29.43	-0.04	24.8	40.5	24.8	-	-	-
01	27	8:50 am	N	38.9	48.6	22.3	12	8.7	ENE	29.44	-0.02	24.3	40.6	24.1	-	-	-
01	27	7:50 am	N	38.9	50.5	23.9	11	9.0	NE	29.46	+0.01	23.7	40.8	23.5	-	-	-
01	27	6:50 am	N	40.8	48.6	22.0	11	8.4	ENE	29.47	-0.04	22.6	40.8	22.6	-	-	-
01	27	5:50 am	N	40.8	52.4	22.3	11	8.6	ENE	29.46	-0.10	24.1	40.8	24.1	-	-	-
01	27	4:50 am	N	40.8	56.3	22.3	11	8.4	ENE	29.45	-0.15	25.3	41.0	25.3	-	-	-
01	27	3:50 am	NNE	40.8	50.5	19.0	11	7.9	NE	29.51	-0.15	26.6	41.0	26.6	-	-	-
01	27	2:50 am	NNE	40.8	48.6	19.7	10	8.0	NE	29.57	-0.17	28.0	41.0	28.0	-	-	-
01	27	1:50 am	NNE	38.9	52.4	19.7	8	7.5	ENE	29.61	-0.20	28.6	40.8	28.6	-	-	-
01	27	12:50 am	NNE	40.8	48.6	15.4	9	7.0	ENE	29.66	-0.20	28.9	40.6	28.8	-	-	-
01	26	11:50 pm	NE	35.0	44.7	14.1	8	6.7	NE	29.73	-0.21	30.4	40.6	30.4	-	-	-
01	26	10:50 pm	NE	35.0	40.8	12.8	8	6.5	NE	29.80	-0.17	30.4	40.6	30.4	-	-	-
01	26	9:50 pm	NE	33.0	38.9	10.8	7	6.0	ENE	29.86	-0.13	31.1	40.6	30.9	-	-	-
01	26	8:50 pm	NE	29.1	35.0	9.8	7	5.8	ENE	29.94	-0.07	30.9	40.6	30.7	-	-	-
01	26	7:50 pm	ENE	29.1	33.0	7.5	6	5.2	ENE	29.97	-0.04	31.1	40.6	28.8	-	-	-
01	26	6:50 pm	ENE	27.2	31.1	7.2	6	5.0	ENE	29.99	-0.03	31.3	41.0	28.6	-	-	-

Detailed Wave Summary
for 44013 as of (6:00 pm EST)
2300 GMT on 01/27/2015:

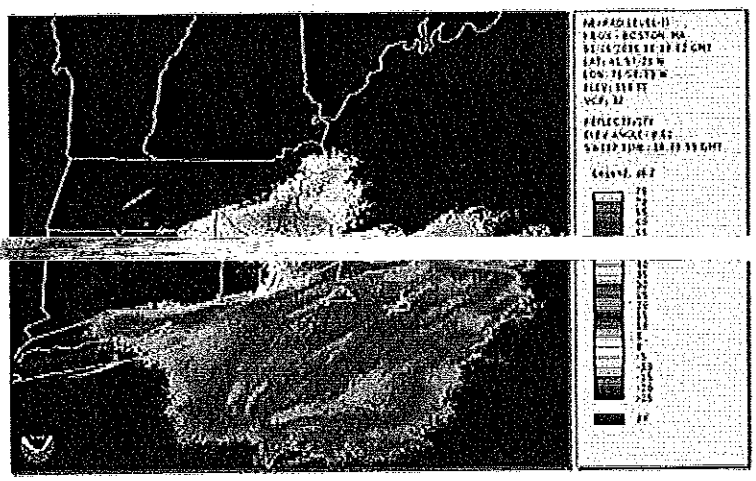
Figure 5. Observed wind and wave data at the Boston Buoy (44013).

The USGS with assistance from the WFO Taunton Senior Service Hydrologist, Nicole Belk, installed two new tide gages, Dennis (Sesuit Harbor) and Provincetown Harbor on Cape Cod, just a few weeks before the January 27 coastal storm. At the time of this writing, these two tide gages were being calibrated to report from a Mean Lower Low Water (MLLW) datum. Data were received during the storm and should help assess storm surge along the Cape Cod Bay side of Cape Cod. Once the data have been thoroughly checked out, data from these two tide gages will become available in the Advance Hydrologic Prediction System (AHPS). Dennis will become a new coastal impact forecast site.

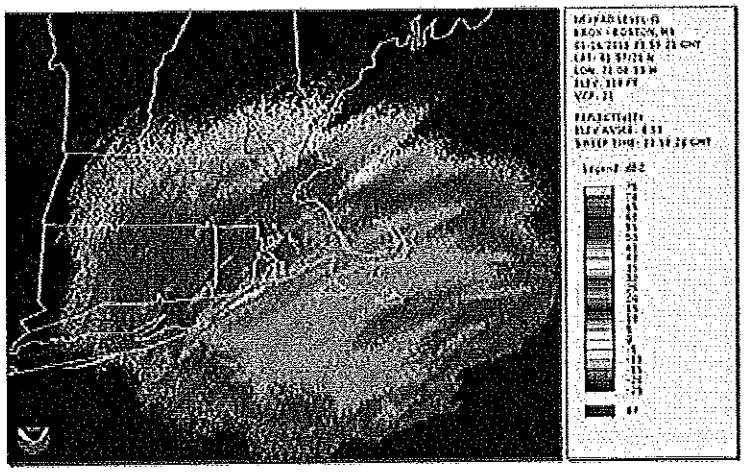
Both the ETSS and ESTOFS guidance underforecasted the surge from Boston south, being exceeded by nearly a couple of feet at some times and locations. A regional FVCOM model, referred to as NECOFS, also provides water level guidance but has been difficult to interpret on the fly due to the units and datum used. NWS staff has been working with the developers to enable storm surge as a model output parameter. WFO Taunton forecasters were able to significantly improve upon the operational storm surge guidance. This event once again illustrated that the forecaster can add value to the guidance.

RADAR IMAGERY

1 pm Mon 1/26



7 pm Mon 1/26



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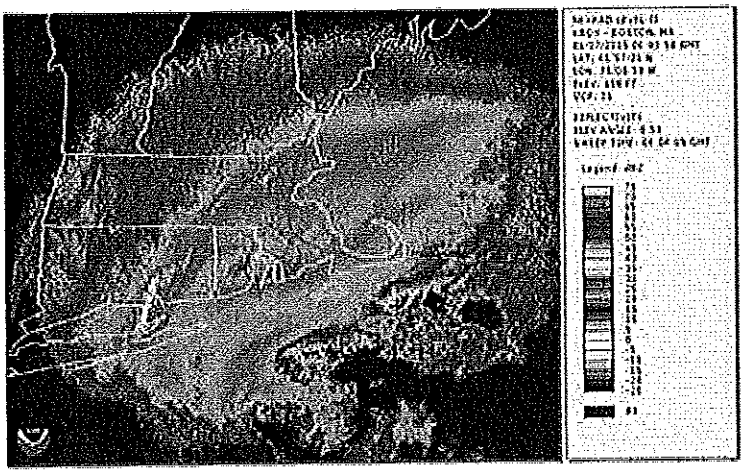

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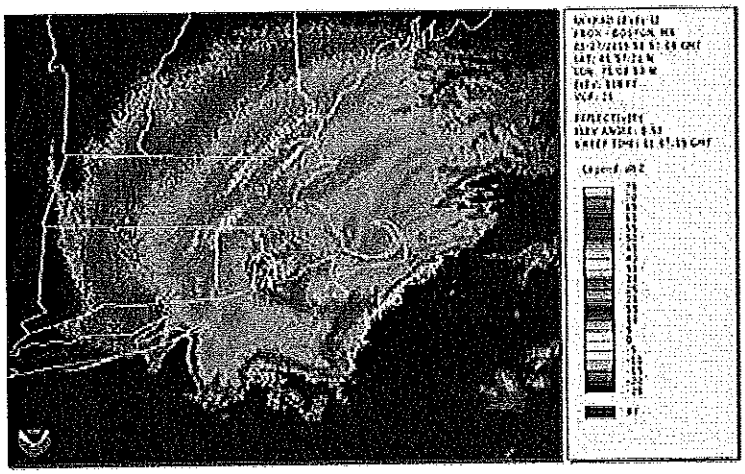
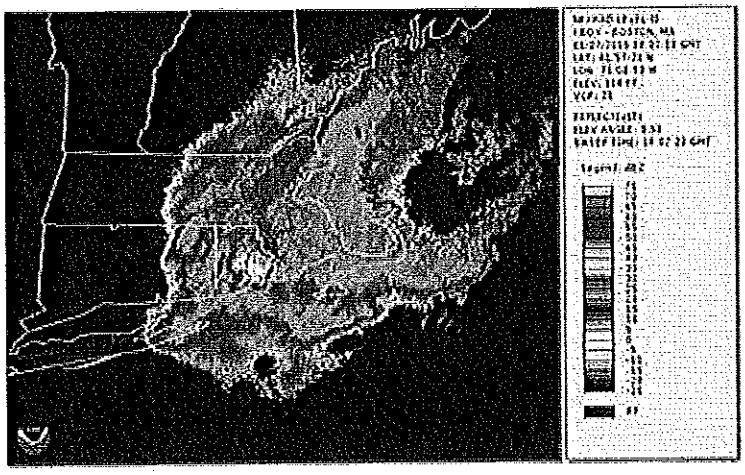
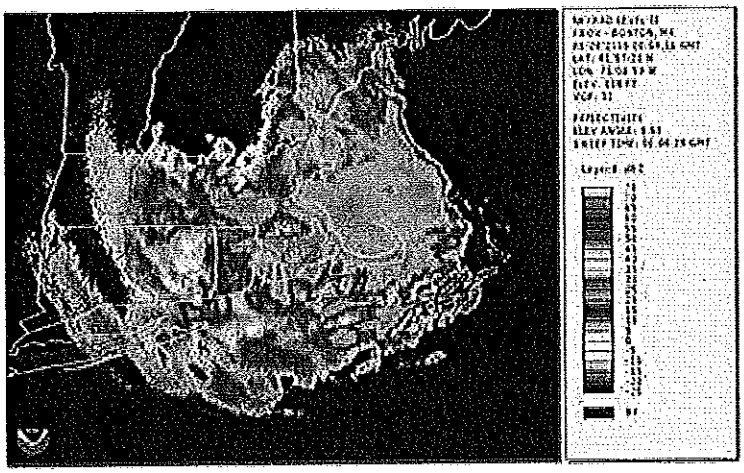


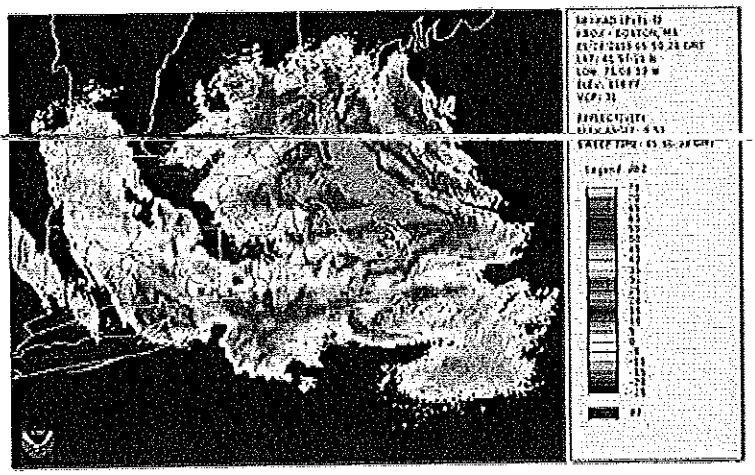
1 pm Tue 1/27



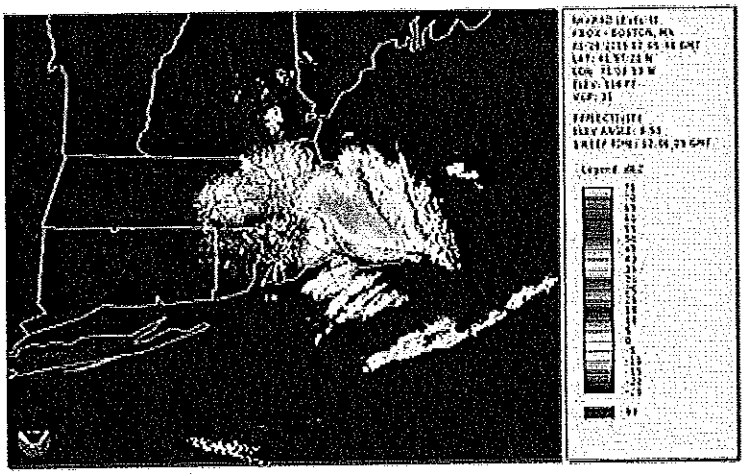
7 pm Tue 1/27



1 am Wed 1/28



7 am Wed



From: Glenn Field (NOAA Federal)
To: MacLeod, Scott (CDA); Heidelberg, Erica (CDA)
Cc: Thompson, Robert; Joseph Dellicarpini
Subject: Norwood Ouration
Date: Thursday, February 05, 2015 12:46:10 PM

Hi Scott & Erica,

Sorry for not including Norwood, MA (OWD) in the analysis. Their duration for 2 miles or less visibility for the Blizzard of 2015 was 26.5 hours.

-- Glenn

ENCLOSURE D-2

National Climatic Data Center (NCDC) - Historic Snowfall Data for 1-, 2- & 3-Day Events

18 February 2015

Below are the 1-day, 2-day, and 3-day current Massachusetts and Rhode Island County Snowfall Records through June 2014. These are based on analysis of the available GHCN-Daily data. Please note that the stations considered for analysis are only those with long-term, consistent snowfall records, as per FEMA request when the original snowfall climatology was constructed. For most of these counties, there are stations with short periods of record or less robust snow observation history that were not considered in this analysis. In some cases, these values differ from those listed in prior analyses. These differences are largely attributable to improvements in quality assurance algorithms since the prior analysis.

Note, this contains a correction for GARDNER, MA, relative to a document sent 30 January 2015.

Deke Arndt
Climate Monitoring Branch Chief
National Climatic Data Center

MASSACHUSETTS County	Station Name	Station ID (GHCN-Daily)	Event Duration	Total Snowfall	For the Period
BARNSTABLE County	CHATHAM	USC00191386	1-Day	19.5"	ending 19 Feb 1993
	CHATHAM	USC00191386	2-Day	28.0"	ending 10 Feb 1987
	CHATHAM	USC00191386	3-Day	28.0"	ending 10 Feb 1987
	HATCHVILLE	USC00193471	1-Day	15.0"	ending 27 Jan 1987
	HATCHVILLE	USC00193471	2-Day	20.0"	ending 5 Mar 1960
	HATCHVILLE	USC00193471	3-Day	20.0"	ending 5 Mar 1960
	HYANNIS	USC00193821	1-Day	24.0"	ending 23 Jan 2005
	HYANNIS	USC00193821	2-Day	24.0"	ending 23 Jan 2005
	HYANNIS	USC00193821	3-Day	24.0"	ending 23 Jan 2005
BERKSHIRE County	ADAMS	USC00190049	1-Day	24.0"	ending 9 Feb 1895
	ADAMS	USC00190049	2-Day	24.0"	ending 9 Feb 1895
	ADAMS	USC00190049	3-Day	24.0"	ending 9 Feb 1895
	GREAT BARRINGTON 2N	USC00193213	1-Day	18.0"	ending 14 Mar 1993
	GREAT BARRINGTON 2N	USC00193213	2-Day	32.0"	ending 9 Jan 1996
	GREAT BARRINGTON 2N	USC00193213	3-Day	34.0"	ending 10 Jan 1996
	HOOSAC TUNNEL	USC00193713	1-Day	20.0"	ending 3 Mar 1947
	HOOSAC TUNNEL	USC00193713	2-Day	27.5"	ending 17 Feb 1958
	HOOSAC TUNNEL	USC00193713	3-Day	30.5"	ending 5 Mar 1947
	LANESBORO	USC00194075	1-Day	13.0"	ending 14 Mar 1984
	LANESBORO	USC00194075	2-Day	16.0"	ending 13 Dec 1992
	LANESBORO	USC00194075	3-Day	18.0"	ending 13 Dec 1992
	PERU	USC00196311	1-Day	19.0"	ending 4 Mar 1947

	PERU	USC00196311	2-Day	26.8"	ending 4 Mar 1947
	PERU	USC00196311	3-Day	43.3"	ending 4 Mar 1947
	SOUTH EGREMONT	USC00197692	1-Day	18.0"	ending 10 Feb 1969
	SOUTH EGREMONT	USC00197692	2-Day	20.0"	ending 10 Feb 1969
	SOUTH EGREMONT	USC00197692	3-Day	20.0"	ending 10 Feb 1969
	STOCKBRIDGE	USC00198181	1-Day	15.0"	ending 21 Feb 1947
	STOCKBRIDGE	USC00198181	2-Day	24.0"	ending 10 Feb 1969
	STOCKBRIDGE	USC00198181	3-Day	24.0"	ending 10 Feb 1969
	WASHINGTON 2	USC00198843	1-Day	18.0"	ending 21 Jan 1961
	WASHINGTON 2	USC00198843	2-Day	20.0"	ending 28 Dec 1969
	WEST OTIS	USC00199371	1-Day	25.9"	ending 30 Oct 2011
	WEST OTIS	USC00199371	2-Day	27.0"	ending 13 Jan 2011
	WEST OTIS	USC00199371	3-Day	29.1"	ending 30 Oct 2011
BRISTOL County	FALL RIVER	USC00192642	1-Day	18.0"	ending 27 Jan 1894
	FALL RIVER	USC00192642	2-Day	18.0"	ending 27 Jan 1894
	FALL RIVER	USC00192642	3-Day	22.0"	ending 30 Nov 1898
	NEW BEDFORD	USC00195246	1-Day	21.0"	ending 6 Feb 1978
	NEW BEDFORD	USC00195246	2-Day	26.0"	ending 7 Feb 1978
	NEW BEDFORD	USC00195246	3-Day	26.0"	ending 7 Feb 1978
	TAUNTON	USC00198367	1-Day	21.5"	ending 6 Feb 1978
	TAUNTON	USC00198367	2-Day	38.5"	ending 7 Feb 1978
	TAUNTON	USC00198367	3-Day	38.5"	ending 7 Feb 1978
DUKES County	EDGARTOWN	USC00192501	1-Day	16.0"	ending 23 Jan 2005
	EDGARTOWN	USC00192501	2-Day	23.0"	ending 24 Jan 2005
	EDGARTOWN	USC00192501	3-Day	23.0"	ending 24 Jan 2005
ESSEX County	GROVELAND	USC00193276	1-Day	18.5"	ending 12 Dec 1992
	GROVELAND	USC00193276	2-Day	26.0"	ending 23 Jan 2005
	GROVELAND	USC00193276	3-Day	26.4"	ending 7 Mar 2001
	HAVERHILL	USC00193505	1-Day	25.3"	ending 7 Feb 1978
	HAVERHILL	USC00193505	2-Day	27.0"	ending 6 Mar 2001
	HAVERHILL	USC00193505	3-Day	29.0"	ending 26 Feb 1969
	IPSWICH	USC00193876	1-Day	30.0"	ending 25 Feb 1969
	IPSWICH	USC00193876	2-Day	43.7"	ending 8 Feb 1978
	IPSWICH	USC00193876	3-Day	43.9"	ending 8 Feb 1978
	LAWRENCE	USC00194105	1-Day	31.0"	ending 7 Feb 1978
	LAWRENCE	USC00194105	2-Day	37.0"	ending 8 Feb 1978
	LAWRENCE	USC00194105	3-Day	37.0"	ending 8 Feb 1978
	MARBLEHEAD	USC00194502	1-Day	21.0"	ending 1 Apr 1997
	MARBLEHEAD	USC00194502	2-Day	32.5"	ending 24 Jan 2005
	MARBLEHEAD	USC00194502	3-Day	32.5"	ending 24 Jan 2005
	MIDDLETON	USC00194744	1-Day	28.0"	ending 7 Feb 1978

	MIDDLETON	USC00194744	2-Day	29.4"	ending 7 Feb 1978
	MIDDLETON	USC00194744	3-Day	30.S"	ending 26 Feb 1969
	NEWBURYPORT 4 NNW	USC00195285	1-Day	24.0"	ending 26 Dec 1947
	NEWBURYPORT 4 NNW	USC0019S28S	2-Day	32.0"	ending 26 Feb 1969
	NEWBURYPORT 4 NNW	USC0019S28S	3-Day	3S.0"	ending 27 Feb 1969
	PEABODY	USC0019624S	1-Day	24.0"	ending 20 Jan 1978
	PEABODY	USC0019624S	2-Day	24.0"	ending 20 Jan 1978
	PEABODY	USC0019624S	3-Day	28.0"	ending 20 Jan 1978
	ROCKPORT 1 ESE	USC00196977	1-Day	29.0"	ending 7 Feb 1978
	ROCKPORT 1 ESE	USC00196977	2-Day	32.0"	ending 8 Feb 1978
	ROCKPORT 1 ESE	USC00196977	3-Day	36.0"	ending 26 Feb 1969
FRANKLIN County	ASHFIELD	USC00190213	1-Day	24.0"	ending 6 Feb 2001
	ASHFIELD	USC00190213	2-Day	29.0"	ending 8 Dec 1996
	ASHFIELD	USC00190213	3-Day	30.3"	ending 8 Dec 1996
	COLRAIN	USC00191611	1-Day	20.0"	ending 7 Apr 1982
	COLRAIN	USC00191611	2-Day	21.S"	ending 7 Apr 1982
	COLRAIN	USC00191611	3-Day	21.S"	ending 7 Apr 1982
	HEATH	USC00193S49	1-Day	26.0"	ending 19 Dec 1986
	HEATH	USC00193S49	2-Day	26.0"	ending 19 Dec 1986
	HEATH	USC00193S49	3-Day	27.S"	ending 19 Dec 1986
	NEW SALEM	USC0019S306	1-Day	20.0"	ending 10 Feb 1969
	NEW SALEM	USC0019S306	2-Day	23.0"	ending 10 Feb 1969
	NEW SALEM	USC0019S306	3-Day	25.0"	ending 11 Feb 1969
	SUNDERLAND	USC00198278	1-Day	22.3"	ending 9 Feb 2013
	SUNDERLAND	USC00198278	2-Day	22.3"	ending 9 Feb 2013
	SUNDERLAND	USC00198278	3-Day	22.8"	ending 11 Feb 2013
	TURNERS FALLS	USC00198S80	1-Day	18.0"	ending 28 Jan 1897
	TURNERS FALLS	USC00198S80	2-Day	18.0"	ending 28 Jan 1897
	TURNERS FALLS	USC00198S80	3-Day	19.0"	ending 1S Feb 1894
HAMPDEN County	CHESTER	USC0019142S	1-Day	20.0"	ending 20 Feb 1934
	CHESTER	USC0019142S	2-Day	20.0"	ending 20 Feb 1934
	CHESTER	USC0019142S	3-Day	21.5"	ending 22 Feb 1934
	CHESTER 2	USC00191430	1-Day	26.0"	ending 12 Feb 1988
	CHESTER 2	USC00191430	2-Day	26.0"	ending 12 Feb 1988
	CHESTER 2	USC00191430	3-Day	28.0"	ending 6 Apr 1982
	HOLYOKE	USC00193702	1-Day	18.0"	ending 12 Feb 1983
	HOLYOKE	USC00193702	2-Day	19.0"	ending 8 Feb 1978
	HOLYOKE	USC00193702	3-Day	19.0"	ending 8 Feb 1978
	SPRINGFIELD	USC00198046	1-Day	22.1"	ending 13 Dec 191S
	SPRINGFIELD	USC00198046	2-Day	22.2"	ending 13 Dec 191S

