U.S. Department of Transportation Climate Adaptation Plan

2014

Ensuring Transportation Infrastructure and System Resilience

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1. Introduction

Pursuant to Executive Orders No. 13514 and 13653, as well as Council on Environmental Quality (CEQ) Implementing Instructions, the U.S. Department of Transportation (DOT) is required to submit a Climate Adaptation Plan. DOT's work on climate adaptation began with the understanding that climate impacts will affect DOT's strategic goals of safety, state of good repair and environmental sustainability. This plan is an update from the 2012 DOT Climate Adaptation Plan, which includes the new requirements of E.O. 13653 and guidance from CEQ. It reflects FY2013 and FY2014 commitments as well as other DOT accomplishments.

This adaptation plan is organized into sections based on the guidance from CEQ and describes steps DOT will take to move towards fully integrating considerations of climate change adaptation and resiliency into DOT policies, programs, and operations. The Office of the Secretary and modal administrations are each playing a role in implementing this plan. The Office of Safety, Energy and Environment (OSEE), in the Office of the Secretary (OST), coordinates DOT's actions with support from the DOT's Climate Change Center, staffed from the Office of the Assistant Secretary for Research and Innovation, also located in OST. OSEE has participated in the Interagency Climate Change Adaptation Task Force, the related CEQ working group and the community of practice. DOT staff has presented work on regional impacts, pilots and best practices before Federal forums and with Federal agencies in order to share information and exchange best practices. OST's Office of the Assistant Secretary of Administration manages DOT's facilities and assets across the country.

The DOT administrations listed below have committed to fulfilling specific actions related to DOT's high-level priority actions. Most DOT administrations report progress on adaption actions along with other regulatory and sustainability actions to the Deputy Secretary at regularly scheduled meetings.

- Federal Aviation Administration (FAA)
- Federal Highway Administration (FHWA)
- Federal Transit Administration (FTA)
- Federal Railroad Administration (FRA)
- Federal Motor Carrier Safety Administration (FMCSA)
- Maritime Administration (MARAD)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)
- Saint Lawrence Seaway Development Corporation (SLSDC)

2. Identification and Assessment of Climate Change Related Impacts on the Risk of the Agency's Ability to Accomplish Its Missions, Operations and Programs

DOT's mission is to serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future. The Department and its modal agencies

oversee the safe operation of the United States transportation system including more than 3.9 million miles of public roads, 120,000 miles of major railroads, 25,000 miles of commercially navigable waterways, 5,000 public-use airports, 500 major urban public transit operators and more than 300 coastal, Great Lakes, and inland waterways ports.[1]

Scientists have concluded that some level of climate change is already occurring. Weather patterns are changing, and these changes are expected to continue or accelerate in the future.[2] The Third National Climate Assessment concludes that higher temperatures, increased atmospheric water vapor, rising sea levels, and the frequency of extreme weather events over the past 50 years have resulted from increased levels of greenhouse gases emitted from human activity.[3] Past weather and climate patterns appear to be much less reliable indicators of future weather and climate than in recent decades, which makes greater flexibility in planning and decision-making processes ever more important.

Transportation is and will continue to be affected by climate change (See Figure 1: Notable Potential Impacts). While mitigating transportation contributions to greenhouse gas emissions and adapting to climate impacts on the transportation system are equally important for the transportation sector to address, and the Department is engaged in a wide variety of activities meeting each goal, this plan addresses adaptation work only.

[1] Source: http://nationalmap.gov/small_scale/.

[2] Intergovernmental Panel on Climate Change. "Climate Change 2013: The Physical Science Basis: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change." 2013. http://www.climatechange2013.org/report/full-report/ and U.S. Global Change Research Program. "Climate Change Impacts in the United States: U.S. National Climate Assessment." 2014. http://nca2014.globalchange.gov/report.

[3] Walsh, J., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunkel, G. Stephens, P. Thorne, R. Vose, M. Wehner, J. Willis, D. Anderson, S. Doney, R. Feely, P. Hennon, V. Kharin, T. Knutson, F. Landerer, T. Lenton, J. Kennedy, and R. Somerville, 2014: Ch. 2: Our Changing Climate. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 19-67.