	SPRINGFIELD	USC00198046	3-Day	22.2"	ending 13 Dec 1915
	WESTFIELD	USC00199191	1-Day	21.0"	ending 12 Feb 1983
	WESTFIELD	USC00199191	2-Day	21.0"	ending 12 Feb 1983
	WESTFIELD	USC00199191	3-Day	21.0"	ending 12 Feb 1983
HAMPSHIRE County	AMHERST	USC00190120	1-Day	18.0"	ending 28 Jan 1897
	AMHERST	USC00190120	2-Day	20.0"	ending 1 Feb 1898
	AMHERST	USC00190120	3-Day	20.0"	ending 1 Feb 1898
	BELCHERTOWN	USC00190562	1-Day	20.0"	ending 6 Feb 2001
	BELCHERTOWN	USC00190562	2-Day	24.0"	ending 8 Dec 1996
	BELCHERTOWN	USC00190562	3-Day	24.0"	ending 8 Dec 1996
	CHESTERFIELD	USC00191436	1-Day	22.0"	ending 1 Apr 1997
	CHESTERFIELD	USC00191436	2-Day	23.5"	ending 8 Dec 1996
	CHESTERFIELD	USC00191436	3-Day	29.0"	ending 8 Dec 1996
	CUMMINGTON HILL	USC00191774	1-Day	24.0"	ending 19 Dec 1986
	CUMMINGTON HILL	USC00191774	2-Day	24.0"	ending 19 Dec 1986
	CUMMINGTON HILL	USC00191774	3-Day	25.0"	ending 13 Dec 1992
	KNIGHTVILLE DAM	USC00193985	1-Day	17.0"	ending 15 Feb 1962
	KNIGHTVILLE DAM	USC00193985	2-Day	19.0"	ending 17 Feb 1958
	KNIGHTVILLE DAM	USC00193985	3-Day	19.0"	ending 17 Feb 1958
	PELHAM	USC00196251	1-Day	20.0"	ending 10 Feb 1969
	PELHAM	USC00196251	2-Day	22.0"	ending 10 Feb 1969
	PELHAM	USC00196251	3-Day	25.0"	ending 28 Dec 1969
	PLAINFIELD	USC00196425	1-Day	24.0"	ending 7 Apr 1982
	PLAINFIELD	USC00196425	2-Day	26.5"	ending 26 Jan 1979
	PLAINFIELD	USC00196425	3-Day	26.5"	ending 26 Jan 1979
	WARE	USC00198793	1-Day	24.0"	ending 7 Feb 1978
	WARE	USC00198793	2-Day	27.0"	ending 8 Feb 1978
	WARE	USC00198793	3-Day	27.0"	ending 8 Feb 1978
MIDDLESEX County	ASHLAND	USC00190218	1-Day	21.0"	ending 10 Feb 1969
	ASHLAND	USC00190218	2-Day	26.0"	ending 26 Feb 1969
	ASHLAND	USC00190218	3-Day	28.0"	ending 26 Feb 1969
	BEDFORD	USC00190535	1-Day	21.0"	ending 4 Mar 1960
	BEDFORD	USC00190535	2-Day	29.0"	ending 7 Feb 1978
	BEDFORD	USC00190535	3-Day	32.0"	ending 26 Feb 1969
	FRAMINGHAM	USC00192975	1-Day	20.0"	ending 10 Feb 1969
	FRAMINGHAM	USC00192975	2-Day	23.5"	ending 26 Feb 1969
	FRAMINGHAM	USC00192975	3-Day	25.5"	ending 26 Feb 1969
	GROTON	USC00193270	1-Day	21.0"	ending 23 Jan 1935
	GROTON	USC00193270	2-Day	26.5"	ending 19 Feb 1952
	GROTON	USC00193270	3-Day	29.5"	ending 19 Feb 1952
	LOWELL	USC00194313	1-Day	22.1"	ending 9 Feb 2013
	LOWELL	USC00194313	2-Day	28.0"	ending 24 Jan 2005

	LOWELL	U5C00194313	3-Day	28.0"	ending 24 Jan 2005
	NATICK	USC00195175	1-Day	29.0"	ending 1 Apr 1997
	NATICK	U5C00195175	2-Day	32.0"	ending 2 Apr 1997
	NATICK	U5C00195175	3-Day	32.0"	ending 2 Apr 1997
	READING	U5C00196783	1-Day	20.4"	ending 7 Feb 1978
	READING	U5C00196783	2-Day	29.0"	ending 2S Feb 1969
	READING	U5C00196783	3-Day	34.5"	ending 26 Feb 1969
	SPOT POND	U5C00198030	1-Day	20.0"	ending 8 Feb 1945
	5POT POND	U5C00198030	2-Day	25.0"	ending 26 Feb 1969
	5POT POND	U5C00198030	3-Day	27.0"	ending 27 Feb 1969
	WESTON	USC00199360	1-Day	16.5"	ending 4 Mar 1960
	WESTON	USC00199360	2-Day	29.5"	ending 20 Feb 1934
	WESTON	USC00199360	3-Day	29.5"	ending 20 Feb 1934
	CONCORD	U5C00191622	1-Day	17.5"	ending 20 Feb 1921
	CONCORD	USC00191622	2-Day	24.5"	ending 1 Feb 1898
	CONCORD	U5C00191622	3-Day	24.5"	ending 1 Feb 1898
	LAKE COCHITUATE	USC00194012	1-Day	19.0"	ending 20 Feb 1934
	LAKE COCHITUATE	USC00194012	2-Day	21.0"	ending 5 Mar 1960
	LAKE COCHITUATE	U5C00194012	3-Day	21.0"	ending 5 Mar 1960
NANTUCKET County	NANTUCKET MEM AP	U5W00014756	1-Day	15.S"	ending 12 Dec 1960
	NANTUCKET MEM AP	U5W00014756	2-Day	24.2"	ending 4 Mar 1960
	NANTUCKET MEM AP	U5W00014756	3-Day	31.3"	ending 5 Mar 1960
NORFOLK County	8EECHWOOD	U5C00190551	1-Day	16.0"	ending 7 Feb 1978
	BEECHWOOD	USC00190551	2-Day	20.0"	ending 8 Feb 1978
	BEECHWOOD	U5C00190551	3-Day	20.0"	ending 8 Feb 1978
	BLUE HILL	U5C00190736	1-Day	27.4"	ending 24 Feb 1969
	BLUE HILL	U5C00190736	2-Day	34.6"	ending 2S Feb 1969
	BLUE HILL	U5C00190736	3-Day	37.8"	ending 26 Feb 1969
	FRANKLIN	U5C00192997	1-Day	28.0"	ending 13 Dec 1992
	FRANKLIN	U5C00192997	2-Day	28.0"	ending 13 Dec 1992
	FRANKLIN	U5C00192997	3-Day	28.0"	ending 13 Dec 1992
	WALPOLE	USC00198755	1-Day	19.4"	ending 12 Dec 1960
	WALPOLE	U5C00198755	2-Day	22.4"	ending 4 Mar 1960
	WALPOLE	U5C00198755	3-Day	24.4"	ending 5 Mar 1960
	WALPOLE 2	U5C00198757	1-Day	29.3"	ending 7 Feb 1978
	WALPOLE 2	U5C00198757	2-Day	36.1"	ending 8 Feb 1978
	WALPOLE 2	U5C00198757	3-Day	36.1"	ending 8 Feb 1978
	WEST MEDWAY	U5C00199316	1-Day	25.0"	ending 7 Feb 1978
	WEST MEDWAY	USC00199316	2-Day	29.0"	ending 8 Feb 1978
	WEST MEDWAY	USC00199316	3-Day	29.0"	ending 8 Feb 1978
PLYMOUTH County	BROCKTON	USC00190860	1-Day	15.8"	ending 8 Jan 1996
	BROCKTON	U5C00190860	2-Day	24.8"	ending 8 Jan 1996

	BROCKTON	USC00190860	3-Day	24.8"	ending 8 Jan 1996
	EAST WAREHAM	USC001924S1	1-Day	19.0"	ending 23 Jan 200S
	EAST WAREHAM	USC001924S1	2-Day	27.S"	ending 24 Jan 2005
	EAST WAREHAM	USC001924S1	3-Day	27.S"	ending 24 Jan 2005
	HINGHAM	USC00193624	1-Day	24.0"	ending 7 Feb 1978
	HINGHAM	USC00193624	2-Day	28.0"	ending 7 Feb 1978
	HINGHAM	USC00193624	3-Day	28.3"	ending 8 Feb 1978
	MIDDLEBORO	USC00194711	1-Day	29.0"	ending 28 Feb 1969
	MIDDLEBORO	USC00194711	2-Day	30.0"	ending 23 Jan 200S
	MIDDLEBORO	USC00194711	3-Day	33.S"	ending 19 Mar 19S6
	PEMBROKE	USC00196262	1-Day	18.0"	ending 23 Jan 193S
	PEMBROKE	USC00196262	2-Day	22.S"	ending S Mar 1960
	PEMBROKE	USC00196262	3-Day	22.S"	ending S Mar 1960
	PLYMOUTH-KINGSTON	USC00196486	1-Day	21.0"	ending 8 Feb 2013
	PLYMOUTH-KINGSTON	USC00196486	2-Day	24.3"	ending 8 Jan 1996
	PLYMOUTH-KINGSTON	USC00196486	3-Day	24.3"	ending 8 Jan 1996
	ROCHESTER	USC00196938	1-Day	24.0"	ending 23 Jan 200S
	ROCHESTER	USC00196938	2-Day	27.0"	ending S Mar 1960
	ROCHESTER	USC00196938	3-Day	27.S"	ending 6 Mar 1960
SUFFOLK County	CHESTNUT HILL	USC00191447	1-Day	20.0"	ending 10 Feb 1969
	CHESTNUT HILL	USC00191447	2-Day	24.0"	ending S Mar 1960
	CHESTNUT HILL	USC00191447	3-Day	24.8"	ending 23 Dec 197S
	BOSTON LOGAN INTL AP	USW00014739	1-Day	23.6"	ending 17 Feb 2003
	BOSTON LOGAN INTL AP	USW00014739	2-Day	27.6"	ending 18 Feb 2003
	BOSTON LOGAN INTL AP	USW00014739	3-Day	27.6"	ending 18 Feb 2003
	BOSTON CITY WSO	USW00094701	1-Day	16.S"	ending 20 Feb 1921
	BOSTON CITY WSO	USW00094701	2-Day	16.S"	ending 20 Feb 1921
	BOSTON CITY WSO	USW00094701	3-Day	16.S"	ending 20 Feb 1921
WORCESTER County	ASHBURNHAM	USC00190190	1-Day	22.0"	ending 2 Jan 1987
	ASHBURNHAM	USC00190190	2-Day	24.0"	ending 21 Jan 1961
	ASHBURNHAM	USC00190190	3-Day	26.0"	ending 8 Dec 1996
	BARRE FALLS DAM	USC00190408	1-Day	24.0"	ending 9 Feb 2013
	BARRE FALLS DAM	USC00190408	2-Day	26.0"	ending 10 Feb 2013
	BARRE FALLS DAM	USC00190408	3-Day	26.0"	ending 10 Feb 2013
	BIRCH HILL DAM	USC00190666	1-Day	24.0"	ending 6 Feb 2001
	BIRCH HILL DAM	USC00190666	2-Day	24.0"	ending 6 Feb 2001
	BIRCH HILL DAM	USC00190666	3-Day	24.0"	ending 6 Feb 2001
	BOYLSTON	USC00190801	1-Day	20.S"	ending 12 Feb 1899
	BOYLSTON	USC00190801	2-Day	20.S"	ending 12 Feb 1899
	BOYLSTON	USC00190801	3-Day	23.0"	ending 30 Nov 1898

	BUFFUMVILLE LAKE	USC00190998	1-Day	26.3"	ending 9 Feb 2013
	BUFFUMVILLE LAKE	USC00190998	2-Day	30.4"	ending 10 Feb 2013
	BUFFUMVILLE LAKE	USC00190998	3-Day	30.4"	ending 10 Feb 2013
	CLINTON	USC00191S61	1-Day	23.0"	ending 20 Feb 1934
	CLINTON	USC00191S61	2-Day	23.8"	ending 7 Feb 1978
	CLINTON	USC00191S61	3-Day	24.8"	ending 26 Feb 1969
	EAST BRIMFIELD LAKE	USC00192107	1-Day	28.0"	ending 1 Apr 1997
	EAST BRIMFIELD LAKE	USC00192107	2-Day	28.0"	ending 1 Apr 1997
	EAST BRIMFIELD LAKE	USC00192107	3-Day	28.0"	ending 1 Apr 1997
	FITCHBURG 4 SE	USC00192806	1-Day	19.5"	ending 8 Jan 1958
	FITCHBURG 4 SE	USC00192806	2-Day	26.0"	ending 21 Jan 1961
	FITCHBURG 4 SE	USC00192806	3-Day	26.0"	ending 21 Jan 1961
	GARDNER	USC001930S2	1-Day	30.0"	ending 5 Feb 2001
	GARDNER	USC001930S2	2-Day	31.0"	ending 1 Apr 1997
	GARDNER	USC001930S2	3-Day	31.0"	ending 1 Apr 1997
	HARDWICK	USC00193401	1-Day	22.0"	ending 6 Feb 2001
	HARDWICK	USC00193401	2-Day	22.0"	ending 6 Feb 2001
	HARDWICK	USC00193401	3-Day	23.0"	ending 8 Dec 1996
	HUBBARDSTON	USC00193772	1-Day	18.0"	ending 12 Apr 1933
	HUBBARDSTON	USC00193772	2-Day	18.0"	ending 12 Apr 1933
	HUBBARDSTON	USC00193772	3-Day	19.6"	ending 26 Feb 1969
	MILFORD	USC00194760	1-Day	22.5"	ending 18 Feb 2003
	MILFORD	USC00194760	2-Day	24.0"	ending 13 Dec 1992
	MILFORD	USC00194760	3-Day	24.5"	ending 26 Feb 1969
	NORTHBRIDGE 2	USC00195S24	1-Day	24.1"	ending 9 Feb 2013
	NORTHBRIDGE 2	USC00195S24	2-Day	26.0"	ending 2 Apr 1997
	NORTHBRIDGE 2	USC00195S24	3-Day	36.0"	ending 23 Dec 2008
	PETERSHAM 3 N	USC00196322	1-Day	22.8"	ending 13 Apr 1933
	PETERSHAM 3 N	USC00196322	2-Day	24.0"	ending 10 Mar 1916
	PETERSHAM 3 N	USC00196322	3-Day	24.0"	ending 10 Mar 1916
	QUABBIN INTAKE	USC00196699	1-Day	17.0"	ending 12 Feb 1983
	QUABBIN INTAKE	USC00196699	2-Day	17.0"	ending 12 Feb 1983
	QUABBIN INTAKE	USC00196699	3-Day	18.0"	ending 17 Mar 1956
	SOUTHBRIDGE 3 SW	USC00197627	1-Day	21.0"	ending 7 Feb 1978
	SOUTHBRIDGE 3 SW	USC00197627	2-Day	27.0"	ending 8 Feb 1978
	SOUTHBRIDGE 3 SW	USC00197627	3-Day	27.0"	ending 8 Feb 1978
	STERLING	USC001981S4	1-Day	20.0"	ending 31 Jan 1898
	STERLING	USC001981S4	2-Day	20.0"	ending 31 Jan 1898
	STERLING	USC001981S4	3-Day	20.0"	ending 31 Jan 1898
	TULLY LAKE	USC00198573	1-Day	21.0"	ending 6 Feb 2001
	TULLY LAKE	USC00198573	2-Day	23.0"	ending 8 Feb 1978
	TULLY LAKE	USC00198573	3-Day	23.0"	ending 8 Feb 1978

	WINCHENDON 2	USC00199780	1-Day	22.0"	ending 10 Feb 1969
	WINCHENDON 2	USC00199780	2-Day	26.0"	ending 8 Feb 1978
	WINCHENDON 2	USC00199780	3-Day	26.0"	ending 8 Feb 1978
	WORCESTER RGNL AP	USW00094746	1-Day	21.1"	ending 12 Jan 2011
	WORCESTER RGNL AP	USW00094746	2-Day	32.1"	ending 12 Dec 1992
	WORCESTER RGNL AP	USW00094746	3-Day	32.1"	ending 12 Dec 1992
	JEFFERSON	USC00193931	1-Day	21.0"	ending 14 Feb 1899
	JEFFERSON	USC00193931	2-Day	21.0"	ending 14 Feb 1899
	JEFFERSON	USC00193931	3-Day	21.0"	ending 14 Feb 1899
	MILLBURY	USC00194771	1-Day	18.0"	ending 4 Mar 1960
	MILLBURY	USC00194771	2-Day	22.0"	ending 5 Mar 1960
	MILLBURY	USC00194771	3-Day	22.0"	ending 5 Mar 1960
	NORTHBRIDGE	USC00195514	1-Day	22.5"	ending 4 Mar 1960
	NORTHBRIDGE	USC00195514	2-Day	29.5"	ending 5 Mar 1960
	NORTHBRIDGE	USC00195514	3-Day	29.5"	ending 5 Mar 1960
	PRINCETON	USC00196644	1-Day	21.0"	ending 13 Feb 1899
	PRINCETON	USC00196644	2-Day	21.0"	ending 13 Feb 1899
	PRINCETON	USC00196644	3-Day	21.0"	ending 13 Feb 1899
	WARE 2	USC00198798	1-Day	13.0"	ending 25 Feb 1933
	WARE 2	USC00198798	2-Day	16.0"	ending 26 Feb 1934
	WARE 2	USC00198798	3-Day	16.0"	ending 26 Feb 1934
	WINCHENDON	USC00199770	1-Day	22.0"	ending 12 Apr 1933
	WINCHENDON	USC00199770	2-Day	22.0"	ending 12 Apr 1933
	WINCHENDON	USC00199770	3-Day	22.0"	ending 12 Apr 1933
	WORCESTER	USC00199928	1-Day	20.0"	ending 4 Mar 1960
	WORCESTER	USC00199928	2-Day	24.6"	ending 4 Mar 1960
	WORCESTER	USC00199928	3-Day	25.6"	ending 5 Mar 1960

RHODE ISLAND County	Station Name	Station ID (GHCN-Daily)	Event Duration	Total Snowfall	For the Period
NEWPORT County	NEWPORT ROSE	USC00375215	1-Day	20.0"	ending 7 Feb 1978
	NEWPORT ROSE	USC00375215	2-Day	28.0"	ending 7 Feb 1978
	NEWPORT ROSE	USC00375215	3-Day	28.0"	ending 7 Feb 1978
PROVIDENCE County	NORTH FOSTER 1 E	USC00375270	1-Day	22.0"	ending 12 Jan 2011
	NORTH FOSTER 1 E	USC00375270	2-Day	36.0"	ending 7 Feb 1978
	NORTH FOSTER 1 E	USC00375270	3-Day	36.0"	ending 7 Feb 1978
	WOONSOCKET	USC00379423	1-Day	30.0"	ending 7 Feb 1978
	WOONSOCKET	USC00379423	2-Day	38.0"	ending 8 Feb 1978
	WOONSOCKET	USC00379423	3-Day	38.0"	ending 8 Feb 1978
	PROVIDENCE T F	USW00014765	1-Day	18.3"	ending 4 Feb 1961

	GREEN AP				
	PROVIDENCE T F GREEN AP	USW00014765	2-Day	28.6"	ending 7 Feb 1978
	PROVIDENCE T F GREEN AP	USW00014765	3-Day	28.6"	ending 7 Feb 1978
WASHINGTON County	KINGSTON	USC00374266	1-Day	21.3"	ending 7 Feb 1978
	KINGSTON	USC00374266	2-Day	23.0"	ending 8 Feb 1978
	KINGSTON	USC00374266	3-Day	24.6"	ending 8 Feb 1978
	BLOCK ISLAND STATE AP	USW00094793	1-Day	21.2"	ending 20 Jan 1978
	BLOCK ISLAND STATE AP	USW00094793	2-Day	22.0"	ending 20 Jan 1978
	BLOCK ISLAND STATE AP	USW00094793	3-Day	22.0"	ending 20 Jan 1978

ENCLOSURE D-3

Cumulative Snowfall Total Matrix January 26, 2015 – February 22, 2015

Cumulative Snow Event Totals

Jan. 26, 2015 thru Feb. 22, 2015

County	NWS Public Information Statement Snowfall Totals									Conversion (inches to feet)
	1/26-1/28 2015 Snowfall Total [1]	2/2-2/3 2015 Snowfall Total [1]	2/5/2015 Snowfall Total [1]	2/9-2/10 2015 Snowfall Total [1]	2/14-2/15 2015 Snowfall Total [1]	2/17/2015 Snowfall Total [1]	2/18/2015 Snowfall Total [1]	2/21/2015 Snowfall Total [1]	*Snowfall Subtotal (Jan. 26th to Feb. 22nd)* [2]	
Barnstable	30.5	4.3	0.2	7.3	12.0	6.1	3.0	0.8	*64.2*	5.35
Bristol	26.0 [3]	11.2	2.0	16.3	22.8 [5]	4.5	2.5	2.8	*85.3*	7.11
Dukes	27.0	3.0	N/A	N/A	10.0	2.5	1.3	N/A	*43.8*	3.65
Essex	31.5	18.0	4.0	25.0	22.0	0.1	3.0	3.5	*107.1*	8.93
Middlesex	36.0	17.0	4.7	19.8	17.5	T	3.1	3.2	*101.3*	8.44
Norfolk	31.0	16.5	3.5	28.3	19.1	3.5	3.9	2.0	*107.8*	8.98
Plymouth	30.7	14.0	0.5	28.9 [4]	20.0	5.5	1.0	2.5	*103.1*	8.59
Suffolk	31.0	17.3	0.8	23.8	16.2	0.6	1.6	1.2	*92.5*	7.71
Worcester	36.0	20.7	8.0	18.0	13.3	0.2	3.2	6.3	*105.7*	8.81

= Potential Record Snowfall

= Potential Near Record Snowfall (w/ in 10% of record snowfall)

= Potential Contiguous County

Footnotes:

[1] *Source: NOAA NWS Public Informotion Stotements*

[2] *Subtotol bosed on individuol NWS Public Informotion Stotements*

[3] *Record for 1- doy event durotion, bosed on NWS event summory (duration of 20.7 hours)*

[4] *Neor Record for 1- or 2- doy event, no contiguous counties*

[5] *Record for 1-doy event durotion, no contiguous counties*

ENCLOSURE D-4

National Weather Service Taunton Memo Regarding Severe Weather Pattern

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE
FORECAST OFFICE
445 Myles Standish Boulevard
Taunton, MA 02780

March 17, 2015

Mr. Kurt Schwartz
Director, Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, MA 01702

Dear Director Schwartz:

Late January through February 2015 proved to be an extraordinary period weatherwise for the Commonwealth of Massachusetts. Although you, I, and our staffs are very cognizant of something unprecedented through the length and pace of our operations since late January, this letter attempts to place in perspective the historical nature of the snow and cold that have impacted our state, especially the more densely populated eastern and central sections of Massachusetts.

Official observation sites at Boston's Logan Airport, Blue Hill Observatory in Milton, National Weather Service Taunton, and Worcester have all recorded their snowiest February and snowiest month on record. As of mid-March, Boston had recorded its snowiest winter season ever, and Blue Hill was less than a half inch shy of its record snowiest season. This is especially significant when one considers that snowfall records for the Boston area go back to 1891, and Blue Hill's records began in 1885.

Drilling deeper into the snowfall experienced in Boston, the numbers are nothing less than astounding. In one 30 day period from late January to late February, the major city of Boston received an incredible 94.4 inches of snow, which has eclipsed the prior 30 day record of 58.8 inches during a 30 day period in 1978 (incorporating the famed 1978 Blizzard). During the January 27 to February 15 period (just shy of 20 days), four major snow storms struck Boston with 22.1 inches on January 26-27, 16.2 inches on February 2nd, 23.1 inches on February 7-9, and 16.2 inches on February 14-15. For the month of February 2015, Boston received 64.8 inches of snow, far above the prior monthly record of 43.3 inches set in January 2005. Similarly, Worcester measured 94.6 inches of snow during a 30 day period, a value that far surpassed the prior 30 day record of 66.2 inches. The cities of Boston and Worcester also smashed 20 and 14 day snowfall records. From the perspective of the number of days of snowfall exceeding thresholds in February 2015, a whole other set of records was broken. For example, measurable snow fell in Boston on a record number of 16 days in February (i.e., more than half of the days in February received measurable snowfall in Boston!). And three days had 12 or more inches of snow (prior record was one).

There have also been exacerbating factors. A couple of the storms (January 27 and February 15) contained high winds that caused blizzard conditions. The January storm featured extreme blowing and drifting snow with winds that gusted between 65 and 75 mph along much of coastal Massachusetts. The February 15 storm produced wind gusts between 55 and 65 mph across southeastern Massachusetts.

Notably, sustained cold temperatures accompanied the snowfall. The average temperature for February was 19.0 degrees, in second place behind the all-time record cold monthly average temperature of 17.5 degrees. The month featured an extraordinary record 22 days with *maximum* temperatures below 32 degrees and included a stretch of 15 *consecutive days* of maximum temperatures below freezing. The sustained cold allowed the snow to build up and caused a range of problems involving high snowbanks, narrow streets, roof loading/collapses, ice dams, etc.

New Englanders have a reputation for being resilient and experienced with winter storms. Nonetheless, as the above numbers validate, the period of late January through February 2015 brought unprecedented snowfall to the Commonwealth of Massachusetts accompanied by one of the coldest periods on record. It is a testimony to your agency and the extraordinary dedication of public employees throughout the Commonwealth that the people of Massachusetts have continued to maintain a relatively high level of functionality in the face of truly historical adversity.

Sincerely,

Robert M. Thompson
Meteorologist-in-Charge

DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

OMB No. 1660-0009 Expires March 31,2015

REQUEST FOR PRESIDENTIAL DISASTER DECLARATION MAJOR DISASTER OR EMERGENCY

1. Request Date Mar 28, 2015

Burden Disclosure Notice

Public reporting burden for this form is estimated to average 9 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and submitting the form. This collection of information is required to obtain a benefit. You are not required to respond to this collection of information unless it displays a valid OMB control number. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing the burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 500 C Street SW, Washington, DC 20472, Paperwork Reduction Project (1660-0009). NOTE: Do not send your completed form to this address.

Completion of this form including applicable attachments satisfies legal requirements for emergency and major disaster declaration requests under 42 U.S.C. §§ 5170, 5191, 44 C.F.R. §§ 206.35 and 206.36. Failure to provide this form may result in a failure to meet these requirements and/or a delay in processing the request.

2a. Name of State (as defined in Stafford Act 102, 42 U.S.C. § 5122) or Indian tribal government requesting declaration.	2b. Population (as reported by 2010 Census) or estimated population of Indian tribal government's damaged area(s).
Commonwealth of Massachusetts	6,547,629

3. Governor's or Tribal Chief Executive's Name	4. Designation of State or Tribal Coordinating Officer upon declaration (if available) and phone number
Charles D. Baker	Kurt N. Schwartz, 508-820-2000

5. Designation of Governor's Authorized Representative or Tribal Chief Executive Representative upon declaration (if available) and phone number

Kurt N. Schwartz, 508-820-2000

6. Declaration Request For: [X] Major Disaster (Stafford Act Sec. 401) [ ] Emergency (Stafford Act Sec. 501(a))

7. Incident Period: Beginning Date Jan 26, 2015 End Date Feb 22, 2015 or [ ] Continuing

If requesting a "continuing" incident period, enclose an official statement from a qualified Federal Government agency acknowledged as a national authority in a specific incident field (e.g., United States Geological Survey for seismic incidents, the National Weather Service for flooding).

7b. Type of Incident (Check all that apply)

[ ] Drought [ ] Earthquake [ ] Explosion [ ] Fire [ ] Flood [ ] Hurricane [ ] Landslide [ ] Mudslide

[ ] Severe Storm (rain, high water, wind-driven rain, hail, lightning) [X] Snowstorm (Must include Enclosure O: Historic and Current Snowfall Data) [ ] Straight-Line Winds

[ ] Tidal Wave [ ] Tornado [ ] Tropical Depression [ ] Tropical Storm [ ] Tsunami [ ] Volcanic Eruption [X] Winter Storm

[ ] Other (please specify)

8. Description of damages (Short description of impacts of disaster on affected area and population). Include additional details in enclosed Governor's or Tribal Chief Executive's cover letter.

Twenty-five (25) storm related deaths.
Two hundred fifty (250) storm related roof collapses.
State and City of Boston offices and local schools closed for multiple days each for multiple storms.
Massachusetts Bay Transportation Authority (MBTA) forced to suspend services system-wide on 3 separate occasions. Service was restored incrementally, but continued to run far below normal service levels.
Local jurisdictions, on average, exceeded their budgeted snow removal appropriations by 2.5 times by the end of February.

Joint Preliminary Damage Assessments conducted for the Jan. 26-28th storm indicate damage in the 10 requested counties exceeds $35 million for this disaster.

9. Description of the nature and amount of State and local or Indian tribal government resources which have been or will be committed. Include additional details in enclosed Governor's or Tribal Chief Executive's cover letter.

The Governor issued a statewide emergency declaration, a statewide driving ban and activated the State emergency operations plan. The State Emergency Operations Center implemented a 24/7, Level III (Full Activation). Massachusetts National Guard troops were deployed and high water/high access rescue vehicles were staged in coastal communities to assist with evacuations from flood prone areas or communities experiencing flooding. High access rescue vehicles were also staged at State Police barracks throughout the Commonwealth to assist state and local law enforcement with rescuing stranded motorists and emergency response through heavy snow.
Mutual aid assistance was requested pursuant to the Emergency Management Assistance Compact (EMAC) resulting in the receipt of 151 pieces of heavy equipment with accompanying personnel from five states. Additionally, the Massachusetts Emergency Management Agency contracted with private vendors in two states for approximately 100 additional pieces of heavy equipment.

10. Joint Preliminary Damage Assessment*

☐ Individual Assistance Dates Performed Requested _____ Start _____ End _____

Individual Assistance Accessibility Problems (Areas that could not be accessed, and why)

☒ Public Assistance Dates Performed Requested Feb 2, 2015 Start Feb 17, 2015 End Mar 2, 2015

Public Assistance Accessibility Problems (Areas that could not be accessed, and why)

11. Programs and Areas Requested

Individual Assistance ☒ N/A ☐ Individuals and Households Program ☐ Crisis Counseling Program ☐ Disaster Unemployment Assistance

☐ All ☐ Disaster Case Management ☐ Disaster Legal Services

For the following jurisdictions, specify programs and areas (counties, parishes, independent cities; for Indian tribal government, list tribe(s) and/or tribal area(s)) If additional space is needed, please enclose additional documentation).

For States, identify Federally-recognized Tribes in the requested counties (if applicable).

Please see **Enclosure A: Supplemental Information for Individual Assistance** for additional information in support of this request*.

**Not Required for Emergency Declaration Request*

11. Programs and Areas Requested (Continued)

Public Assistance ☐ N/A ☒ Debris Removal (Category A) ☒ Emergency Protective Measures (Category B) ☒ Permanent Work (Categories C-G)* (not available for Emergency Declaration Requests)

For the following jurisdictions, specify programs and areas (counties, parishes, independent cities; for Indian tribal government, list tribe(s) and/or tribal area(s)). If additional space is needed or your request includes different categories of work for different jurisdictions; please enclose additional documentation.

Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk and Worcester counties.

For States, identify Federally-recognized Tribes included in the requested counties (if applicable).

Mashpee Wampanoag Tribe - Barnstable County
Wampanoag Aquinnah Tribe - Dukes County

Please see Enclosure B: **Supplemental Information for Public Assistance** for additional information in support of this request*.

Indemnification for Debris Removal Activity

☐ I do not anticipate the need for debris removal.

☒ I anticipate the need for debris removal, which poses an immediate threat to lives, public health and safety. Pursuant to Sections 403 and 407 of the Stafford Act, 42 U.S.C. §§ 5170b & 5173, the State or Indian tribal government agrees to indemnify and hold harmless the United States of America for any claims arising from the removal of debris or wreckage for this disaster. The State or Indian tribal government agrees that debris removal from public and private property will not occur until the landowner signs an unconditional authorization for the removal of debris.

Request for Direct Federal Assistance

☒ I do not request direct Federal assistance at this time.

☐ I request direct Federal assistance for work and services to save lives and protect property, and:

a. I request the following type(s) of assistance:

b. List of reasons why State and local or Indian tribal government cannot perform, or contract for, required work and services.

c. In accordance with 44 C.F.R. § 206.208, the State or Indian tribal government agrees that it will, with respect to direct Federal assistance: (1) Provide without cost to the United States all lands, easements, and rights-of-ways necessary to accomplish the approved work; (2) Hold and save the United States free from damages due to the requested work, and shall indemnify the Federal Government against any claims arising from such work; (3) Provide reimbursement to FEMA for the non-Federal share of the cost of such work in accordance with the provisions of the FEMA-State or FEMA-Tribe Agreement ; and (4) Assist the performing Federal agency in all support and local jurisdictional matters.

Request for Snow Assistance

☐ N/A ☒ I request snow assistance.

Snow assistance for the following jurisdictions (Specify counties, independent cities or tribes and/or tribal areas).
Barnstable, Bristol, Dukes, Essex, Middlesex, Norfolk, Plymouth, Suffolk and Worcester counties.

Please see Enclosure D: **Historic and Current Snowfall Data** for additional information in support of this request*.

*Not Required for Emergency Declaration Request

11. Programs and Areas Requested (Continued)

Hazard Mitigation* ☒ Statewide OR

For the following specific counties, parishes, independent cities or tribes and/or tribal areas.

12. Mitigation Plan Information*

a. Mitigation Plan Expiration Date Oct 10, 2018 b. Type of Plan ☐ Enhanced ☒ Standard

13. Other Federal Agency Programs

☐ I do not anticipate requirements from Other Federal Agencies ☒ I do anticipate requirements from Other Federal Agencies

Please see **Enclosure C**: Requirements for Other Federal Agency Programs for additional information in support of this request*.

14. Findings and Certifications

☒ I certify the following:

a. I have determined that this incident is of such severity and magnitude that effective response is beyond the capabilities of the State and the affected local government or Indian tribal government and that supplementary federal assistance is necessary.

b. In response to this incident, I have taken appropriate action under State or tribal law and have directed the execution of the State or Tribal Emergency Plan on Jan 26, 2015 In accordance with the Stafford Act.

c. The State and local governments, or Indian tribal government will assume all applicable non-Federal share of costs required by the Stafford Act.

15. List of Enclosures and Supporting Documentation

☒ Cover Letter ☐ Enclosure A (Individual Assistance)* ☒ Enclosure B (Public Assistance)*

☒ Enclosure C (Requirements for Other Federal Agency Programs) ☒ Enclosure D (Historic and Current Snowfall Data)

☒ Additional Supporting Documentation Attachment A: 2015 Severe Winter Weather Pattern Supplemental Information

Governor's or Tribal Chief Executive's Signature

3/27/15
Date

If anyone except the Governor or Tribal Chief Executive signs this document, please provide the documentation that establishes that this individual has the legal authority to act on behalf of the Governor or Tribal Chief Executive.

Not Required for Emergency Declaration Request

Attachment A: 2015 Severe Winter Weather Pattern Impacts - Supplemental Information

March 27, 2015

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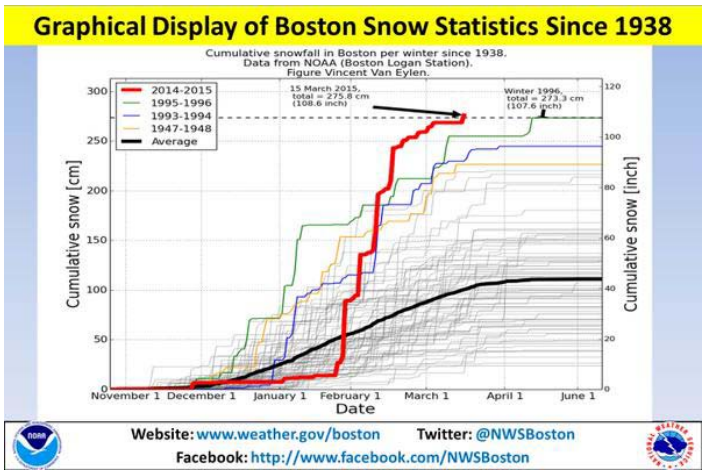
1. WEATHER/METEOROLOGICAL BACKGROUND

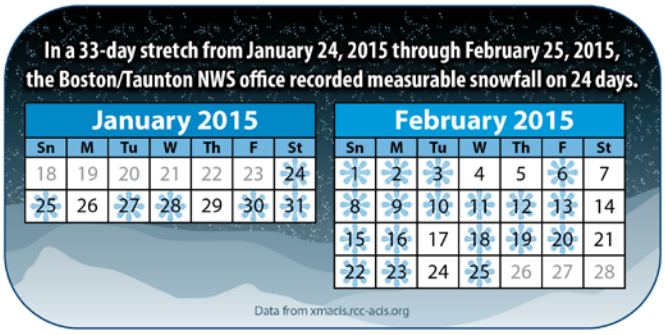
The winter of 2015 was unprecedented, unrelenting, and devastating. The large-scale weather pattern that set up across the U.S. and remained constant for weeks on end resulted in persistent, extreme cold temperatures and unending snowfall. The condensed timeframe in which this historic and devastating snow fell created a public safety crisis, resulted in dozens of deaths and hundreds of injuries and caused tens of millions of dollars in destruction.

Anomalous Winter Weather Pattern

It is hard to put into perspective an anomalous winter weather pattern such as this, when it is so far beyond any winter event in the recorded history of Massachusetts. Similar to previous stretches of winter weather, this year we observed in the jetstream a pronounced ridge over the west coast and a trough downstream. During the early part of this winter, the typical flow pattern over the U.S. resulted in the jetstream being zonal over the Pacific Ocean but split between two branches near the west coast of the U.S. due to a blocking dipole. As a result, the jetstream formed an ideal configuration to bring persistent warm air north over the west and cold arctic air south over the eastern continental U.S.



The blocking dipole formed in the middle of January as the result of a very active Pacific storm track. A sequence of low-pressure systems moved along the Pacific jet, advecting warm moist air and maturing near the west coast. This coincided with the establishment of a blocking upper atmospheric high-pressure system. This year however, the ridge was particularly pronounced and was positioned further downstream of the Rockies than normal. This led to extremely persistent warm weather out west and cold bitter temperatures out east. This continual pattern was also an ideal configuration to favor winter storms over the East Coast.



Once the blocking pattern was established downstream of the Rockies, storms moving in from the west, were forced to move north around the high and then south along the jet which oriented itself north-south, encouraging steady storm development over the eastern U.S. Disturbances developing downstream of the blocking dipole were forced to move south and then east toward the Gulf region where they interacted with the warm ocean and developed into strong surface lows over the East Coast, causing the record snow falls over Massachusetts.

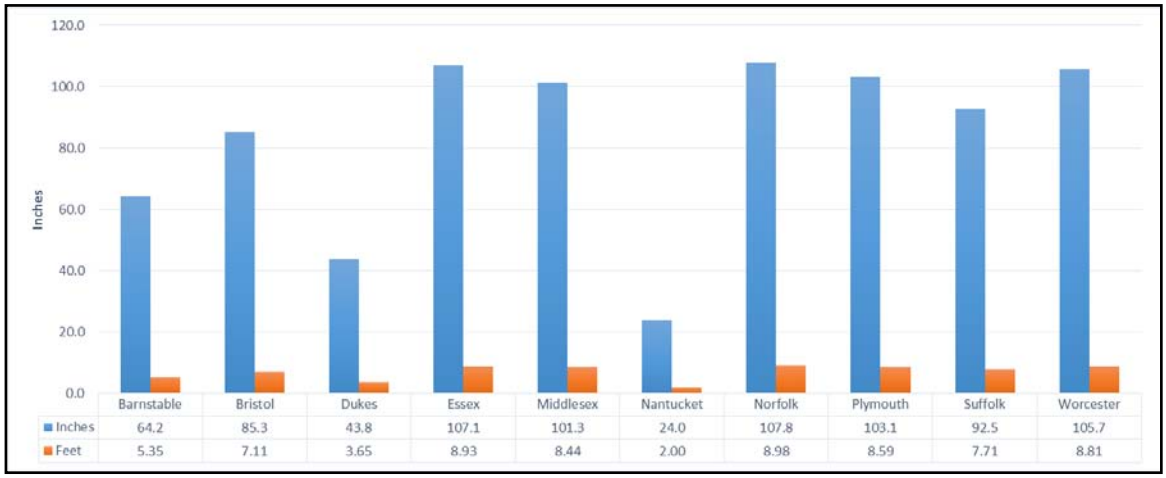
In addition to the unusual positioning of the jetstream, the numbers of high-end snowstorms observed in such rapid succession are near the limits of what the atmosphere can produce locally. Following the passage of a significant coastal storm, there is a surge of arctic air that pushes the coastal baroclinic zone southeastward and temporarily decreases the amplitude of the temperature gradient over the open ocean. As a result, a disturbance that follows two to three day later (average synoptic timescale) often features a much weaker low pressure system tracking south of the previous storm track. The atmosphere essentially has to “reload” before the next

significant storm. To overcome this limitation, disturbances tracking toward the East Coast must be ideally spaced apart, with sufficient amplitude to trigger surface cyclogenesis and restore the baroclinic zone. This is effectively what happened during late January to late February in 2015.

As this large-scale weather pattern persisted from mid-January through February, the Commonwealth of Massachusetts experienced extraordinary and unprecedented weather events in rapid succession. In these first two months of 2015, a continuous series of events created challenges across the entire state and buried the eastern regions under almost nine feet of snow. In a 33-day stretch from January 24, 2015 through February 25, 2015, the Boston/Taunton NWS office recorded measurable snowfall on 24 days. The snowfall experienced in eastern areas of the Commonwealth during the 2015 winter season was nothing less than astounding. In the 30-day period from late January to late February, Boston received an incredible 94.4 inches of snow, which eclipsed the prior 30-day record of 58.8 inches by almost 3 feet. Since 1937, the date of the earliest data from the National Climatic Data Center (NCDC), only two winters have recorded over 90 inches in a season. During those two seasons, it took a 78-day span and an 85-day span to achieve 90.3 inches of snowfall.

In the 20-day period from January 27 to February 15, four significant bursts of snow from this series of extraordinary events assaulted Boston: 22.1 inches on January 26-27th, 16.2 inches on February 2-3, 23.1 inches on February 9-10th, and 16.2 inches on February 14-15th. For the month of February 2015, Boston received 64.8 inches of snow, far beyond the prior monthly record of 43.3 inches set in January 2005. Similarly, Worcester received 94.6 inches of snow during the 30-day period, a value that far surpassed the prior monthly record of 66.2 inches. Furthermore, records for the number of days receiving measurable snow were shattered for the month of February in Boston, with 16 days (more than half the month) receiving snow, and more than 12 inches falling on 3 days (the past record was 1 day). The accretion of this series of events delivered in such rapid succession was unprecedented, shattering nearly every winter weather record. The unfathomable snowfall subtotals from January 26 through February 23 for the counties of Massachusetts are provided below.

Figure 1.1: Cumulative Snowfall in Massachusetts Counties (1/26/2015 to 2/23/2015)



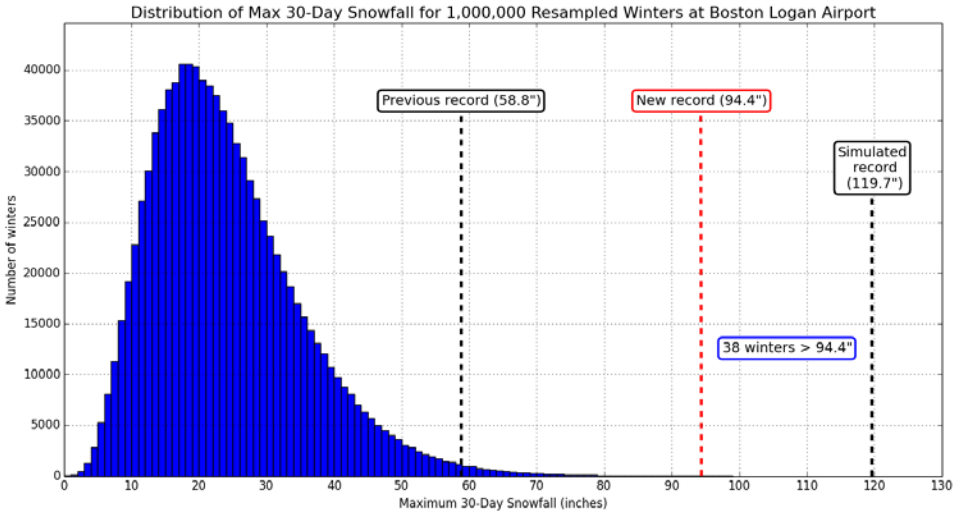
	Barnstable	Bristol	Dukes	Essex	Middlesex	Nantucket	Norfolk	Plymouth	Suffolk	Worcester
Inches	64.2	85.3	43.8	107.1	101.3	24.0	107.8	103.1	92.5	105.7
Feet	5.35	7.11	3.65	8.93	8.44	2.00	8.98	8.59	7.71	8.81

Statistical Analysis

In an attempt to quantify the rarity of this extraordinary weather series, University of Oklahoma meteorologist, Sam Lillo, conducted a statistical study, where climate is static, comparing one million resampled winters. Mr. Lillo's study determined that the 2015 winter season has a return period of just over 26,000 years. In other words, Boston can expect a series of winter weather events with a 30-day stretch like the one experienced from late January to late February 2015 approximately once every 26,315 years (38 out of a million). For comparison purposes, Mr. Lillo ran the same study for the District of Columbia's "Snowmaggeddon" winter of 2009-2010. He

concluded the 2009-2010 winter for D.C. was only a 1 in 238 year occurrence, 110 times more likely than Boston's stretch of winter weather.