Figure 1: Notable Potential Impacts

Notable Potential Impacts

- More frequent/severe flooding of underground tunnels and low-lying infrastructure, requiring drainage and pumping, due to more intense precipitation, sea level rise, and storm surge.
- Increased numbers and magnitude of storm surges and/or relative sea level rise potentially shorten infrastructure life.
- Increased thermal expansion of paved surfaces, potentially causing degradation and reduced service life, due to higher temperatures and increased duration of heat waves.
- Higher maintenance/construction costs for roads and bridges, due to increased temperatures, or exposure to storm surge.
- Asphalt degradation and shorter replacement cycles; leading to limited access, congestion, and higher costs, due to higher temperatures.
- Culvert and drainage infrastructure damage, due to changes in precipitation intensity, or snow melt timing.
- Decreased driver/operator performance and decision-making skills, due to driver fatigue as a result of adverse weather.
- Increased risk of vehicle crashes in severe weather.
- System downtime, derailments, and slower travel times, due to rail buckling during extremely hot days.
- Reduced aircraft performance leading to limited range capabilities and reduced payloads.
- Air traffic disruptions, due to severe weather and precipitation events that impact arrival and departure rates.
- Reduced shipping access to docks and shore equipment and navigational aid damage.
- Restricted access to local economies and public transportation.

DOT recognizes that climate variability and change pose threats to U.S. transportation systems. The range of impacts from these threats may include roadway deterioration, flooding, limited waterway access, and weakened structures. Severe conditions may reduce the life of capital assets and increase operational disruptions. Some consequences may require changes in the design, construction, and maintenance of infrastructure. For example, incorporation of certain materials and building techniques will enable infrastructure to better withstand extreme conditions.

DOT's modal administrations are taking steps to address the impacts of climate change on their respective missions, which, in turn, address many of DOT's overarching vulnerabilities. These steps vary among modes, but collectively substantial effort is focused on adapting to climate variability and change implications.

In response to E.O. 13514, E.O. 13653, and CEQ Implementing Instructions, DOT identified three high-level priority actions for implementation in both Fiscal Years 2014 and 2015. Each of these actions will support DOT's mission and improve the transportation sector's ability to assess and build resilience to risks posed by climate variability and change. DOT modal administrations have committed to implementing the following priority actions:

- **Planning.** DOT will take actions to ensure that Federal transportation investment decisions address potential climate impacts in statewide and metropolitan transportation planning and project development processes as appropriate in order to protect federal investments. Through such actions, transportation systems will gradually become better prepared for future climate shifts.

- **Asset Management**. DOT will work to incorporate climate variability and change impact considerations in asset management. For example, modal administrations will work with grantees to assure that potential impacts are incorporated into existing grantee asset management systems and their own buildings and operations. Agencies will assess the policy, guidance, practices, and performance measures of its asset management programs to incorporate such considerations.

- **Tools**. DOT will provide tools, case studies, best practices, outreach, and performance measures for incorporating climate considerations into transportation decision-making.

DOT identified three general vulnerabilities to climate change, which its climate change adaptation and resilience actions will address. Addressing these general vulnerabilities will foster a resilient transportation system.

1. **Existing Infrastructure Resilience**: Existing transportation infrastructure is owned and operated by various public agencies and private firms, and covers an enormous range of ages, service life and levels of sophistication. Existing infrastructure has been built to many different design standards, and its current and future environmental risk is similarly varied. As environmental risks change, the probability of unexpected failures may increase. Further, as existing infrastructure approaches the end of its service life, decisions about replacement or abandonment should, but may not currently, take into account changing future risks.

2. **New Infrastructure Resilience**: Similarly, newly constructed infrastructure should be designed and built in recognition of the best current understanding of future environmental risks. In order for this to happen, understanding of projected climate changes would need to be incorporated into infrastructure planning and design processes, across the many public and private builders and operators of transportation infrastructure.