Figure 1.2: Statistical Frequency of Winter Weather Events Experienced by Boston from late January to Late February 2015



Temperatures[1]

As witnessed during late January into late February, snowfall was accompanied by sustained cold temperatures. As a result, a record 22 days experienced maximum temperatures below 32 degrees, with 15 consecutive days not getting above freezing. Boston recorded its second coldest February on record with an average high of 27.8 degrees. The average mean temperature for Boston during this time was 19.0 degrees, resulting in the second coldest month ever, after the February 1934 record of 17.5 degrees.

Figure 1.3: Temperature Data from Boston Logan (1/26/2015 to 2/28/2015)

[1] All temperatures are being reported in Fahrenheit.

Wind was also a factor this winter season. Blizzard-like conditions were recorded on January 27 and February 15. Extreme blowing and drifting snow resulted from gusts between 65 and 75 mph along the Massachusetts' coastline on January 27. Similar cascading effects were experienced on February 15, as wind gusted between 55 and 65 mph across the southeastern portion of the state. The above numbers validate the fact that the series of winter weather events sustained from late January through February 2015 brought unprecedented snowfall to the Commonwealth of Massachusetts accompanied by one of the coldest periods on record.

The above written weather summary was a joint effort between personnel at the National Weather Service (NWS) Office of Taunton and Ms. Caitlin Kelly, B.S. Meteorology. All record, snowfall, wind, and temperature data was derived from NWS sources. Both NWS Taunton and Ms. Kelly concur on the meteorological position taken in this summary regarding the month-long winter weather pattern from late January 2015 into late February 2015. Ms. Kelly received her Bachelor of Science degree in meteorology in 2007 from Millersville University of Pennsylvania. From 2007-2010, Ms. Kelly worked at NBC – Lancaster (WGAL-TV Channel 8), as a meteorologist and weather forecaster. During her tenure, Ms. Kelly was responsible for synthesizing complex technical data from surface and upper air stations, satellites and radar into cogent daily forecasts.

2. EMERGENCY PROTECTIVE MEASURES

In response to the extreme threat posed by the pattern of severe winter weather, the Massachusetts State Emergency Operations Center (SEOC) was activated to Level 3 (Full Activation) and remained operational for 28 consecutive days. The Governor directed the implementation of the state emergency operations plan and executed a number of emergency protective measures to ensure the health and safety of the residents of the Commonwealth.

At the local level, 122 cities and towns declared a local State of Emergency. Local Emergency Operations Centers (EOCs) were activated in 87 cities and towns, with many local jurisdictions closing government offices and schools, and implementing parking bans. Thirty-six local shelters were opened, many of which were supported by the American Red Cross.

Timeline

The following timeline chronicles State activities throughout the unprecedented pattern of severe winter weather.

EOC Activations

- SEOC open for 28 consecutive days
- 87 Local EOCs open

State of Emergency Declarations

- 01/26/15 1130: Gov. Baker issued State of Emergency Declaration
- 01/28/15 1730: Gov. Baker lifted the State of Emergency
- 02/09/15 1720: Gov. Baker issued State of Emergency Declaration
- 02/25/15 2000: Gov. Baker lifted the State of Emergency

Travel Bans

- 01/27/15 0000: Statewide travel ban went into effect.
- 01/27/15 1200: Travel ban lifted for the following counties: Berkshire, Franklin, Hampden and Hampshire; with the exception of the I-90 Turnpike.
- 01/28/15 0000: Statewide travel ban lifted.

High Water Rescue Asset Staging

- 01/26/15 2100: Massachusetts State Police (MSP) and Massachusetts Army National Guard (MANG) assets pre-staged in the following locations to assist communities with evacuations: Plum Island, Nahant, Quincy, Hingham, Plymouth and OTIS Air National Guard Base / Camp Edwards.
- 01/27/15 1900: MSP and MANG assets released from evacuation mission.
- 02/14/15 1700: MSP and MANG assets pre-staged in the following locations to assist communities with evacuations: Newburyport, Ipswich, Gloucester, Hull, Scituate and Sandwich.
- 02/15/15 2200: MSP and MANG assets released from evacuation mission.

Stranded Motorist Asset Staging

- 01/26/15: MSP, Massachusetts Environmental Police (MEP), and MANG assets pre-staged in the following locations to assist with stranded motorists: Andover, Bourne, Charlton, Concord, Danvers, Foxboro, Framingham, Holden, Leominster, Middleborough, Milton, Newbury, Northampton, Norwell, S. Boston, Springfield, Sturbridge, Weston, and Westover.
- 01/27/15 2300: MSP, MEP, and MANG assets released from stranded motorists mission.
- 02/14/15 2000: MSP, MEP, and MANG assets pre-staged in the following locations to assist with stranded motorists: Andover, Bourne, Concord, Danvers, Foxboro, Middleborough, Milton, Norwell, S. Boston, Springfield, and Weston.
- 02/15/15 1345: MSP, MEP, and MANG assets released from stranded motorists mission.

Emergency Medical Services Waivers

- 1/26/15 – 1/29/15: Staffing Waiver
- 1/26/15 – 1/29/15: Transport Waiver
- 2/8/15 – 2/10/15: Staffing Waiver
- 2/14/15 – 2/16/15: Staffing Waiver

108.6" of Snow
315,753 Miles Plowed
114,057 Tons of Salt Used
211,732 Hours Worked

Fuel Delivery Hours of Service Waiver

- 2/8/15 – 2/21/15: transport of gas, oil and natural gas
- 2/10/15 – 2/21/15: gasoline and diesel fuel
- 2/22/15 – 3/7/15: propane gas, heating oil, natural gas, diesel fuel and gasoline

Despite the deliberate and precise actions of the Commonwealth to prepare and position for a rapid recovery, unrelenting and continuous winter weather conditions overwhelmed the Commonwealth's capacity to respond requiring the support of both out-of-state and contracted resources.

Snow Removal Operations

Snow removal operations were a critical emergency protective measure that had to be continuously implemented throughout the duration of the severe winter weather pattern.

The unrelenting snow and nonexistent melting created dangerously high snowbanks along roadways and pedestrian routes that greatly inhibited line of sight and afforded little to no room for snow to be plowed from roadways. Each significant snow accumulation period further narrowed streets and roadways, rendering many of them impassable or nearly impassible for days at a time. Many urban areas were forced to convert streets narrowed by snow from two-way traffic to one-way travel.

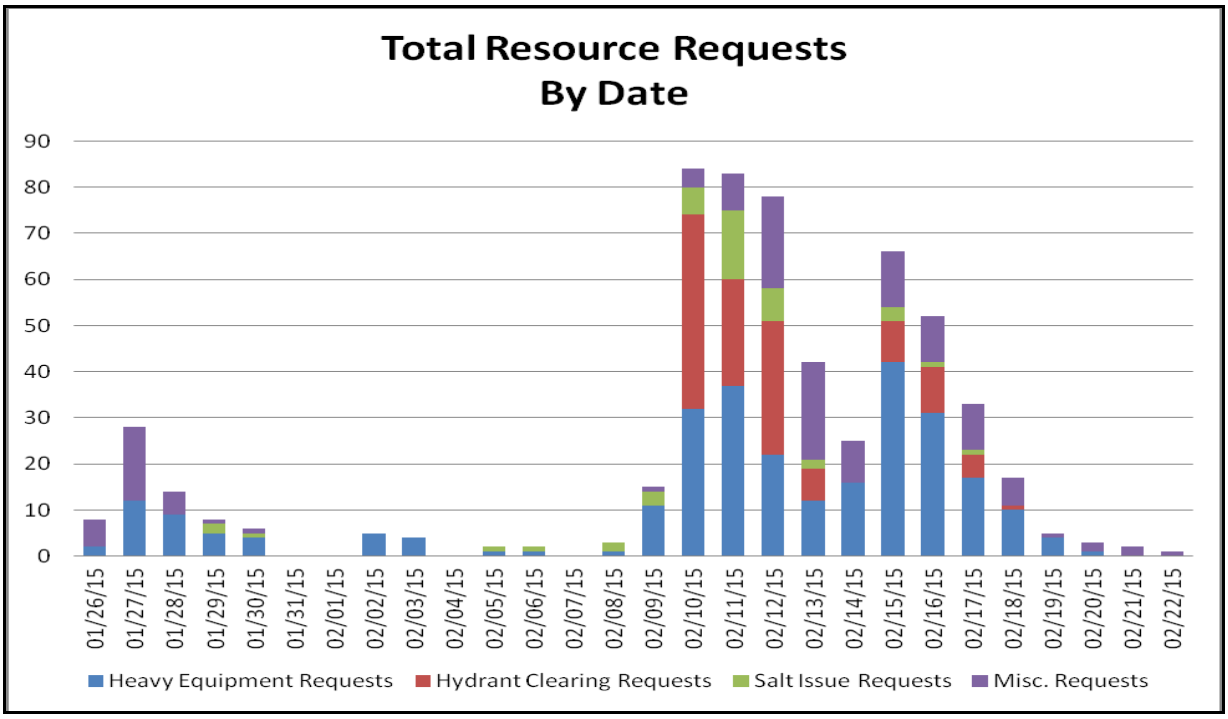
Sidewalks and pedestrian walkways remained unplowed for days and even weeks on end, creating significant life-safety issues by forcing pedestrians to walk the narrowed roadways, and requiring them to share this space with moving cars, plows and emergency response vehicles. In fact, six pedestrians were struck and killed by snow plows or moving vehicles during this time period.

The narrowed roadways also greatly impacted the flow of traffic; indeed, the narrowed streets in the City of Boston resulted in hours-long gridlock during morning and evening commutes in the days after each period of significant snowfall accumulation. These gridlock conditions created public safety issues as emergency vehicles were incapable of quickly navigating through traffic.

Requests for State Assistance

In all, the SEOC fielded and sourced a total of 586 resource requests received from 153 communities between January 26 and February 22. The nature of the resource requests are shown in the figure below.

Figure 2.1: Resource Requests for State Assistance



EMAC Support

Despite the deliberate and precise actions of the Commonwealth to prepare and position for a rapid recovery, unrelenting and continuous winter weather conditions overwhelmed the Commonwealth's capacity to respond requiring the support of both out-of-state and contracted resources. The SEOC was inundated with requests for resources to support clearing snow and opening roads and critical transportation routes. With essentially all in-state heavy equipment resources already engaged in snow removal operations, the Commonwealth was required to issue a request for resources through the Emergency Management Assistance Compact (EMAC).

As a result of this EMAC request, five states deployed a total of 151 pieces of heavy equipment from eight agencies to Massachusetts. Assistance was received from the following:

- Maine National Guard
- New Jersey Department of Transportation
- New York City Department of Sanitation

- New York State Department of Transportation
- New York Thruway
- Pennsylvania Department of Transportation
- Pennsylvania Turnpike
- Vermont National Guard

To manage the influx of heavy equipment resources into the Commonwealth, MEMA, in collaboration with the MANG, the Massachusetts Port Authority and the Massachusetts Department of Fire Services stood up a state staging area that operated on a 24/7 basis from February 11-22. This required a vast amount of support resources, including a Type III Incident Management Team, two mobile command posts, and numerous personnel to ensure the effective and timely deployment of equipment to the most heavily impacted areas of the Commonwealth.

Heavy Equipment from New York State Arriving at State Staging Area

Table 2.1 shows the support provided to the Commonwealth through the EMAC.

Table 2.1: EMAC Resource Support

EMAC STATE	Resource	Mobilization Date	Demobilization Date
NY Thruway	4 Dump Trucks, 3 Front End Loaders	02/11/2015	02/14/2015
NY State DOT	14 Dump Trucks, 15 Front End Loaders, 18 Skid Steers, 1 Large FEL w/blower	02/11/2015	02/23/2015
NY NYC	2 Snow Melters	02/11/2015	02/17/2015
NJ State DOT	10 Dump Trucks, 6 Front End Loaders, 12 Skid Steers	02/11/2015	02/23/2015
PA SEOC Support	10 personnel	02/13/2015	02/24/2015
PA State DOT	15 Dump Trucks, 3 Backhoes	02/12/2015	02/20/2015
PA Turnpike	5 Dump Trucks, 5 Backhoes	02/13/2015	02/20/2015
VT National Guard	12 Dump Trucks, 2 Front End Loaders, 2 Backhoes, 2 Skid Steers**,** 39 personnel	02/11/2015	02/23/2015
ME National Guard	10 Dump Trucks, 2 Front End Loaders, 4 Backhoes, 5 Skid Steers**,** 52 Personnel	02/12/2015	02/23/2015

Additionally, the Massachusetts Emergency Management Agency (MEMA) contracted with private vendors in two states to supply nearly 100 additional pieces of heavy equipment for emergency snow removal operations. The Massachusetts National Guard also deployed heavy equipment and soldiers to support snow removal operations.[2] The MANG was deployed in coordination with the SEOC, tasked with a total of 190 missions (183 Completed, 7 Cancelled) throughout the Commonwealth. MANG Mission highlights include: 7,382 fire hydrants cleared, over 120,564 yards of snow cleared, 2964 truckloads of snow removed, 52 bus stops shoveled, 174 miles of road cleared, and over 4 miles of MBTA track shoveled.

Snow being loaded into a National Guard Dump Truck
Deployed to Support a Massachusetts Community

MassDOT owns and operates approximately 2,150 miles of the 22,000 city/town owned roads in the most heavily impacted areas. At peak times throughout the severe weather pattern, MassDOT had 753 DOT personnel working, and continuously used over 3,000 pieces of contracted equipment. This level of engagement required MassDOT to spend 34% over their budget.

The MBTA was forced to suspend services system-wide on three occasions as a result of this persistent weather pattern and its record cold temperatures and repeated periods of significant snowfall. Even when some modes of transit were able to come back online, they ran far below normal service levels for weeks while the MBTA worked to recover from the impacts of the snow and cold. The resources of the MBTA for clearing snow and ice from tracks, railbeds, platforms, maintenance yards, bus stops, and commuter lots were significantly overwhelmed. The specialized equipment used for track clearing operations could not handle the large-scale, system-wide impacts, leaving the MBTA with the need to hand shovel accumulated snow, ice and snowdrifts from more than 15 miles of track. The SEOC supported MBTA by re-directing MANG crews, coordinating DOC crews on shoveling missions. Contracted support was also activated to support track clearing.

[2] By February 22, the MANG removed more than 120,000 yards and 3,000 truckloads of snow, clearing 52 Bus stops, 174 miles of road, and over 4 miles of MBTA track.

Personnel deployed to hand shovel 15 miles of MBTA rail track.

Snow Disposal Operations

Cold temperatures allowed for accumlating snowfall to quickly consume the landscape leaving no space to push and plow snow. It quickly became necessary to load and haul snow to dumping locations, or 'snow farms' to provide emergency access, open roads, and maintain public safety. As snow farms exceeded capacity, many communities were left with the last resort option of coordinating emergency requests with the Massachusetts Department of Environmental Protection (MassDEP) and the US Environmental Protection Agency for open water disposal of snow. The Commonwealth also coordinated the purchase of two snow melters to facilitate snow removal and disposal operations.

3. DAMAGE AND COST ESTIMATES

Initial Damage Assessment (IDAs) for January 26-28 Severe Winter Weather

In the days immediately following the emergency response to the severe winter storm of January 26-28, the Massachusetts Emergency Management Agency (MEMA) began to assess the impacts to help determine whether federal disaster assistance may be warranted. The Commonwealth's damage assessment efforts were focused on collection of emergency response costs and repair of physical damages to public infrastructure resulting from this incident to determine if the most heavily impacted areas of the State may qualify for FEMA's Public Assistance (PA) disaster assistance.

Immediately following the blizzard of January 26-28, MEMA sent IDA forms to all municipal emergency management directors and state agencies in the most heavily impacted areas (the ten counties included in this disaster declaration request). The IDA forms asked for initial estimates of storm related costs and damages in the following FEMA categories of work:

- Category A - Debris clearance and removal, including overtime and equipment costs associated with clearing downed trees, limbs and poles from roadways, sidewalks and public infrastructure;
- Category B - Emergency response and protective measures, including first responder overtime and equipment costs, fuel costs, shelter costs, etc.

  - Local communities and state agencies were asked to report snow removal costs separately for a continuous 48-hour period (including snow removal, de-icing, salting and sanding of roads, etc.) in accordance with the requirements of FEMA's Snow Assistance Policy (DAP 9523.1).

- Categories C thru G - Repair and replacement costs associated with storm damage to roads, bridges, seawalls, piers, culverts, government owned buildings, utilities and other public infrastructure.

As part of the IDA process for the January 26-28 blizzard, local communities and state agencies reported more than $87 million dollars in estimated costs for snow removal, permanent repair of physical damages and other potentially eligible PA costs. Based on MEMA's analysis of this IDA data, it appeared that the required PA damage cost thresholds in all ten counties were exceeded.

FEMA/State Joint Preliminary Damage Assessments (PDAs)

On February 9, MEMA initiated the second step in the damage assessment process and requested that FEMA conduct joint preliminary damage assessments (PDAs) to verify and validate reported costs. From February 17 and continuing through March 2, MEMA, in conjunction with FEMA, conducted more detailed PDAs to verify reported costs for January 26-28 and to confirm that the state will be eligible to request federal disaster assistance under the FEMA PA program.

The PDA process entailed sending damage assessment teams, comprised of state and federal technical experts, to those communities and state agencies that reported the most significant storm related costs and damages on their IDA forms. PDAs were not conducted in each and every community – generally assessments were completed for those areas that reported the most significant costs with the goal of exceeding federal damage dollar thresholds as quickly as possible in support of a request for federal disaster assistance. During these PDAs, the FEMA/State PDA teams viewed damages, as well as examined local and state financial records to verify and validate reported costs.

The results of the FEMA/State Joint PDAs conducted for the January 26-28 blizzard are presented in Table 3.1 below. More than $35 million in costs associated with damages and emergency protective measures (including snow removal costs) were verified and validated by FEMA as part of the FEMA/State Joint PDAs. It is important to note that once the FEMA/State Joint PDA teams verified that county and state costs exceeded the minimum per capita thresholds of each county as well as the $9,232,157 statewide threshold, the PDA process stopped; therefore not all $87 million of reported costs were reviewed. Accordingly, the PDA figures do not represent the total magnitude and economic impact of this disaster.

Table 3.1: Summary FEMA/State Joint PDA Total Estimates by PA Category of Work

JOINT PDA ESTIMATES FOR JANUARY 26-28 SNOWFALL									
County	**PA Threshold**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**TOTAL**
Barnstable	*$768,561.28*		$1,787,192						$1,787,192
Bristol	*$1,951,894.60*		$2,517,943						$2,517,943
Dukes	*$58,864.60*		$104,022						$104,022
Essex	*$2,645,646.04*		$4,149,796				$60,310		$4,210,106
Middlesex	*$5,350,982.60*		$6,916,469					$3,239	$6,919,708
Nantucket	*$36,212.32*						$144,166	$1,200,000	$1,344,166
Norfolk	*$2,388,226.00*		$3,370,742			$5,000			$3,375,742
Plymouth	*$1,761,911.64*		$2,905,082	$165,200		$65,355		$2,767,645	$5,903,282

JOINT PDA ESTIMATES FOR JANUARY 26-28 SNOWFALL									
County	**PA Threshold**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**TOTAL**
Suffolk	*$2,570,401.88*		$5,347,398						$5,347,398
Worcester	*$2,842,845.12*		$3,661,691						$3,661,691
Total Estimates		*$0*	*$30,760,335*	*$165,200*	*$0*	*$70,355*	*$204,476*	*$3,970,884*	*$35,171,250*
% of total		0%	87.46%	0.47%	0%	0.20%	0.58%	11.29%	

Total Estimated Costs Associated with the Severe Winter Weather Pattern (January 26 through February 22, 2015)

As a result of the continued snowfall throughout the month of February 2015, local communities and state agencies continued to incur significant costs associated with implementing emergency protective measures including snow removal operations and other actions to protect public health and safety. The tremendous snow accumulations also caused additional physical damages to public infrastructure such as building, equipment and utilities.

MEMA recognized that these additional costs and damage estimates would not be captured in the ongoing FEMA/State Joint PDAs; therefore on February 26, MEMA engaged in an effort to gather all costs associated with the entire severe weather pattern of January 26 through February 22. MEMA conducted a second IDA process to collect cumulative cost data related to the severe weather pattern. As part of this cumulative IDA process, MEMA again requested that cities, towns and state agencies in the most heavily impacted area (the same 10 counties included in this disaster declaration request) report their costs for snow removal and other FEMA PA categories of work. The cumulative IDA forms asked for initial estimates of storm related costs and damages in the following FEMA categories of work:

- Category A - Debris clearance and removal, including overtime and equipment costs associated with clearing downed trees, limbs and poles from roadways, sidewalks and public infrastructure;
- Category B - Emergency response and protective measures, including first responder overtime and equipment costs, fuel costs, shelter costs, etc.
    - To understand the true scope and magnitude of the impacts of this severe winter weather pattern, local communities and state agencies were asked to report 100 percent of their eligible snow removal costs in approximately one week increments that coincided with the most significant snowfall accumulations occurring between January 26 and February 22.
- Categories C thru G - Repair and replacement costs associated with storm damage to roads, bridges, seawalls, piers, culverts, government owned buildings, utilities and other public infrastructure.

As detailed in Table 3.2 below, the overwhelming majority of cumulative costs reported for January 26 to February 22 were directly related to implementing emergency protective measures in the form of snow removal operations. This included emergency protective measures costs in the form of snow removal (by both force account overtime as well as hired equipment), plowing, sanding and salting of roads, and establishment and operation of 'snow farms'. Of the total $393 million in estimated PA costs reported by cities, towns and state agencies for January 26 through February 22, more than $343 million of this (or 87%) was related to emergency protective measures associated with snow removal.

Table 3.2: Total Estimated Cumulative Costs/Losses (Jan. 26th to February 22nd 2015)

County	FEMA Categories of Work (A-G)	Additional Emergency Snow Removal Costs	Total
Barnstable	$1,906,496	$7,082,417	$8,988,914
Bristol	$1,295,296	$13,266,559	$14,561,854
Dukes	$63,545	$366,809	$430,354
Essex	$5,370,566	$30,630,184	$36,000,750
Middlesex	$8,439,215	$63,596,775	$72,035,991
Nantucket	$4,346	$330,454	$334,800
Norfolk	$6,315,240	$38,475,007	$44,790,247
Plymouth	$3,814,758	$16,785,375	$20,600,134
Suffolk	$1,483,217	$29,328,898	$30,812,115
Worcester	$1,263,437	$19,159,354	$20,422,791
State Agencies	$19,985,717	$124,580,130	$144,565,847
TOTAL	**$49,941,834**	**$343,601,963**	**$393,543,796**

When compared against damages verified as part of the previous FEMA/State Joint PDA, this cumulative IDA damage cost data revealed substantially more in snow removal costs and estimated damages reported for other FEMA PA categories of work. More specifically, the cumulative IDA data shows significant damages reported and cost estimates for permanent repair work reported in Category D (Water Control Facilities), Category E (Buildings, Contents and Equipment), Category F (Utilities) and Category G (Parks , Recreation and Other). Additional information regarding reported damage estimates for these categories of permanent repair work can be found below.

Anticipated Permanent Repairs (FEMA Category C through G) for January 26 through February 22

Based on the damage cost data collected during the IDA for January 26 through February 22, the Commonwealth estimates that there is $28,723,779 in anticipated permanent work.

Table 3.3: IDA Cost Estimate Data (Categories C-G)

	CATEGORY C (Road Systems and Bridges)	CATEGORY D (Water Control Facilities)	CATEGORY E (Buildings, Contents and Equipment)	CATEGORY F (Utilities)	CATEGORY G (Parks, Recreation and Other)	Total
Joint FEMA/State PDA Estimates	$165,200	$0	$70,355	$204,476	$3,970,884	$4,410,095
Jan. 26-Feb. 22 IDA Reported Estimates	$1,938,994	$651,571	$17,806,859	$1,090,352	$2,825,088	$ 24,313,684
Totals	$2,104,194	$651,571	$17,877,214	$1,294,828	$6,795,972	$28,723,779

Collapsed buildings and structures contributed to a 25,310% increase in Category E (Buildings, Contents and Equipment) costs when compared to the costs captures in the FEMA/State Joint PDA process.

Cumulative State Agency and Authority Cost Estimate Data

During the IDA data collection process, 21 state agencies and authorities reported costs associated with responding to the incident and estimates for future repairs. The Massachusetts Department of Transportation Highway Division (MassDOT), Massachusetts Bay Transit Authority and the Massachusetts Port Authority (MassPort) represent 86% of the total state agency expenditures from January 26 through February 22 and comprise approximately 94% of the emergency road and rail clearing activities.

Table 3.4: State Agency Cumulative Cost Data

	Emergency Snow Removal (Additional Cat B)	Traditional A-G	Total
MassDOT	$87,292,544	$2,089,915	$89,382,459
MBTA	$16,914,220	$5,500,024	$22,414,245
MassPort	$12,839,652	$ 515,882	$13,355,534
All Other	$ 7,533,712	$11,879,894	$19,413,607
Total	**$124,580,130**	**$19,985,717**	**$144,565,847**

It is important to note that these figures are only estimates and will be refined by local governments and state agencies over the next several months. An example of this is the MBTA, which reported nearly double the damage costs in their second IDA report.

> *"To date, we have identified approximately $40 million in projected storm costs that include labor, equipment, materials, police, and supplemental bus services. Of this amount, approximately $4.7 million is attributed to revenue loss. The full cost of the storm impacts and recovery are likely to exceed these amounts."*

Annual Snow Removal Budget Comparison – Cities and Towns

As described in Section 1 – Weather/Meteorology, the Commonwealth receives snowfall each winter season, and state agencies along with cities and towns establish annual budgets for snow removal activities. The Massachusetts Department of Revenue, Division of Local Services estimates that "over the previous three years, snow and ice budgets for Massachusetts cities and towns have averaged about $90 million."

In an effort to demonstrate the uniqueness of this severe winter weather pattern, the Massachusetts Municipal Association (MMA) issued a statewide survey on February 25, 2015 asking all 351 Massachusetts communities how much they budgeted for snow removal activities versus how much they had expended (as of March 1, 2015). This statewide snow and ice budget and expenditure data from MMA was 'filtered' to only examine the survey responses from the 249 cities and towns located in the counties eligible for FEMA snow assistance. Of the 249 communities in these counties, 142 responded to the MMA survey – a 57 percent response rate. The purpose of obtaining this data was to compare snow and ice budgets against estimated expenditures for snow removal activities for the winter of 2014/2015.

Table 3.5 illustrates that the cumulative budgets for the 142 cities and towns for the current season is $68,690,551 whereas expenditures totaled $164,861,781 - an overage of $96,171,230 or approximately 1.4 times what was budgeted.

Table 3.5: Snow Removal Costs for Cities and Towns: Budgeted versus Actual

FY15 Budget	Actual Expenditures	Overage ($)	Overage (%)
$ 68,690,551	$ 164,861,781	$96,171,230	140%

As stated by the Department of Revenue – Division of Local Services, the impacts on overspending on snow and ice removal have deep impacts within the community.

> *"Although snow and ice accounts may be legally overspent under Massachusetts municipal finance laws, communities must either appropriate from limited reserves to cover the shortfall or provide for the deficit in the tax rate of the following year. In either case, expenditures of this magnitude will cause communities to deplete precious, one-time reserves, or reduce spending on local priorities such as education and public safety to finance these deficits. Drawing down limited reserves to cover the overspending will not be viewed favorably by the municipal bond rating agencies, potentially increasing the cost of borrowing for communities going forward. In instances where communities reduce other local budgets to finance the deficit, there is added risk that the community will not be able to meet minimum state spending requirements on education."*

Annual Snow Removal Budget Comparison – State Agencies and Authorities

As described in the preceding section on cities and towns, state agencies and authorities also budget for snow and ice removal annually. Between January 26 and February 22, the state agencies and authorities exceeded their budgeted amount by an average of 208% as illustrated in Table 3.6.

Table 3.6: Snow Removal Costs State Agencies: Budgeted versus Actual

	14/15 Snow and Ice Budget	Actual Snow Removal Costs	Overage ($)	Overage (%)
MassDOT	$57,355,389[3]	$143,017,305[4]	$85,661,916	149%
MBTA	$3,400,000	$16,914,220	$13,514,220	397%
Massport	$7,240,271	$12,839,652	$5,599,381	77%

4. FATALITIES, INJURIES AND HEALTHCARE IMPACTS

The severe winter weather pattern created significant public health and safety threats. Based on data provided by the Massachusetts Office of Chief Medical Examiner (OCME) and the Massachusetts Department of Public Health (MDPH), the severe weather resulted in loss of life, injuries, and impacted

Public Health Impacts
25 Fatalities
1,320 Falls
181 Cold Exposure

[3] MassDOT statewide budget figure includes $8.7M from toll funded roads and $48.6M in State funds.
[4] Statewide snow & ice expenditures as of 3/18/2015.

emergency medical services and healthcare facilities.

Fatalities

The extreme cold temperatures and record breaking snow accumulation created hazardous conditions that contributed to the weather related deaths of 25 people between January 26 and March 12, 2015.

Based on data provided by the OCME for the Commonwealth, 17 fatalities resulted from blunt trauma injuries sustained in relationship to emergency road clearing activities, clearing of private property to prevent roof collapses or icy conditions. The exact numbers of fatalities resulted from weather-related blunt force trauma incidents are as follows:

- 4 pedestrians struck by snow plows
- 2 pedestrians struck by motor vehicles
- 2 while setting up towing of motor vehicles
- 2 fell off roof while clearing snow
- 1 fell on ice while clearing snow
- 1 fell down steps while clearing snow
- 1 driver of car struck front-end loader clearing snow
- 1 fell through skylight while assessing snow removal
- 3 slipped on ice

An additional eight (8) fatalities were attributed to cardiac episodes during snow removal activities.

Injuries

Hospitals and urgent care centers around the Commonwealth treated numerous injuries to individuals throughout the severe weather pattern that were directly attributable to the hazardous conditions during and created by the severe winter weather pattern.

Based on data collected by the Massachusetts Ambulance Trip Recovery Information System (MATRIS), there were a total of 1,320 individuals transported to area hospitals with blunt force trauma injuries related to the impacts of the weather pattern, and an additional 181 individuals transported with symptoms of exposure related to the cold temperatures.

Healthcare Impacts

Impacts to Emergency Medical Services

Further exacerbating the issues associated with the injuries sustained by the public and caused by the hazardous conditions were the impacts to the Emergency Medical Services (EMS) vehicles transporting those in need of urgent care.

Delays: Based on data collected by the Massachusetts Ambulance Trip Recovery Information System (MATRIS), which collects EMS trip data, during the most heavily impacted days throughout the severe weather pattern, there were 964 ambulance runs with weather-related delays on one or more legs of each run. These included 574 response delays, 214 on-scene delays, and 425 transport delays.

Emergency Medical Services Waivers: Under M.G.L. c. 111C Section 22, the Commissioner of the Department of Public Health acted on her authority to issue waivers of certain regulatory requirements for ambulance services. These waivers loosened ambulance staffing requirements to allow an increased number of ambulances to operate at the paramedic level, and authorized transport to alternate care facilities such as shelters. The transport waiver was issued for the period from January 26 through January 29. The staffing requirement waiver was issued February 8 through February 10, and again on February 14 through February 16.

Impacts to Healthcare Facilities

Healthcare facilities throughout the region were tremendously impacted by this winter weather pattern. Staffing – both direct clinical care givers and support staff - was especially challenging given the major service disruptions to the MBTA system. Hospitals, nursing homes and long-term care facilities had to take extraordinary steps to accommodate staff and meet clinical care responsibilities. This included multiple clinical care shifts with associated overtime costs, providing taxi vouchers, and in some cases providing hotel rooms for staff. In the most extreme cases police officers were required to transport doctors and nurses to their medical care facilities.

These facilities also incurred substantial snow removal costs associated with maintain system availability, and suffered damages associated with roof collapses and frozen pipes. For example, Brigham and Women's Hospital, which is a major teaching hospital in Boston, expended $400,000 clearing snow and ice, and saw overtime increases of $700,000 due to the inability to bring in personnel for regular shifts while suffering $10M in lost revenue for factors such as cancelled elective surgery as well as reduced general admissions, outpatient services and visitors. Another Boston hospital, Faulkner Hospital, spent approximately $560,000 clearing snow and ice between January 26 and February 22.

Table 4.1: Estimated Costs from Several Boston Area Hospitals

Institution	Category	Direct Costs	Other
Brigham and Women's Hospital	Overtime	$ 700,000	
	Snow removal (main campus)	$ 400,000	
	Lost revenue		$ 10,000,000
	Excess utilities		$ 300,000
	Subtotal	**$ 1,100,000**	**$ 10,300,000**
Faulkner Hospital	Snow Removal (Jan/Feb)	$ 561,000	
	Snow Removal (Ongoing/March)		$ 84,000
	Overtime (TBD)		
	Subtotal	**$ 561,000**	**$ 84,000**
Massachusetts General Hospital	Overtime	$ 1,329,023	
	Snow Removal (Purchased)	$ 670,000	
	Taxi and hotel fees	$ 14,800	
	Subtotal	**$ 2,013,823**	**$ -**
Partners IS	Overtime	$ 23,500	
	Building/Roof Damage	$ 17,500	
	Subtotal	**$ 41,000**	**$ -**
	Totals	**$ 3,715,823**	**$ 10,384,000**

5. PROPERTY AND INFRASTRUCTURE DAMAGE

A significant amount of infrastructure was damaged as a result of the persistent severe weather pattern. Extreme snowfall accumulations and bitterly cold temperatures contributed to hundreds of roof and building collapses as well as the failure of a city's sewer system. In addition, wind and storm surge contributed to the destruction of piers and seawalls.

Building Collapses

The impacts to private property can be most notably illustrated by the 270 reported incidents of collapsed structures and significant damage. Residential homes, outbuildings (barns, garages) and commercial/industrial structures (grocery stores, churches, ice skating rinks, and warehouses) caved under the weight of high accumulations of snow and ice. Table 5.1 describes in greater detail the number of collapsed structures by category.

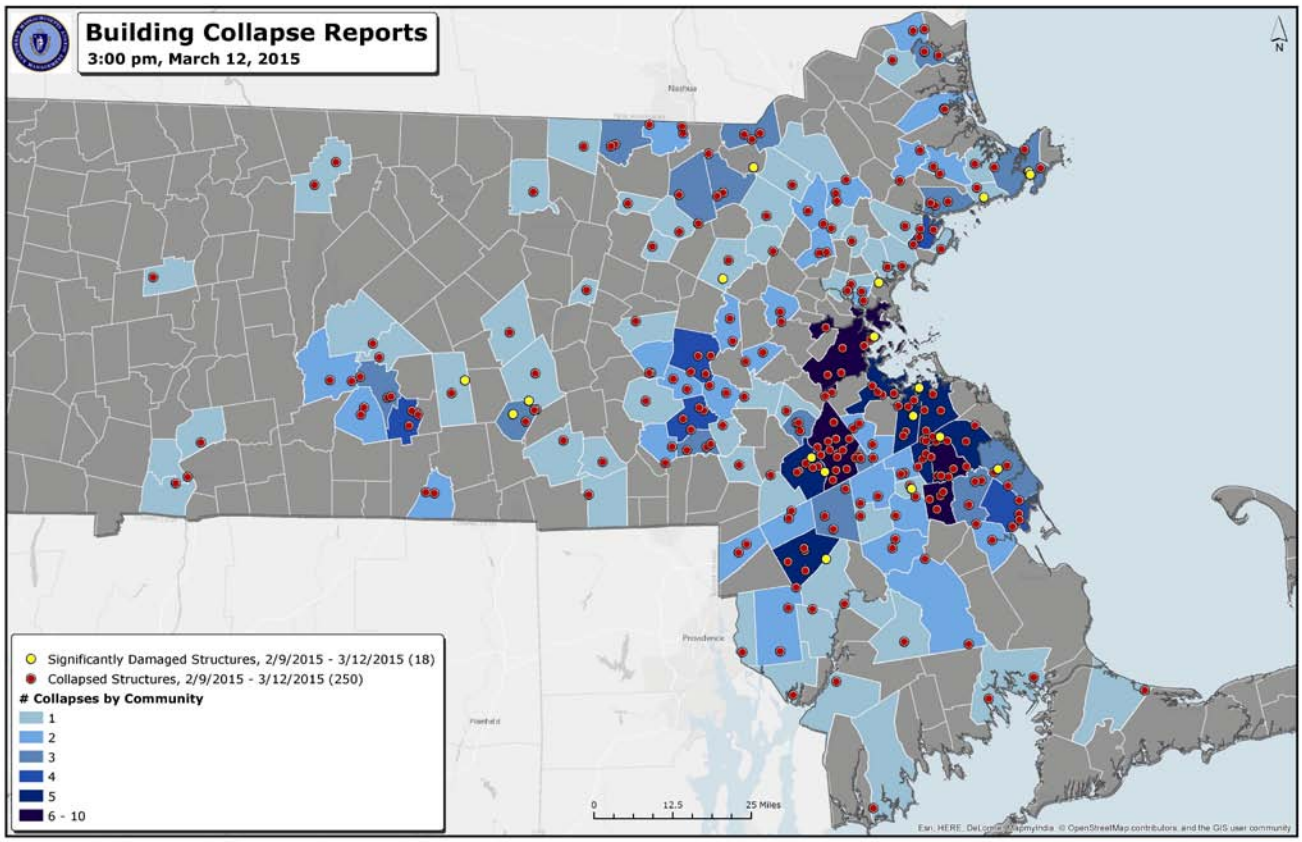
Table 5.1: Collapsed Structures

Classification	Collapsed Structures
Residential Home or Outbuilding	132
Commercial/Industrial	89
Private Non-Profit/School	6
Local/State	5
Federal	1
Unspecified	37
Total	**270**

The snow load and roof collapse issues were so unusual and extreme that on Thursday February 26, 2015 the FEMA Building Science Branch of the Flood Insurance and Mitigation Administration (FIMA) sent a team of engineers and architects to several Massachusetts communities to investigate roof damage and partial collapses of public school buildings. This team conducted a focused forensic investigation on the roof failures that occurred due to the excessive snow accumulation for the severe winter that impacted Massachusetts. The team was comprised of FEMA Building Sciences Branch subject matter experts, an architect, and structural engineers with specific expertise in roof snow loading - these teams were also accompanied by local officials and State building inspectors from the Massachusetts Department of Public Safety. These investigations by the FEMA Building Sciences Branch highlight the truly historic nature and cumulative impacts of these weather events on structures in Massachusetts.

Figure 5.1 illustrates the widespread nature of the collapses throughout eastern Massachusetts. Throughout the Commonwealth, numerous communities experienced building collapses and responded with emergency medical and law enforcement services to examine the structure, secure the area, and conduct searches of the area.

Figure 5.1: Structures Collapses throughout the Commonwealth



In addition to the safety concerns for those in and around those structures at the time of collapse and beyond, some collapsed structures presented additional public health and safety threats due to the use of the facility or in some cases the sheer size of the facility. Table 5.2 provides examples of collapsed structures that posed on-going threats to the public:

Table 5.2: Examples of Collapsed Structures that Pose Ongoing Threats to the Public

Category	Name	Description
Commercial/Industrial	Former chemical processing facility	Approximately 50x300 FT. with complete roof / building collapse and numerous drums inside of unknown material.
State	Hopkinton Mass DOT Salt Shed	One of the two salt barns at the MassDOT Hopkinton Depot collapsed.
School	Mitchell Elementary School	Approximately 40,000 Ft^2 school home to 1,200 students partially collapsed.
Local	Manchester-By-The-Sea Water Filtration Plant	Snow load on the roof has caused damage to the water filtration plant, resulting in the plant needing to be shut down.

Plum Island Sewer System

The combination of extreme cold and deep snowpack also contributed to the failure of the City of Newburyport's sewer system on Plum Island. The City's air-vacuum sewer system serves hundreds of local residents. This system experienced frozen valve pits and feet of accumulated snow blocked air vents which are required to keep

the pressurized system operational. The failure of the system resulted in sewer back-ups into dozens of homes, and a prohibition on the use of water for basic household needs. Residents were urged to refrain from using water, including flushing toilets, doing laundry and taking showers until the system function was restored. The system was impacted for approximately 4-weeks and resulted in the City placing approximately 60 households into local hotels for approximately 2-weeks. To assist impacted residents, an information center was established and staffed by City officials as well as representatives from the American Red Cross, Massachusetts Division of Insurance, State and local public health officials, Massachusetts Department of Housing and Community Development and the Massachusetts Emergency Management Agency.

Nantucket Industrial and Recreational Pier

On Nantucket, a town-owned pier with more than 100 boat slips was severely damaged. This pier is one of the busiest on the east coast of the United States during the summer and serves both commercial and recreational users. Preliminary damage estimates collected during FEMA's Preliminary Damage Assessment (PDA) process indicate that the cost of repair to the pier and associated pump-out facilities is approximately $1.2 million dollars.

6. TRANSPORTATION IMPACTS

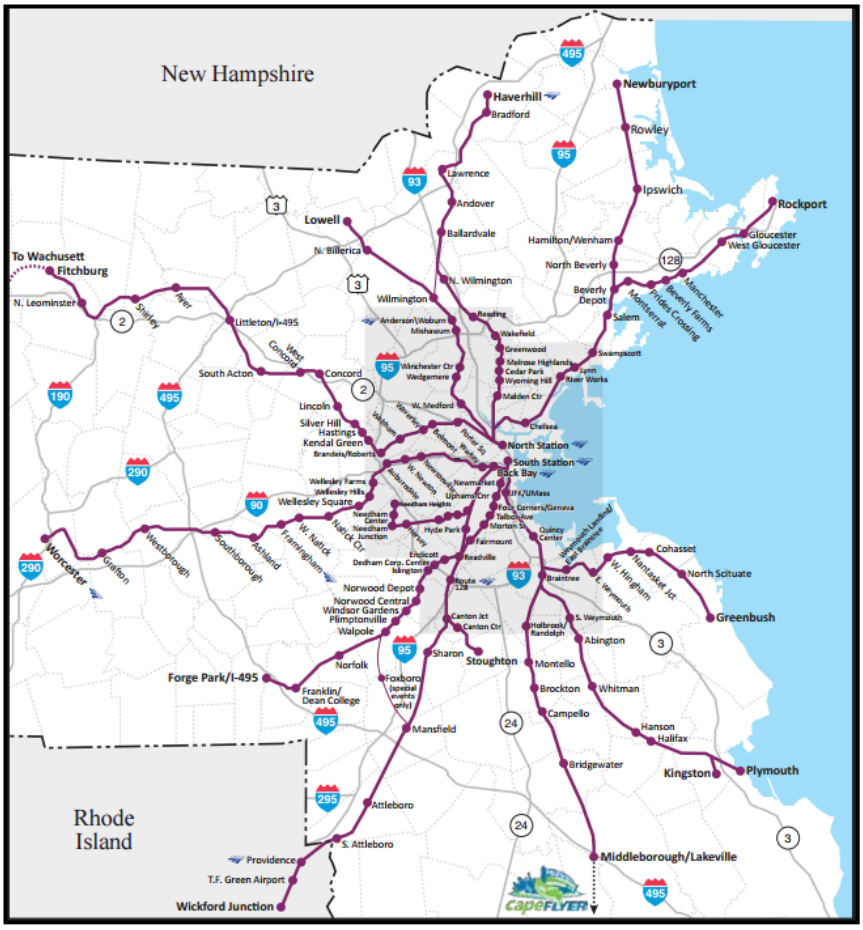
Massachusetts Bay Transportation Authority (MBTA)

The Massachusetts Bay Transportation Authority (MBTA), the country's fifth largest mass transit system, provides public transit service to 176 cities and towns with an area of 3,249 square miles and a total population of nearly 5 million. The MBTA system includes a number of transit modes, including three rapid transit lines and five light rail lines, four trackless trolley lines, 13 commuter rail lines, 183 bus routes, paratransit service, and ferry service. The MBTA has a large ridership that relies on its services to get to and from work each day, including healthcare professionals. Average weekday ridership for the entire MBTA system is approximately 1.3 million passengers. The following tables and figures describe the MBTA service area and ridership statistics.