3. **System Resilience**: Transportation systems are more than just the sum of their individual parts. Some elements are of particular importance because of their vital economic role, absence of alternatives, heavy use, or critical function. The National Airspace System, for example, plays a vital economic role, while hurricane evacuation routes perform a critical function. Transportation systems are potentially vulnerable to the loss of key elements. Therefore, selectively adding redundant infrastructure may be a more efficient strategy than hardening many individual facilities on the existing system. System resilience is best viewed across transportation modes and multiple system owners. While some key elements are obvious, other dependencies may be less well recognized. For example, some airports rely on petroleum pipelines, which may depend, in turn, on electric power for pumping. Transportation systems are also interdependent when passengers or freight carriers rely on

multiple transportation modes to reach their destination.

In addition to providing transportation services to the public, transportation systems have a special role in emergencies by providing for the emergency evacuation of populations and limited access for essential services under extreme conditions. Vulnerabilities to emergency operation can place lives at risk.

The vulnerabilities described above may disrupt transportation operations and damage transportation assets. The greater the extent of the vulnerability, the greater the risk is for transportation systems and infrastructure. Transportation vulnerabilities to climate impacts must be evaluated alongside other risks to ensure better management of assets and, ultimately, ensure the long-term viability of American transportation systems.

DOT initially began adaptation efforts by identifying transportation related vulnerabilities to the potential impacts of climate variability, change and severe weather events. Understanding the range of potential impacts is essential for DOT to develop adaptation actions and options.

Higher Temperatures

Fluctuating temperatures or longer periods of high temperature are expected to place additional stress on transportation infrastructure. For example, transit, highway, airport and other transportation systems across the country will face steadily increasing numbers of days in excess of 90 degrees Fahrenheit and less predictable weather patterns. Some transportation systems may also face more intense storms and changes in precipitation, though projections of precipitation are less clear than those of temperature. Some of the impacts may require changes in the design, construction, or maintenance of infrastructure such as incorporating materials and building techniques that allow infrastructure to better withstand temperature extremes.

More extreme conditions also may reduce the life of capital assets and increase operational disruptions. Higher temperatures can break down asphalt, buckle rail track or increase the demand for air conditioning, potentially overloading the power grid. Any of these impacts can cause system downtime and/or derailments.

On the other hand, some climate change effects may positively affect transportation goals, as higher average temperatures in certain regions could reduce safety and maintenance concerns associated with snow and ice accumulation. Climate change may also cause modal shifts. For example, roads and bridges that are not accessible due to more frequent flooding may cause shippers to move goods by vessel.

Warmer temperatures are expected to affect the volume and rates of water flow in rivers, lakes, reservoirs and marshes, ultimately affecting water depth and the cargo carrying capacity of marine vessels. Increasing temperatures may create greater demands from hydroelectric systems that depend on the water system of the Saint Lawrence Seaway, which may reduce the water available for commercial shipping.

Higher water temperatures may allow invasive species to take hold in more areas of navigable water, causing infrastructure demands that would not otherwise occur. Likewise, the migration

of endangered species into navigable waterways due to sea temperature rise is also a possibility, causing additional costs to navigation.

Severe Weather and Precipitation

Severe weather and precipitation already heavily affect transportation infrastructure, and potential changes in precipitation could increase future impacts. For example, four of the seven largest US public transit systems are located in the country's northeast, where climate models project the largest increase in rain intensity in coming decades. One day in August 2007, the New York City subway system was shut down by flooding caused by heavy rains during the morning rush hour, affecting 2 million commuters. Severe weather events also often impair or disable critical power lines and systems.

Severe precipitation that increases the flooding of roadways, tunnels and evacuation routes can reduce the service life of highway infrastructure. It can also increase the number of road washouts, landslides, and mudslides that damage roadways and overload drainage systems, causing traffic backups and street flooding. Ultimately, severe precipitation and wind speeds can damage bridges, signs, overhead cables and other tall structures. Storm surge can damage and destroy coastal roadways, bridges and airport facilities.