Table 6.1: MBTA Service Area

MBTA Service Area Statistics	
Cities and Towns	176
Size in Square Miles	3,249
Population (2010)	4,812,658

Figure 6.1: MBTA Ridership Area



The MBTA, more commonly known as “The T”, is woven into the fabric of the community it services much like “The Metro” is to Washington, D.C. or the “The L” is to Chicago. For the residents of eastern Massachusetts, the transportation services provided by the MBTA are akin to other essential public utility services like water, sewer or electric power. In addition, a large percentage of the workforce who are employed by organizations located in Boston use public transit to commute to work. As such, disruptions to the MBTA for extended periods of time bring social, economic and public safety impacts to the region.

Table 6.2: MBTA Profile

MBTA Service Area Profile Statistics	
1.297M riders per weekday (FY2013)	**25%** of riders do not have access to a vehicle
23% of riders on the commuter rail system utilize multiple public transportation systems on trip	**30%** of riders use MBTA to get to work or school

MBTA Service Area Profile Statistics	
40% of riders have a household income of less than $40,000; and **17%** with a household income less than 20,000	Population proximity within ½ mile of MBTA stations: **2M** – Bus **665K** – subway/light rail **700K** – commuter rail

Extensive Service Disruptions as A Result of Severe Weather Pattern Impacts

Record breaking snow accumulations, wind, and brutally low temperatures not only buried MBTA stations, tracks, switches, equipment, bus yards and shops, but also resulted in significant freezing throughout the system. Snow and ice covered the subway system's third rail – the rail that provides power to the train cars on the tracks – and caused traction motor failures, resulting in power losses to trains. In addition, switches failed throughout the heavy rail and commuter rail networks, and ice encased vehicle doors, freezing them shut. Ice and snow on the brakes of commuter rail trains delayed the necessary inspections needed to operate trains. While, these challenges are not new to the MBTA, they are normally addressed on a much smaller scale and cause only minor and intermittent service disruptions; record snowfall and cold temperatures in a condensed period of time, created system-wide interruptions and failures from which the MBTA is still actively working to recover.

The impacts from the severe winter weather pattern crippled the infrastructure and the vehicle fleet forcing an unprecedented complete shutdown of the transit system. **The MBTA completely shut down revenue service on three separate occasions** to clear tracks, switches and rights of way, shovel out maintenance and storage facilities, and repair/replace critical component parts that were damaged, some beyond repair.

The closures coupled with lingering, widespread, system-wide interruptions compromised the ability of the public to resume daily activities and impacted employers across the Commonwealth. Based on an interview with MBTA staff, the system is still not operating at 100 percent as of the publication of this document; however they anticipate a full recovery by April 30, 2015, more than 3 months after the initial impacts to the system in late January.

People were both inconvenienced and placed at great risk trying to access a transit system that was crippled for weeks on end. Service disruptions resulted in long waits for commuters in adverse weather conditions, pushing them into the roadways in the countless locations where bus stops and sidewalks were buried in snow. The disastrous impacts to the subway and light rail systems forced riders onto alternate shuttle buses, which further congested highways and local roads. Even when some modes of transit were able to come back online, service was severely impacted as they ran far well below normal service levels for weeks while the MBTA worked to recover from the impacts of the snow and cold.

Rail Performance – Heavy Rail

Both heavy and light rail operations were grossly impacted as a result of the serve winter weather pattern. The compounding effects of snow and cold temperatures crippled the outdoor portions of the rail system, forcing long-term service suspensions and significant delays.

The graphs below provide a snapshot of the percentage of train cars in operation between January 15 and March 10, 2015. A rate of 100% means that the MBTA was able to run a full complement of trains during peak-hour service. A rate over 100% indicates additional service was added. The black bars indicate a system-wide suspension of service.

Figure 6.2: Weekday Morning Peak Service for MBTA Subway System

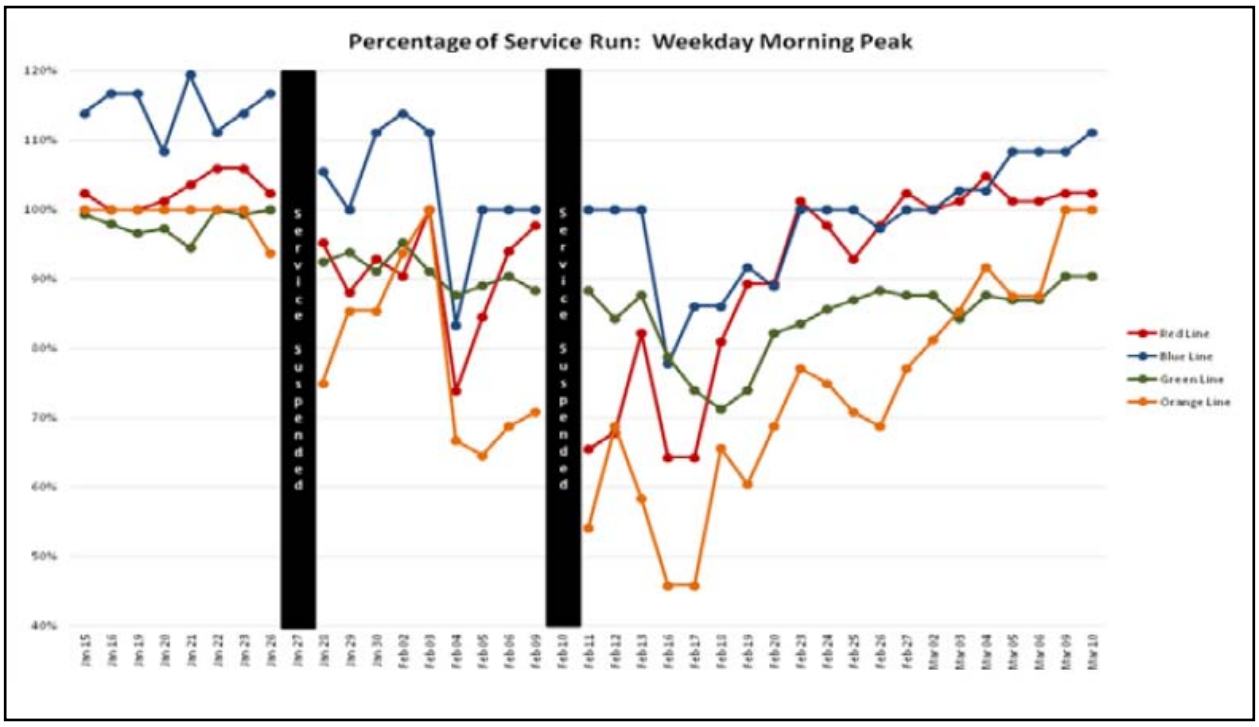
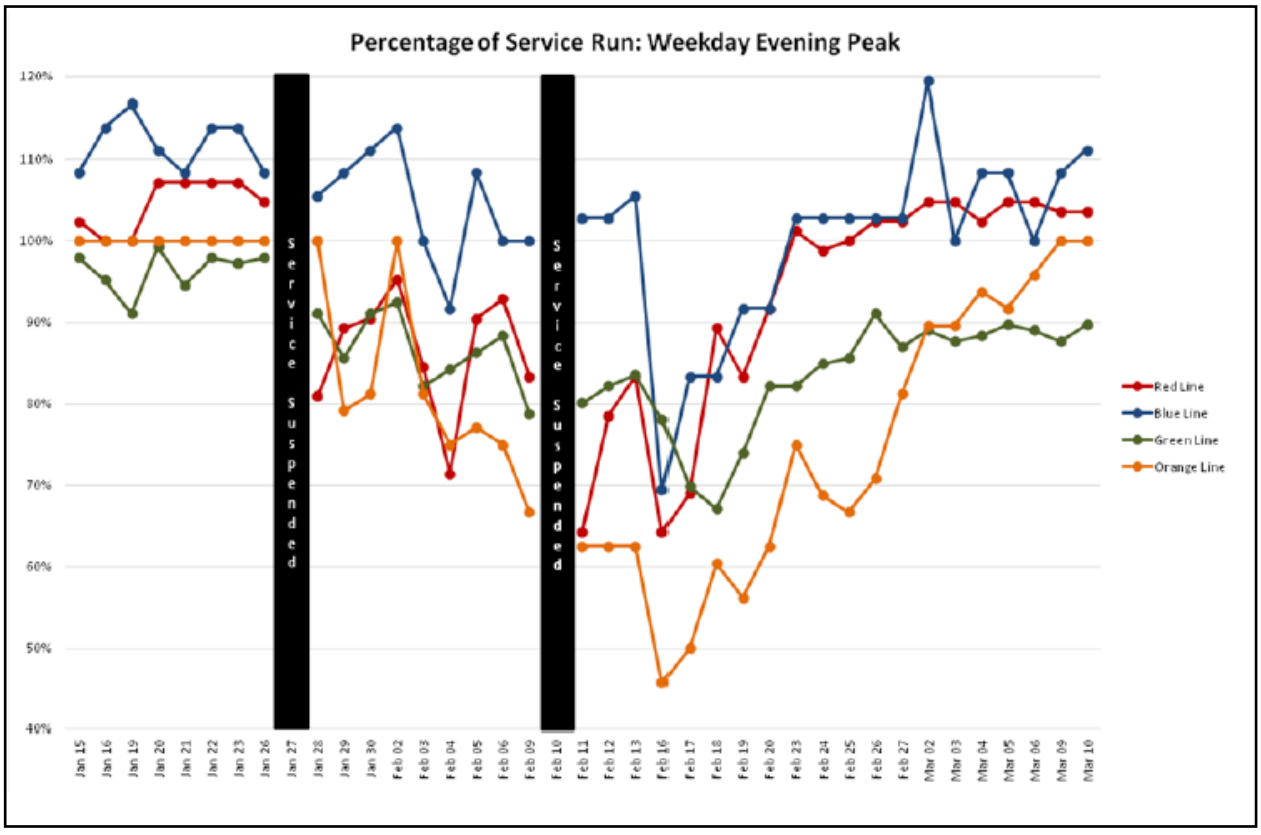
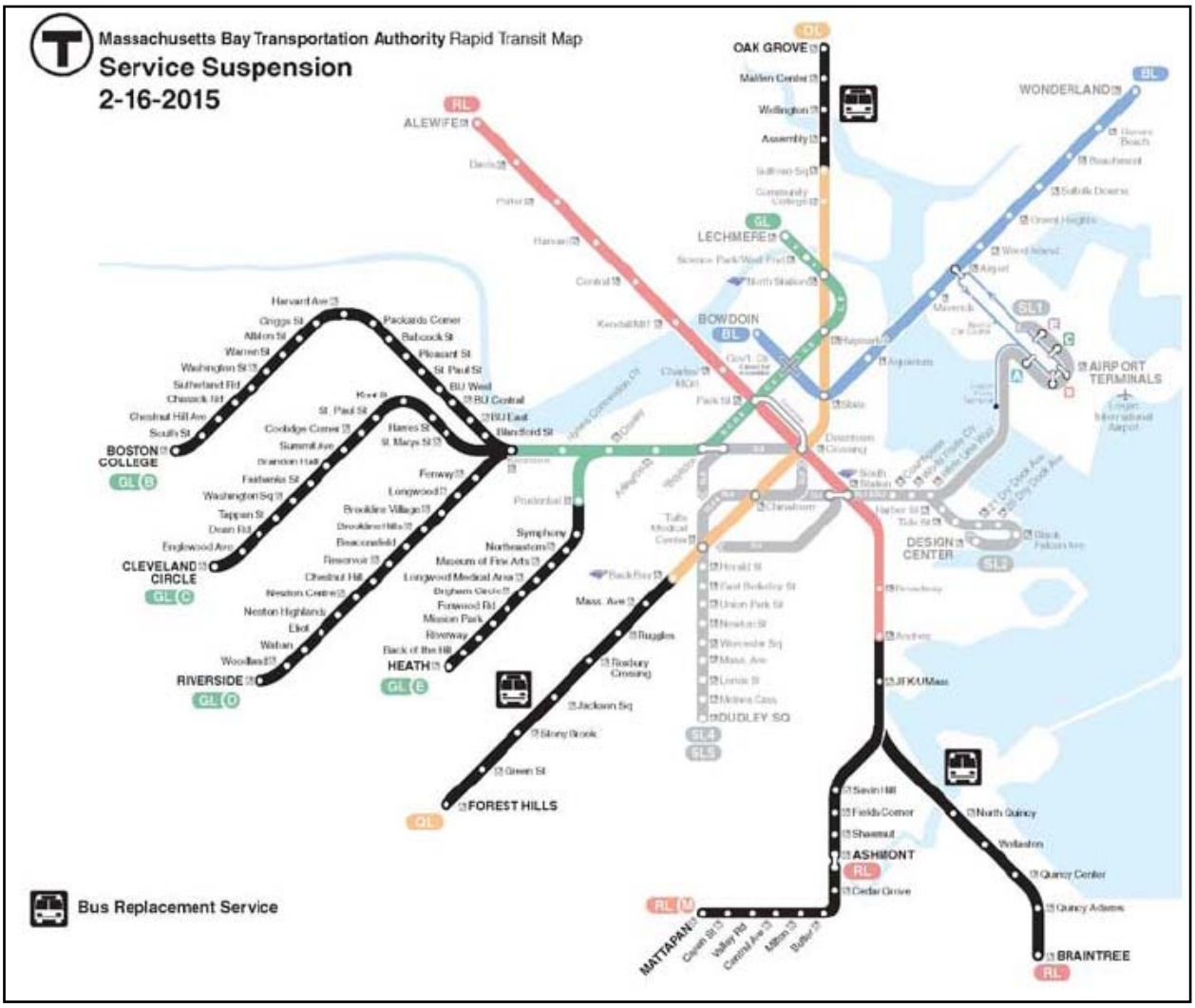


Figure 6.3: Weekday Evening Peak Service for MBTA Subway System



The graphic below of the MBTA subway system on February 16, 2015 depicts the peak of ongoing service disruptions for the subway and light rail systems: lines colored in black show the areas and subway lines that suffered complete service suspensions. This extent of disruption continued for two days before small portions of service began to be recovered.

Figure 6.4: Peak Service Disruption on MBTA Subway System



During the period from January 27, 2015 through February 28, 2015, buses provided alternate service on many rail lines that were unable to operate. In addition to the MBTA buses that provided alternate service throughout this period, private carriers also assisted from February 12 through February 21.

Red Line

The Red Line runs through Boston from north to south, beginning at Alewife Station in Cambridge and then splitting into two southern branches ending at Ashmont Station in the Dorchester neighborhood of Boston, and Braintree Station in the City of Braintree. Trains run above ground along the two southern branches, with the Ashmont Branch running 2.9 miles in length and the Braintree Branch running 8.8 miles.

The Red Line provides more than 270,000 unlinked trips on a typical weekday, with 30,161 riders entering the system along the Braintree Branch, and 19,441 riders entering the system along the Ashmont Branch.

Service Impacts: The Red Line experienced severe service disruptions in the four weeks between January 26, 2015 and February 22, 2015 as a result of snow and ice accumulation on the tracks. In addition, cold temperatures, and snow and ice caused numerous equipment failures, particularly with traction power motor units (67 units) and propulsion line choke failures (13 units). The Red Line operated at reduced peak service levels on most weekdays in the four weeks following the initial snowfall associated with the severe weather pattern. The impact on service to above-ground stations on the Ashmont and Braintree lines were particularly severe. In addition to the three dates when all MBTA rail service was suspended (January 27, February 10, and February 15), train service along the Ashmont Branch was suspended and replaced by limited shuttle bus service on February 7, 9, and 16. Train service on the Braintree Branch was suspended and replaced by limited shuttle bus service from February 9 - February 21.

In addition, Red Line trains experienced several significant safety incidents during this period. On January 29, a Red Line train at Quincy Center Station experienced a mechanical failure that led to smoke and emergency evacuation. On February 9, a train became disabled between Quincy Center and Quincy Adams centered and had to be evacuated.

Orange Line

The Orange Line runs through Boston from north to south, beginning at Oak Grove Station in Malden and running south to Forest Hills Station in the Jamaica Plain neighborhood of Boston. The Orange Line runs 11.1 miles, with approximately three miles of track above ground, servicing the five northern-most stations, and the six southern-most stations along the line. The Orange Line provides more than 200,000 unlinked trips on a typical weekday.

Service Impacts: The Orange Line experienced severe service disruptions in the four weeks between January 26, 2015 and February 22, 2015 as a result of the severe winter weather pattern. Cold temperatures, and snow and ice caused numerous equipment failures, including traction power motor units (currently 125 units with an anticipated total of nearly 160) and propulsion line choke failures (13 units). Service on portions of the aboveground sections of the Orange Line was suspended and replaced by bus service on February 7, 9, 11, 12, 16, 17, and 18. Weekday peak service levels on operational portions of the Orange Line were reduced by 20 to 55 percent from normal levels each day from February 4 through February 27th.

Rail Performance – Light Rail

MBTA light rail services include trolley service along the 23-mile Green Line, which includes the “core” line as well as four branch lines. The “core” of Green Line service runs from Lechmere Station in Somerville through downtown Boston, and includes 13 underground subway stations. There are four branches that are serviced on the Green Line: the B, C, D and E Branches. The E Line branches off from Copley Station in Boston, and in total runs 5.3 miles through Boston between Lechmere Station and Heath Street Station along Huntington Avenue. The remaining branches split off from Kenmore Station in Boston. The B Line runs 6.4 miles in total through Boston along Commonwealth Avenue between Government Center Station and Boston College Station. The C line runs 5.6 miles in total, traversing from North Station in Boston and Cleveland Circle in the town of Brookline. The D line runs 11.9 miles in total, operating through Brookline and Newton between Government Center Station and Highland Station in Newton.

The Green Line vehicle fleet includes 205 Light Rail vehicles. In 2013, the Green Line provided 227,645 unlinked trips on a typical weekday.

Service Impacts: The Green Line experienced severe service disruptions in the four weeks between January 26, 2015 and February 22, 2015 as a result of snow and ice accumulation on the tracks. In addition, cold temperatures, and snow and ice caused numerous equipment failures and mechanical issues, compounding the service disruptions, including but not limited to the necessary replacement of sixty (60) “Gate Pulse Amplifier” Circuit Boards and damage to traction power motors. All equipment damage was directly attributed to snow ingestion.

Service was intermittently terminated on the E Line at Brigham Circle on the following dates: January 26 - February 6, February 8, February 11-13, and February 20-26. On February 2, a Green Line train became disabled with a power problem, requiring shuttle buses to operate from Packard's Corner to Boston College. On February 3, a cracked rail at Copley Station required alternate service shuttle buses between Arlington Station and Kenmore and Prudential Stations. Additionally, services on the B, C, and E Branch Lines were suspended on February 6. On February 8, 9, 11 and 12, Green Line D Line service was terminated at Park Street due to intermittent switch failures at North Station. On February 16 and 17, service was suspended on the B, C and D Lines from Kenmore Station to the end of the respective lines, and on the E line between Prudential Station and Heath Street Station. On February 19, service was suspended on the B Line between Kenmore Station and Boston College Station, and on the E Line between Prudential and Heath Street Station.

Rail Performance - Commuter Rail

The MBTA's Commuter Rail system is the sixth-busiest commuter rail in the U.S., behind New York, Chicago, and Philadelphia area systems, and is tied for fifth-busiest with Philadelphia's SEPTA Regional Rail in terms of weekday ridership. Trains originate at two major terminals in Boston — South Station and North Station — both transportation hubs offering connections to Amtrak, and local bus and subway lines. Through a third party contractor, Keolis, the MBTA provides Commuter Rail service along 14 active trunkline routes essentially split into two districts.

The MBTA owns over 500 pieces of commuter rail rolling stock, including passenger locomotives, utility locomotives, work train equipment (e.g., flat cars, hopper cars, etc.), snow plows, midtrain coaches, and cab cars. Keolis is responsible for the operation, staffing, and maintenance of this equipment. Heavy maintenance on trains is performed at the Commuter Rail Maintenance Facility in Somerville while running maintenance and special work are performed at the Southside Service and Inspection Facility near South Station and at the Readville Interim Repair facility in the Hyde Park neighborhood of Boston.

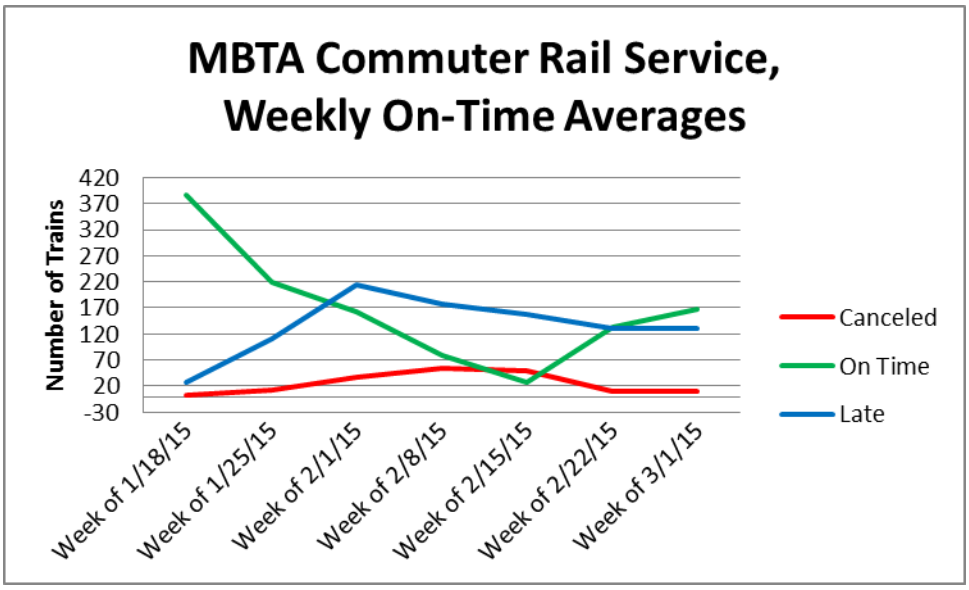
Service Impacts: During this historic winter weather pattern, commuter rail related equipment suffered heavily from the lengthy sub-freezing temperatures. Because of the sustained below freezing temperatures, the accumulated snow never melted or packed, resulting in fine dusty snow constantly being kicked up by trains. This fine snow-dust got stuck inside traction motors, causing failures. Packed ice and snow along brake rigging, underframes, electrical connections and MU cables made connecting trains in the field extremely difficult and caused failures during service.

Salt spread on the roadways caused grade crossings to fail, resulting in delays. Dwarf signals were buried by snow and were unable to be seen by trains. There were innumerable switch failures, because trains passing by constantly reburied switches that had been dug out. Due to the temperatures and quantity of snow, the switch heaters could not keep up with the heavy volume of snow. Terminals also took a long period of time to dig out after heavy snow. Switching at the engine house took two to three times longer than normal. Fortunately, there were very few major track issues, such as broken rails and joints.

As a direct result of the continued impacts brought on by the persistent weather pattern, the MBTA's commuter rail system became extremely fatigued. Limited train schedules had to be created and implemented on very short notice. The limited schedule could not allow extra run time for slower boardings, poor braking, and other weather-related conditions. Additionally, the limited schedule could not accommodate full and excess passenger loads. Extra trains ran when available to cover excess passenger volumes, but the number of extra trains was limited by equipment availability. By February 16, over 50% of scheduled service was cancelled.

Figure 6.5 below provides information on the numbers of commuter trains that ran on time or late, or were cancelled between mid-January and early March. Notably, the number of on-time trains dropped dramatically during this time period.

Figure 6.5: MBTA Commuter Rail Service, Weekly On-Time Averages



Bus Shuttle Service

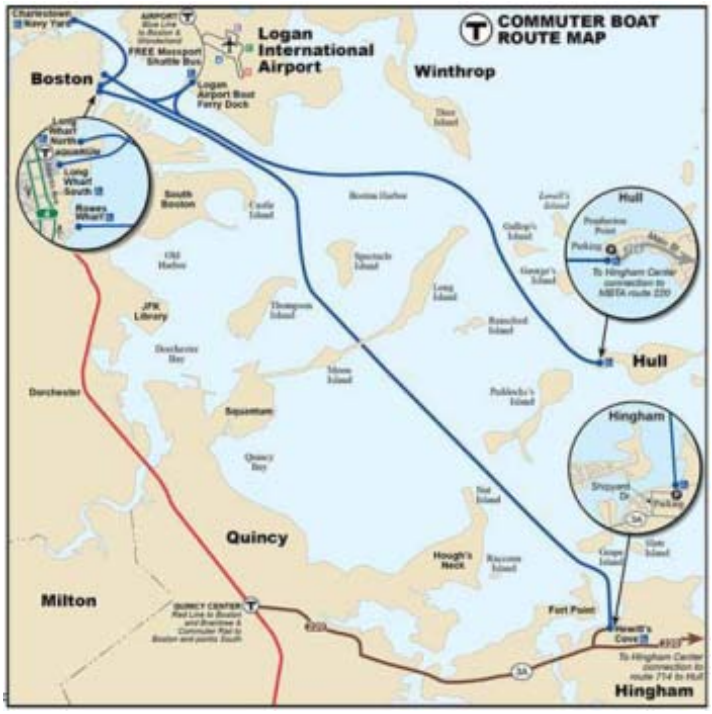
MBTA bus routes were severely impacted during the severe winter weather pattern and some routes, due to snow induced lane restrictions, are continuing to operate with reduced on time performance levels as compared to pre-storm conditions. The roads traveled by the buses were severely compromised by the continuous snowfall. Many of the bus routes were forced to institute travel restrictions taking traditionally 2 lane roads and making them one lane. The traveling public was forced into the streets, in the pathway of oncoming traffic to wait for buses. The frigid temperatures and long wait times put the traveling public at risk. Normal travel times for commuters were tripled given the virtual gridlock that existed across eastern Massachusetts.

Many bus routes had to be diverted during snow removal. In addition, on February 14, the City of Boston modified several streets to one-way traffic routes because of narrowed roadways. As of that date, several bus routes (5, 7, 9, 10 and 11) were modified and will remain rerouted until April 1st.

Ferry Service

The MBTA provides ferry service to downtown Boston from two South Shore communities (Hingham and Hull) and the Boston neighborhood of Charlestown.

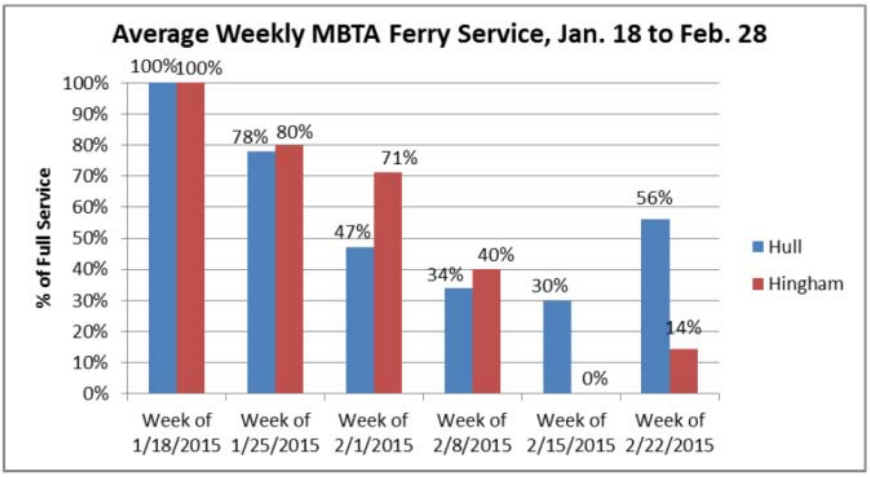
Figure 6.6: Ferry Service Route Map



Service impacts: The severe winter weather pattern impacted MBTA ferry service between January 25 and February 27. The Back River (fresh water) flowed into the Hingham Harbor, which is protected from the tidal and ocean currents, a phenomenon that allowed the brackish waters in the area to freeze. While ice-breaking efforts were intermittently efficient during ebbing tides, ice continually returned to Hingham Harbor causing disruption to the Hingham Service. In addition, the ice in Hingham damaged the Shuggart floats. After evaluating the floats, it has been determined that three of the spuds will need replacement once the ice has cleared. Because of the ice in Hingham Harbor and the limited parking at the Hull Ferry terminal, buses were operated from Nantasket Beach to the Ferry Terminal between February 25, 2015 and March 6, 2015 during weekdays.

Figure 6.7 below illustrates the average weekly MBTA Ferry Service, and demonstrates recovery was slow in terms of restoration of service due to the historic winter weather pattern.

Figure 6.7: Average Weekly MBTA Ferry Service



Response

The MBTA required a significant amount of support to implement measures to recover the transit system. In addition to the MBTA's internal labor force, the MBTA received mutual aid and outside assistance from state partners, outside contractors, and other non-profit organizations. Due to the magnitude of this historic weather pattern, an "all-hands on deck" approach was taken to ensure that the MBTA could properly clear all snow from various right-of-ways. A detailed breakdown of this contracted/outside snow removal is provided in Figure 6.8.

Figure 6.8: Contracted/Outside Snow Removal Support

Organization	2/16	2/17	2/18	2/19	2/20	2/21	2/22
MBTA/MassDOT	✓	✓	✓	✓	✓	✓	✓
MEMA	✓	✓	✓	✓	✓	✓	✓
MA National Guard	✓	✓		✓	✓		
VT National Guard	✓	✓					
MA DOC	✓	✓	✓	✓	✓	✓	
SEIU	✓	✓	✓	✓	✓	✓	
LM Heavy	✓	✓	✓	✓	✓	✓	
McCourt	✓	✓	✓	✓	✓	✓	
Barletta	✓	✓	✓	✓	✓	✓	
JF White	✓	✓	✓	✓	✓	✓	
Reliable						✓	
New Jersey DOT	✓	✓					
Pennsylvania DOT	✓	✓					
Pennsylvania Turnpike	✓	✓					
Northern Tree	✓	✓	✓	✓	✓	✓	
Don Cariati			✓	✓	✓	✓	✓
Butler Company					✓	✓	✓
Salvation Army	✓						
American Red Cross	✓						
UMass Boston	✓						

Economic Impacts

The MBTA continues to recover from the system-wide interruptions and failures it experienced. To date, MBTA estimates total storm costs at approximately $40 million (including labor, equipment, materials, police, and supplemental bus services). Of this, approximately $4.7 million is attributed to revenue loss due to service disruptions and cancellations.

To gather a better understanding of these impacts, A Better City, conducted a survey of its membership, which includes a cross section of the region's largest employers, building owners, and institutions and received detailed feedback from 40 members. While there were many impediments to getting employees to work during and after this winter's storms, each of the following were identified by over 85% of respondents as the most challenging: MBTA Subway Service Disruptions (96%), Poor Roadway Conditions (92%), Disruptions to MBTA/Keolis Commuter Rail Service (88%), and Disruptions to MBTA Bus Service (85%). Sidewalk conditions and parking availability were also identified by 38% of participants each. However, when asked to select the TOP TWO impediments to getting employees to work during and after this winter's storms, MBTA Subway Service (88%) and MBTA/Keolis Commuter Rail Service (56%) were far and away the leading impediments.

These impacts on the workforce have direct impacts to the economy. In addition, the delays and suspension of MBTA service also greatly impacted retail and restaurant businesses throughout the winter weather pattern.

Safety Impacts

The disruptions, delays and shut downs experienced within the MBTA system during the pattern of severe winter weather posed dangers to riders across the service area. These dangers included:

- Prolonged periods of exposure sub-freezing temperatures while waiting at stations
- Stranded MBTA vehicles in between stations for multiple hours requiring evacuations and placing riders directly on the right of way to walk to emergency bus service
- Increased traffic volume on roadways as individuals were forced to take their own vehicles and drive to work, and as alternate service shuttle buses were placed on already congested highways and local roadways. This congestion had direct impacts on the ability of emergency response vehicles to quickly traverse through standstill traffic enroute to emergency response calls.

Massachusetts Port Authority

Boston Logan International Airport

4,576 flight cancellations
230,000 passengers impacted

The severe winter weather pattern had a tremendous impact on all Massachusetts Port Authority (Massport) operations – most notably Boston Logan International Airport (Logan). Logan experienced 4,576 flight cancellations that impacted approximately 230,000 passengers. On January 28, the weather was so severe that Logan Airport, in an extremely rare instance, closed all operations between 1:00 am and 7:50 am. Logan estimates that its direct costs due to the severe winter weather pattern approximate $13 million.

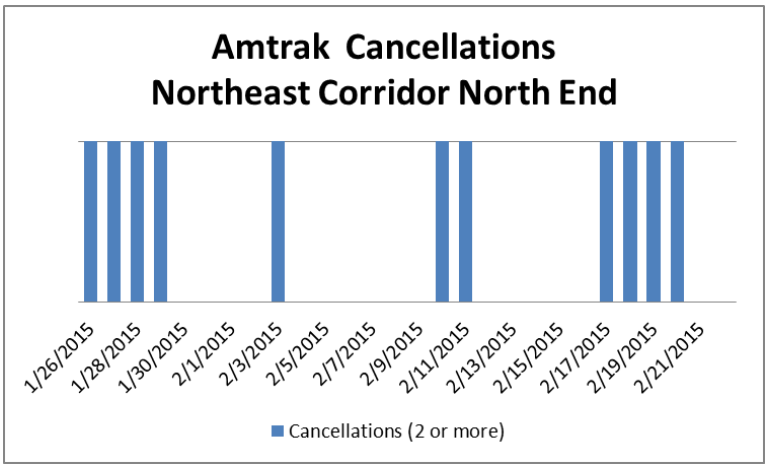
Steamship Authority

The Steamship Authority, which provides ferry services to the islands of Martha's Vineyard and Nantucket, was forced to cancel nearly 50% of all scheduled routes between January 26 and February 22 (142 route cancellations of 291 scheduled routes) because of severe weather conditions.

Amtrak

Severe winter weather considerations lead to the complete cancellation of all Amtrak service between New York Penn Station (NYP) and Boston (BOS) on January 27. Additional weather related cancellations in which two or more trains were cancelled on the northeast corridor north end (NYP-BOS) occurred on 10 additional dates throughout the severe winter weather pattern (January 26, 28 and 29 as well as February 2, 10, 11, 17, 18, 19 and 20).

Figure 6.9: Amtrak Cancellations



MassDOT

MassDOT owns and operates approximately 2,150 miles of the 22,000 city/town owned roads in the most heavily impacted areas. Hundreds of lane and road closures had to be implemented throughout the severe weather pattern. Lane and road closures throughout the severe winter weather pattern are summarized in the table below.

Table 6.3: MassDOT Lane and Road Closures

MassDOT Closures	Number
Lane/Road Closures of Significant Duration	171
Road Closures	66
Lane Closures	105

7. ECONOMIC IMPACTS

The severe winter weather pattern brought significant economic losses associated with the service disruptions to industry, retail, and commercial businesses. According to a survey completed by A Better City (ABC)[5] of its membership, which includes a cross section of the region's largest employers, building owners, and institutions, the severe winter weather pattern had the following impacts:

- The closure of the MBTA on Sunday, February 15th, resulted in the cancellation of the second day of the Boston Wine Expo, as the Seaport Hotel and World Trade Center determined that it would be in the best public interest to close and refund tickets versus encouraging people to try and find other ways to get to the event without the MBTA in service. The direct financial impact of this was more than $200,000 loss in revenues.
- Financial impacts came through a multitude of areas including: lost productivity, canceled appointments, canceled visits, increased costs for maintenance/operations, and increased transportation costs. Respondents reported a drop in overall morale as employees had to utilize sick/personal time because

[5] A Better City is a nonprofit membership organization that provides the business and institutional leadership essential for ensuring progress and tangible results on transportation, land development, and public realm infrastructure investments that are vital to sustaining and improving the Boston area's economy and quality of life.

they were unable to get into work or because they had school-aged children at home due to school closings that necessitated their absence even if they could have traveled into work.

- Due to the impacts of the weather and MBTA service failures, 42% or respondents stated that they allowed employees to work from home during and after the storms. This compares to only 4% of employers that stated that they normally allowed employees to work from home. A significant increase, which aligns with the general feeling that there was a loss in employee productivity as the employees that were being asked to work from home may not have been fully prepared to do so; lacking access to files and other information as well as the inability to meet with colleagues and clients.
- Respondents reported that the median number of days that this winter's weather reduced their business's on-site staff levels or required all employees to stay home was 4 days. In some cases, these closures had a further negative impact on the individual employee as almost half of respondents reported that they continued to pay salaried and contract employees only during the closures and just less than half reported paying all employees including hourly employees for the time lost.

Economic Cost of Disruption Resulting from Severe Winter Weather Pattern

While it is impossible to calculate in real-time the true economic cost of a disruption of this magnitude, the Commonwealth has collected data from economic analysts' forecasts, post incident surveys by the Retailers Association of Massachusetts, as well as general studies by academic institutions on the economic impact of the severe winter weather pattern.

Economic Analyst Forecast Data

In contrast to the hard costs illustrating governments unbudgeted, additional expenditures described in the previous section, the "higher level" economic costs of the 2015 winter weather presented are often difficult to immediately quantify. This "higher level" or macro-economic costs, defined in terms of lost revenue or taxes can be difficult to immediately quantify or measure. The following section describes several data points that illustrate losses due to the pattern of severe winter weather.

Lost Revenue for MBTA: The MBTA identifies the loss of revenue by comparing subway Automated Fare Collection (AFC) fare-gate transactions with the prior two years' seasonal average (January -March). As a result of closures and limited services caused by impacts from the severe weather pattern, the MBTA experienced nearly $4.7 million in revenue loss within the period of January 26–February 22.

Lost Revenue for MassDOT: MassDOT Highway Division compared toll revenues from the period of January 26, 2014 through February 22, 2014 against the same period in 2015. This comparison included toll revenue generated on the Massachusetts Turnpike, the Sumner/Callahan and O'Neill Tunnels, the Tobin Bridge, and the Turnpike Extension. The comparison indicate a difference of $2,681,872.10 (unaudited) between the revenue received between January 26, 2014 and February 22, 2014 and the revenue received between January 26, 2015 and February 22, 2015.

Table 7.1: Estimated Revenue Loss – Tolls

Time Period	Toll Revenue
2014 Toll Revenue (1/26-2/22)	$22,903,085.25
2015 Toll Revenue(1/26-2/22)	$20,221,213.15
Estimated Revenue Loss	**$2,681,872.10**

Lost Revenue for the Steamship Authority: The Steamship Authority, which provides ferry services to the islands of Martha's Vineyard and Nantucket, was forced to cancel nearly 50% of all scheduled routes between January 26 and February 22 (142 route cancellations of 291 scheduled routes) because of severe weather conditions. The estimated Steamship Authority revenue loss due weather cancellations is shown in Table 7.2 below.

Table 7.2: Estimated Steamship Authority Revenue Loss Due to Weather Cancellations

Steamship Authority Route	Revenue Loss
Martha's Vineyard	$174,064
Nantucket	$213,832
TOTAL	**$387,896**

Impact on Taxes: Per the Department of Revenue March 5, 2015 Tax Impact Update report, the Commonwealth suffered a loss of meals and motor fuel tax revenue as a result of the severe winter weather pattern.

Table 7.3: Combined Impact of Severe Winter Weather Pattern on State/Local Tax Revenue

Sates/Local Tax	State	Local Option
Meals Tax*	$21,300,000	$800,000
Motor Fuels Excise	$15,500,000	
Total	$36,900,000	$ 800,000

**State meals include both budgeted meals tax and tax transferred to convention center fund. Local meals tax is also called local option meals tax.*

Impact to Massachusetts Businesses

The Massachusetts Retailers Association polled more than 1,600 companies to gain insight into the impact of the severe winter weather on their businesses. The study found that sales fell an average of 22% between January 26, 2015 and February 22, 2015 as compared to the same time in 2014. The study specifically reported that retailers and restaurants that were hardest hit during the period showing decreases in sales of nearly 50 percent.

Impact on Small Businesses
(1/26/2015 to 2/22/2015)
7% Average Drop in Payroll
22% Average Drop in Sales

The survey also reveals that small businesses were hit particularly hard as the majority of the businesses that responded to this survey (76%) have less than 50 employees and annual sales under $5 million, thereby classified as small businesses.

Macroeconomic Impact of Snowstorms

Several studies over the last several years have been published by academic and private sector institutions that focus on the potential impact of snowstorms to the economy at a macroeconomic level. These studies emphasize that reduction in mobility (especially for public transportation) and store closures can lead to severe economic damage. As reported by IHS Global Insight, each day of snow-related shut down can cost $250 million in lost revenue.

Economic Costs of a Disruption from a Snowstorm
$250 Million per Day

IHS Global Insight Study. IHS Global Study conducted a study on behalf of the American Highway Users Alliance to analyze the Economic Costs of Disruption from a Snowstorm. This study concluded that:

1. Among all economic classes, snow-related shutdowns harm hourly workers the worst, accounting for almost two thirds of direct economic losses.
2. The indirect economic impacts of snow-related shutdowns, including loss of retail sales and income and sales tax revenues, roughly double the initial economic impact.
3. The economic impact of snow-related closures far exceeds the cost of timely snow removal. Although states and localities may be hesitant to expend significant upfront resources in the short-term, the long-term payoff more than justifies the expense.

Attachment A: Severe Winter Weather Pattern Impacts - Supplemental Information

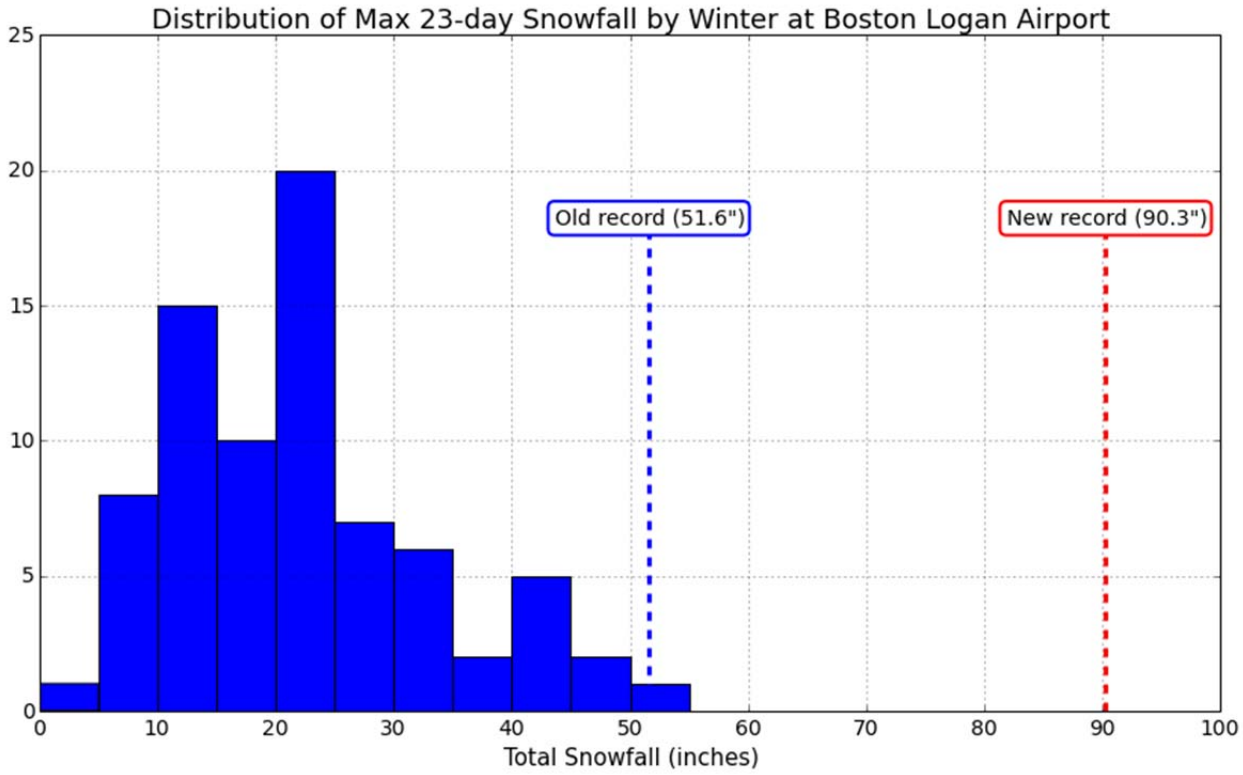
Appendix 1 –

Statistics on an Extremely Anomalous Period of Snowfall in Boston, MA

Statistics of an Extremely Anomalous Period of Snowfall in Boston, MA

Prepared by Sam Lillo, Graduate Research Fellow, University of Oklahoma School of Meteorology

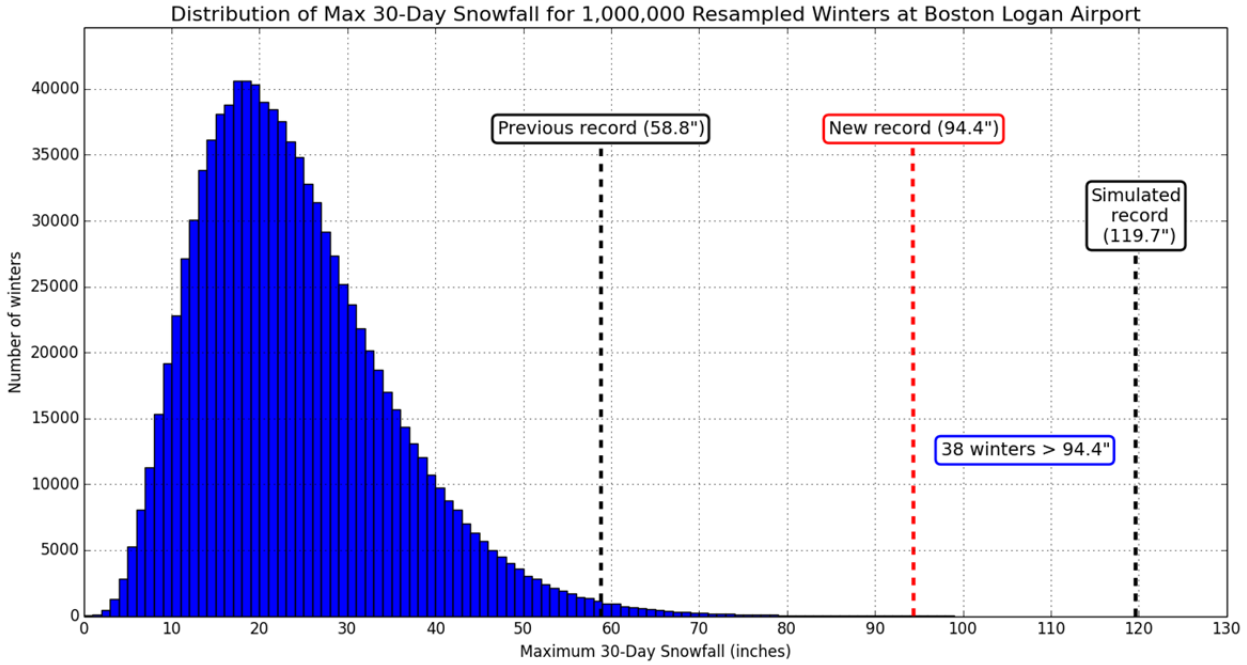
Over the course of 23 days, from 24 January 2015 through 15 February 2015, Boston Logan Airport (BOS) recorded 90.3 inches of snow. This came as a result of four major snowstorms that impacted New England, all of which had snowfall maxima in eastern Massachusetts. It is hard to put into perspective an extraordinary series of events like this, when it so far beyond any other stretch of winter weather in recorded history in Boston. From the National Climatic Data Center (NCDC), 78 winters (starting in 1937) at BOS were analyzed. The average seasonal snowfall for those winters is 44.0". The maximum is 107.6". The previous maximum 23-day snowfall was 51.6" in 1978, and the total seasonal snowfall that winter was 85.2". Since 1937, only two winters have recorded over 90" in a season. During those two seasons, it took a 78-day span and a 85-day span to achieve the 90.3" that fell in 23 days this year. Measurable snow was reported at BOS on 16 of the 23 days, which is also a record.