National airspace system efficiency and aviation system infrastructure can be adversely affected by severe weather and precipitation. Severe weather can cause delays in operations, impacting air traffic flow and reducing runway arrival and departure rates. More severe events may also increase airfield flooding and erosion, potentially requiring adjustments to infrastructure, drainage and erosion control measures.

Severe weather may affect road safety by heightening the risk of commercial motor vehicle or passenger vehicle crashes (see Figure 2: Severe Weather Example—Superstorm Sandy). Adverse weather conditions may increase weather-related delays and traffic disruptions. Traveling in severe weather can also contribute to operator fatigue which may affect driver/operator performance and decision-making skills.

Precipitation type will also dictate the extent of severity. Frozen precipitation events, especially in the form of ice, exacerbate the severity, impeding freight shipments and transportation system operations. Such events also result in significantly higher maintenance costs on the part of the modal agencies, often exceeding budgets.

(Note: Climate effects, and resulting impacts, will vary across the country; impacts in some areas may be positive, such as reduced pavement damage in areas experiencing reduced frequency of freeze-thaw cycles, for example.)

Figure 2: Severe Weather Example – Superstorm Sandy

Severe Weather Example - Superstorm Sandy

Superstorm Sandy illustrates where current vulnerabilities exist in our transportation system, and the potential for future impacts of climate change. Damage from future sea level rise, more severe weather events, and increased temperatures have the potential to magnify existing vulnerabilities and create new vulnerable areas. It is therefore critical for the DOT to plan for climate change adaptation to reduce future damage. A DOT-funded vulnerability assessment for transportation systems in New Jersey, completed in 2011, was predictive of many of the areas actually flooded by Hurricane Irene and Superstorm Sandy.[4] Similarly, the transportation sections of the City of New York's adaptation plan, completed in 2010, anticipated much of the flooding and damage that actually occurred, particularly the disastrous consequences of flooding highway and subway tunnels into Manhattan.[5] The New Jersey vulnerability assessment showed storm surge and flooding for hundred year events, given anticipated climate induced sea level rise in 2050 and 2100. Actual storm surge from Superstorm Sandy in New York Harbor was larger than any anticipated event in the study. Two USDOT agencies, the Federal Highway Administration and the Federal Aviation Administration, are each conducting follow-up Superstorm Sandy Case Studies of the New York/New Jersey area to identify lessons learned and to improve future planning.

Sea level rise

Sea level rise presents challenges to the transportation system and infrastructure. Local sea level rise varies across the US coastline due to variations in vertical land movement, wind patterns and currents. Rising sea level can present flooding risks to underground infrastructure such as subway and road tunnels allowing water to enter through portals and ventilation shafts during storm events and extreme high tides. Where sea level rises, coastlines will change and infrastructure that was not previously at risk to storm surge and wave damage may be exposed.

Rising sea level can affect transit agencies on the US coasts. These systems may experience more downtime due to flooding, requiring system users to be rerouted and possibly making obsolete earlier transportation investments in low-lying coastal areas. Some US airports located in coastal areas could be vulnerable to increased flooding with sea level rise.

Rising sea level may also take a toll on marine highway system infrastructure, including ports, terminals, shipyards, and the interfaces with other transportation modes. Sea level changes may add to the rate of infrastructure deterioration and damage shore side equipment and navigational aids. This damage could impact the ability of vessels to access docks and potentially require rerouting of freight.

[4] Cambridge Systematics. "Climate Change Vulnerability and Risk Assessment of New Jersey's Transportation Infrastructure," (New Jersey Transportation Planning Authority, 2011). http://www.fhwa.dot.gov/environment/climate_change/adaptation/case_studies/new_jersey/index.cfm.

[5] Radley Horton, Cynthia Rosezweig, Vivient Gornitz, Daniel Bader and Megan O'Grady. "Climate Change Scenarios & Implications for NYC Infrastructure: New York City Panel on Climate Change." Annals of the New York Academy of Sciences, May 1, 2010: 57-62. http://www.nyas.org/Publications/Annals/Detail.aspx?cid=ab9d0f9f-1cb1-4f21-b0c8-7607daa5dfcc.