Similar to previous stretches of anomalous wintry weather, there was a persistent atmospheric pattern conducive to higher than normal snowstorm potential in the northeast US. Typically, these patterns might feature one high-end snowstorm, or two at best, because the atmosphere needs time to "reload" following a significant event. The four consecutive major snowstorms observed in the 23-day period is near the limits of what the atmosphere can produce locally. In addition, the repeated precise placement of the snowfall maxima is extraordinary.

In order to provide some context for comparison, simulated winters were generated by stitching together days sampled from past winters. A three-day period was chosen, to represent the typical timescale of synoptic weather systems. In addition, to account for the effect of long-term pattern forcing, the random selection of 3-day periods was weighted by the correlation between consecutive periods. Anomalies tended to persist across multiple periods, such that there's a better chance that a snowier than normal three days would follow a similarly snowy three days. This is well observed (and in extreme cases, like this year), so it's important to include in the simulation.

This method was applied to generate one million resampled winters. The snowiest 10-period (30-day) stretch was taken from each winter. As a check to the veracity of the resampled distribution, the percentile ranges were compared to the distribution of observed winters. The result is 38 winters with greater 30-day snowfall than this year. That puts this new record at a percentile range of 99.996%, with a return period of just over 25,000 years.



Despite the relatively complex logic utilized in this model, it is still simplistic. The idea is to try to quantify the rarity of this series of events. In comparison to the previous record, which had a calculated return period of about 100 years, the new record is 250 times more rare, or unlikely to be repeated.

Attachment A: Severe Winter Weather Pattern Impacts - Supplemental Information

Appendix 2 –

The Impacts of this Winter's Weather on ABC Members

The Impacts of this Winter's Weather on ABC Members

March 2015

Greater Boston experienced a series of winter storms that produced record snow fall throughout the region. The unprecedented amounts of snow caught the region's transportation agencies unprepared to manage the impacts before, during, and after the storms. Now still, a month after the last significant storm, the MBTA's Commuter Rail system, operated by Keolis is still operating on a reduced schedule. The failures of our transportation system had real economic impacts on businesses and commuters from lost productivity, lost business, and lost wages. To gather a better understanding of these impacts, A Better City, conducted a survey of its membership, which includes a cross section of the region's largest employers, building owners, and institutions and received detailed feedback from 40 members.

The following provides a summary and highlights of the responses we received.

- The effects of the MBTA shutting down were significant; 48% of respondents reported that business revenues and net profits decreased in January and February (compared to the year before) because of the impacts of the winter weather events. Another 38% reported that it was too early to know what the impacts might be. Only 14% reported that revenues and net profits remained the same. No respondent reported an increase in revenues or profits. In one instance, the closure of the MBTA on Sunday, February 15th, resulted in the cancellation of the second day of the Boston Wine Expo, as the Seaport Hotel & World Trade Center determined that it would be in the best public interest to close and refund tickets versus encouraging people to try and find other ways to get to the event without the MBTA in service. The direct financial impact of this was more than $200,000 loss in revenues and hopefully no lingering negative sentiment amongst vendors when it comes time to book booths for next year's event.

- Financial impacts came through a multitude of areas including: lost productivity, canceled appointments, canceled visits, increased costs for maintenance/operations, and increased transportation costs. Respondents reported a drop in overall morale as employees had to utilize sick/personal time because they were unable to get into work or because they had school-aged children at home due to school closings that necessitated their absence even if they could have traveled into work.

- Eighteen percent of respondents reported a decrease in the number of transit passes being sold through their corporate pass programs. While not significant, around 1% on average, it is not yet known whether these losses will be long-term or if these riders will return to public transit once the system is up and operating at its full capacity. Based on feedback from individual commuters and our own observations, it appears that monthly pass holders have determined that the likelihood of passes being checked (especially on the commuter rail) is low right now and that the odds are in their favor to simply purchase a pass and pay the additional fee on board the train versus paying up front for the entire month.

- Respondents reported that the median number of days that this winter's weather reduced their business's on-site staff levels or required all employees to stay home was 4 days. In some cases, these closures had a further negative impact on the individual employee as almost half of respondents reported that they continued to pay salaried and contract employees only during the closures and just less than half reported paying all employees including hourly employees for the time lost.

- While there were many impediments to getting employees to work during and after this winter's storms, each of the following were identified by over 85% of respondents as the most challenging: MBTA Subway Service (96%), Roadway Conditions (92%), MBTA/Keolis Commuter Rail Service (88%), and MBTA Bus Service (85%). Sidewalk conditions and parking availability were also identified by 38% of participants each. However, when asked to select the TOP TWO impediments to getting employees to work during and after this winter's storms, MBTA Subway Service (88%) and MBTA/Keolis Commuter Rail Service (56%) were far and away the leading impediments. As is well known, both of these services had a multitude of incidents that greatly impacted normal service operations. In fact, Commuter Rail is still operating on a limited service schedule, which continues to impact commuters who now have fewer and more crowded trains and when engines breakdown or other equipment fails, there are no longer immediately available back-ups to ensure reliability.

- Due to the impacts of the weather and MBTA service failures, 42% or respondents stated that they allowed employees to work from home during and after the storms. This compares to only 4% of employers that stated that they normally allowed employees to work from home. A significant increase, which aligns with the general feeling that there was a loss in employee productivity as the employees that were being asked to work from home may not have been fully prepared to do so; lacking access to files and other information as well as the inability to meet with colleagues and clients. 23% of respondents reported that working from home was not an option for employees as the nature of their job would not allow for it, especially for employees within the healthcare and hospitality sectors.

- When asked if they provided assistance to employees with commuting options to get into work during this winter's storms, above and beyond, their normal commuter services, 42% of

respondents reported in the affirmative. These organizations represented some of the city's largest employers within the healthcare and financial sectors; organizations that could not close or have large numbers of employees working from home. These efforts included providing/reimbursing employee transportation expenses for the use of taxis/Uber/Lyft; asking employees to sleep/stay on site; paying for parking; and providing employees with places to stay (hotels) closer to work. While most reported that the costs associated with these efforts were not yet known, responses that we received ranged from a few hundred dollars to more than $100,000.

While the impacts of this winter's storms on our transportation systems were unprecedented we must accept the fact that severe weather events, whether they be record breaking snow storms, rain induced flooding, tropical storm surges, or high heat will continue to increase in strength and regularity as our world's climate changes. We must learn from these events and develop new plans for action that increase or ability to respond and recover our transportation services so that we minimize the economic impacts.

To be prepared for the next storm, businesses should consider beginning or expanding efforts to increase their resilience. This could include:

- Investing in technology upgrades to provide remote access and facilitate telecommuting during storms and other weather related events.
- Engaging vendors to ensure adequate supplies in advance of storms.
- Establishing written plans and procedures for severe weather procedures.
- Establishing or reviewing staffing requirements.
- Developing written resiliency plans for severe weather and other risks that include transportation and mobility for employees, customers, clients, and patients.

ABC, through its sustainability and climate change initiatives will continue to explore and bring to its members new research and best practices aimed at increasing your organizations preparedness and resilience. We encourage you to view our recently released report and online toolkit for "Enhancing Building Resilience Measures". The toolkit provides members with useful information on over 30 technologies and services that can be implemented to strengthen your building to severe weather events. You may view the toolkit online at: http://challengeforsustainability.org/resiliency-toolkit/.

Attachment A: Severe Winter Weather Pattern Impacts - Supplemental Information

Appendix 3 –

IHS Global Impact Study

GLOBAL INSIGHT

The Source for Critical Information and Insight™

The Economic Costs of Disruption from a Snowstorm

Study Prepared for the American Highway Users Alliance by IHS Global Insight

Executive Summary

This study, commissioned by the American Highway Users Alliance and carried out by renowned global consulting firm IHS Global Insight, quantifies the economic impact of a one-day snow-related shutdown in sixteen states and two Canadian provinces. As winter comes to a close after an abnormally heavy snow season, the study shows the significant expense, both directly and indirectly, a major storm has on businesses and government because of impassable roads, as much as $300-700 million in some states for just a one-day shutdown.

As a result of the study, we have reached three broad conclusions:

1. Among all economic classes, snow-related shutdowns harm hourly workers the worst, accounting for almost two thirds of direct economic losses.

2. The indirect economic impacts of snow-related shutdowns, including loss of retail sales and income and sales tax revenues, roughly double the initial economic impact.

3. The economic impact of snow-related closures far exceeds the cost of timely snow removal. Although states and localities may be hesitant to expend significant upfront resources in the short-term, the long-term payoff more than justifies the expense.

It is hoped that this data will highlight to state and local authorities, as well as the federal government, the immense costs incurred during these storms, and spur them to plan more aggressively for periods of heavy snow.

The report is organized below into two distinct sections, an explanation of the study's methodology, followed by the data, organized by state and province. States and provinces selected represent areas of higher than average snowfall, and include each of the major snow-bearing metropolitan areas in the United States.

--The American Highway Users Alliance

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The Economic Costs of Disruption from a Widespread Snowstorm: Methodology for States

[Canadian equivalents in brackets]

The economic losses that would result from a widespread snowstorm include lost earnings of hourly workers who are paid only for time actually worked and lost revenue of certain types of retail businesses where spending would not subsequently be recouped. Both of these types of losses would result in lost tax revenue at the federal and local levels. Moreover, there are indirect effects that must be taken into account since the ripple effects through the economy of the earnings and revenue that are lost would also not occur. IHS Global Insight's methods of estimating all aspects of the economic impact of a widespread snowstorm are summarized here.

Direct Economic Losses

Lost Wages by Industry

In the event of a temporary shutdown of the majority of industry, the loss of employee income would be limited to workers paid by the hour. We assume that salaried workers would still collect their annual wage, and the work would be made-up at a later date. The Bureau of Economic Analysis (BEA) [SEPH] publishes data on wage and salary disbursements by industry for all employees by state. However, these data do not separate the incomes of salaried from hourly paid employees. The proportion of workers who are paid by the hour can vary considerably from industry to industry. It is very low in educational services and the finance and insurance industries but is very high in construction and manufacturing industries. To make these estimates for states, we assumed proportions would be similar to those in the Canadian provinces for which such data are published.

Essential Services

We assume that even in a widespread snowstorm not all essential services will be closed. To account for the operation of essential services under a skeleton staff, we constructed scaling factors for the proportion of employees that would work. The following service industries were classified as essential services: local and interurban passenger transit and health services. We assumed that 25 percent of the hourly paid staff in these industries would work through the shutdown.

Income Regained

Although hourly employees will lose income during the days in which the area is shut down, a portion of this income will be regained from overtime. Income is not assumed to be regained uniformly across industries. In manufacturing and construction the regain factor is high, while in public administration it is very low. Regain factors were constructed for each industry to account for income made up due to overtime. In addition, it was assumed that a portion of this overtime work was paid at time and a half.

Lost Tax Revenue

There would be lost tax revenues for state and local [provincial] governments

as well as the federal government. Both lost income and retail sales would give rise to lost direct and indirect tax revenues. We calculated an average effective (or implicit) personal tax rate by taking the ratio of taxes paid to state and local governments relative to personal income. The same calculation was made for each state's average effective federal income tax rate. These effective tax rates were applied to the lost income – both direct and indirect.

Statutory tax rates that apply to retail sales in each state [province] were employed to calculate lost tax revenues for state governments arising from lost retail sales. The statutory rate was applied to lost retail sales after the scaling adjustment was made.

Retail Trade

We assume that sales lost due to a widespread snowstorm that would not be recouped subsequently would be limited to gasoline stations, department stores and other general merchandise stores. As with the estimates of lost earnings, scaling factors were developed to implement assumptions about the proportion of each store type's sales that would be recovered in the days following a statewide shutdown.

The starting point for calculating retail sales losses was IHS Global Insight's [Statistics Canada] estimates of retail sales by store type by state for 2009. These estimates were developed from the relationship of retail sales by store type to personal income in each state as reported in the Census of Retail Trade, applied to personal income by state in 2009.

Indirect Impacts

In addition to the direct loss of income and sales, there is an indirect component associated with the rippling effect through the economy that would have been stimulated by the wages and sales that are lost. This is the "Derived" effect that is reported in the economic impact tables. We assume that all of the people who lost income as a result of the shutdown would have spent the majority of that income in the local economy. Lost sales in the local economy will amount to a potential loss of income by most retailers and their employees. The impact ripples further as retailers and employees curtail their purchasing activity.

Multipliers used to estimate these indirect effects were derived from the widely-used IMPLAN economic impact software package. This methodology calculates the changes in output, employment, and value added as the result of changes in final demand for one or more industries. The software calculates two impacts – indirect and induced. Indirect impacts are the changes in interindustry purchases that result from the direct impact. Induced impacts represent the changes in household spending due to changes in production. For the purposes of the study, we are combining the indirect and induced impact into what we call a "derived" impact. [Canada's multiplier on lost earnings was 1.34. Source: IHS Global Insight's macroeconomic model].

Other Economic Effects

IHS Global Insight recognizes that there are additional effects of dangers associated with untreated snow-covered roads. The health, insurance and repair expenses from increased accidents could, in fact, be quite large. However, they are beyond the scope of this report.

Illinois

Total Economic Impact	$ Millions
Direct	182.27
Derived	218.47
Total	400.73
Wages & Salaries	
Direct	114.72
Derived	153.72
Total	268.44
State & Local Taxes	
Direct	3.56
Derived	4.78
Total	8.34
Federal Taxes	
Direct	10.64
Derived	14.25
Total	24.89
Retail Sales	
Direct	53.35
Derived	45.72
Total	99.07

Iowa

Total Economic Impact	$ Millions
Direct	33.40
Derived	36.89
Total	70.28
Wages & Salaries	
Direct	20.14
Derived	26.98
Total	47.12
State & Local Taxes	
Direct	0.95
Derived	1.28
Total	2.23
Federal Taxes	
Direct	1.35
Derived	1.81
Total	3.16
Retail Sales	
Direct	10.96
Derived	6.82
Total	17.78

Indiana

Total Economic Impact	$ Millions
Direct	73.12
Derived	83.52
Total	156.64
Wages & Salaries	
Direct	45.11
Derived	60.44
Total	105.55
State & Local Taxes	
Direct	1.99
Derived	2.66
Total	4.65
Federal Taxes	
Direct	3.32
Derived	4.45
Total	7.76
Retail Sales	
Direct	22.71
Derived	15.97
Total	38.68

Kentucky

Total Economic Impact	$ Millions
Direct	46.58
Derived	49.45
Total	96.03
Wages & Salaries	
Direct	25.61
Derived	34.31
Total	59.92
State & Local Taxes	
Direct	1.41
Derived	1.89
Total	3.30
Federal Taxes	
Direct	1.78
Derived	2.38
Total	4.16
Retail Sales	
Direct	17.79
Derived	10.87
Total	28.66

Maryland Total Economic Impact	$ Millions
Direct	84.16
Derived	99.35
Total	183.51
Wages & Salaries	
Direct	53.82
Derived	72.12
Total	125.94
State & Local Taxes	
Direct	4.17
Derived	5.59
Total	9.76
Federal Taxes	
Direct	4.88
Derived	6.54
Total	11.43
Retail Sales	
Direct	21.28
Derived	15.10
Total	36.38

Michigan Total Economic Impact	$ Millions
Direct	116.92
Derived	134.15
Total	251.07
Wages & Salaries	
Direct	72.73
Derived	97.45
Total	170.18
State & Local Taxes	
Direct	2.72
Derived	3.64
Total	6.35
Federal Taxes	
Direct	5.36
Derived	7.18
Total	12.53
Retail Sales	
Direct	36.12
Derived	25.88
Total	62.00

Massachusetts Total Economic Impact	$ Millions
Direct	119.42
Derived	145.69
Total	265.12
Wages & Salaries	
Direct	82.95
Derived	111.16
Total	194.11
State & Local Taxes	
Direct	4.62
Derived	6.19
Total	10.82
Federal Taxes	
Direct	8.44
Derived	11.31
Total	19.74
Retail Sales	
Direct	23.41
Derived	17.04
Total	40.45

Minnesota Total Economic Impact	$ Millions
Direct	76.27
Derived	91.19
Total	167.46
Wages & Salaries	
Direct	48.14
Derived	64.51
Total	112.65
State & Local Taxes	
Direct	2.69
Derived	3.60
Total	6.29
Federal Taxes	
Direct	4.09
Derived	5.48
Total	9.57
Retail Sales	
Direct	21.35
Derived	17.60
Total	38.95

Missouri

Total Economic Impact	$ Millions
Direct	74.06
Derived	87.57
Total	161.63
Wages & Salaries	
Direct	46.10
Derived	61.78
Total	107.88
State & Local Taxes	
Direct	2.03
Derived	2.72
Total	4.76
Federal Taxes	
Direct	3.44
Derived	4.61
Total	8.05
Retail Sales	
Direct	22.48
Derived	18.46
Total	40.94

New York

Total Economic Impact	$ Millions
Direct	322.40
Derived	377.78
Total	700.17
Wages & Salaries	
Direct	198.92
Derived	266.55
Total	465.47
State & Local Taxes	
Direct	15.00
Derived	20.10
Total	35.10
Federal Taxes	
Direct	20.44
Derived	27.39
Total	47.83
Retail Sales	
Direct	88.04
Derived	63.74
Total	151.78

New Jersey

Total Economic Impact	$ Millions
Direct	132.58
Derived	156.77
Total	289.35
Wages & Salaries	
Direct	85.97
Derived	115.19
Total	201.16
State & Local Taxes	
Direct	4.15
Derived	5.56
Total	9.72
Federal Taxes	
Direct	8.49
Derived	11.38
Total	19.86
Retail Sales	
Direct	33.97
Derived	24.64
Total	58.61

Ohio

Total Economic Impact	$ Millions
Direct	139.54
Derived	160.89
Total	300.43
Wages & Salaries	
Direct	87.96
Derived	117.87
Total	205.84
State & Local Taxes	
Direct	4.87
Derived	6.53
Total	11.40
Federal Taxes	
Direct	6.47
Derived	8.67
Total	15.15
Retail Sales	
Direct	40.23
Derived	27.82
Total	68.05

Pennsylvania

Total Economic Impact	$ Millions
Direct	167.43
Derived	202.13
Total	369.56
Wages & Salaries	
Direct	107.88
Derived	144.56
Total	252.44
State & Local Taxes	
Direct	5.28
Derived	7.07
Total	12.35
Federal Taxes	
Direct	9.04
Derived	12.12
Total	21.16
Retail Sales	
Direct	45.22
Derived	38.37
Total	83.59

Virginia

Total Economic Impact	$ Millions
Direct	120.30
Derived	139.56
Total	259.86
Wages & Salaries	
Direct	76.36
Derived	102.32
Total	178.68
State & Local Taxes	
Direct	3.78
Derived	5.07
Total	8.85
Federal Taxes	
Direct	6.95
Derived	9.31
Total	16.26
Retail Sales	
Direct	33.21
Derived	22.86
Total	56.07

Utah

Total Economic Impact	$ Millions
Direct	30.68
Derived	35.68
Total	66.36
Wages & Salaries	
Direct	18.29
Derived	24.51
Total	42.81
State & Local Taxes	
Direct	0.85
Derived	1.13
Total	1.98
Federal Taxes	
Direct	1.42
Derived	1.90
Total	3.32
Retail Sales	
Direct	10.12
Derived	8.14
Total	18.26

Wisconsin

Total Economic Impact	$ Millions
Direct	69.35
Derived	79.33
Total	148.68
Wages & Salaries	
Direct	44.00
Derived	58.96
Total	102.97
State & Local Taxes	
Direct	2.23
Derived	2.99
Total	5.22
Federal Taxes	
Direct	3.59
Derived	4.81
Total	8.41
Retail Sales	
Direct	19.52
Derived	12.57
Total	32.09

Ontario Total Economic Impact	$ Millions
Direct	205.30
Derived	268.28
Total	473.59
Wages & Salaries	
Direct	152.74
Derived	204.68
Total	357.42
State & Local Taxes	
Direct	9.93
Derived	12.87
Total	22.79
Federal Taxes	
Direct	19.55
Derived	25.81
Total	45.37
Retail Sales	
Direct	23.08
Derived	24.93
Total	48.01

Quebec Total Economic Impact	$ Millions
Direct	108.52
Derived	141.56
Total	250.08
Wages & Salaries	
Direct	79.47
Derived	106.49
Total	185.96
State & Local Taxes	
Direct	8.11
Derived	10.61
Total	18.72
Federal Taxes	
Direct	7.95
Derived	10.42
Total	18.37
Retail Sales	
Direct	13.00
Derived	14.04
Total	27.04