Combined Effects

Some of these effects, such as sea level rise and increased precipitation intensity, present greater challenges to the transportation system and infrastructure, when combined with subsidence of the land and vulnerable local geology, as well as storm surge and wave impacts associated with coastal storms. For example, storm surge can damage and destroy coastal roadways, bridges and airports, and sea level rise will likely exacerbate such effects.

Indirect Impacts

In addition to direct impacts of climate change, transportation systems may also have to adapt to changes in the patterns of settlement or economic activity that may be induced by climate change. For example, changes in the location of agricultural production may demand changes in the transportation system to support moving products to markets. Better understanding of climate change impacts in other sectors will permit a better understanding of potential derivative impacts on transportation.

3. Description of Programs, Policies, and Plans the Agency has Already Put in Place, as well as Additional Actions the Agency Will Take, to Manage Climate Risks in the Near Term and Build Resilience in the Short and Long Term

DOT is working to ensure that climate change vulnerability is considered in all modes of U.S. transportation. Climate change presents new challenges as DOT develops and advocates solutions to national transportation needs. DOT recognizes that changes in global climate and regional weather patterns may require different adaptation and resiliency strategies than in the past. DOT began to explore integrating climate change considerations into its planning and programs several years ago. While DOT has made progress, the process to more fully integrate climate considerations into planning and programs, and to build a more resilient transportation system, will take place over time. Early consideration and development of proactive adaptation strategies can help achieve a more efficient and cost-effective approach to preserve transportation infrastructure and enhance public safety. In addressing the impact of climate change, transportation planners and system operators may consider the following adaptation and resiliency strategies:

- Climate-conscious land-use planning;
- Planning for new infrastructure;
- Hardening of existing infrastructure;
- Relocation or abandonment of at-risk infrastructure;
- Adding redundancy to reduce impacts to the system; and
- Provisions for rapid recovery.

Since the last Adaptation Plan, DOT has delivered several key innovations in advancing consideration of resilience in transportation policymaking:

- On 23 September 2012, FHWA published a memorandum clarifying that State, Local, and Federal agency climate change adaptation planning and resiliency features of highway projects would be eligible for reimbursement under the Federal-Aid and Federal Lands Highway Programs.[6]
- On 26 December 2013, the Federal Transit Administration issued a Notice of Funding Availability (NOFA) for $3 billion in competitive resiliency grants for transit agencies affected by Superstorm Sandy.[7] This follows the commitment of some $1.3 billion in formula grants. Both rounds of funding were provided under the Hurricane Sandy Relief Act. (PL113-92).
- On 3 March 2014, DOT issued a Notice of Funding Availability for the Sixth Round of TIGER (Transportation Investment Generating Economic Recovery) competitive transportation grants, funded at approximately $500 million.[8] The application period closed on 28 April. The TIGER NOFA explicitly considers resiliency as a selection factor for the grants.
- By Summer 2014, DOT expects to finish Phase II of the Gulf Coast Study, a path-breaking multi-year program to assess the vulnerability of the Gulf Coast region to climate change. Phase II is a detailed multimodal study of the Mobile, Alabama region. The Gulf Coast Study has been central to improving public and expert understanding of the range of issues.

DOT has also engaged in outreach and educational activities on climate adaptation for over a decade. The most recent actions are listed in Figure 3: Selected DOT Climate Adaptation Outreach and Education, below.

DOT is participating in a number of interagency groups charged with (1) coordinating and modernizing Federal processes related to development and integration of both man-made and natural infrastructure, (2) evaluating public health and social equity issues, and (3) safeguarding natural resources and other issues affected by climate change. Section 2.c. of E.O. 13653 directs such interagency groups to ensure that climate change related risks are accounted for in such processes. For DOT programs, consideration of environmental justice and climate change impacts is best addressed through transportation planning activities and environmental review of Federally assisted or approved actions.

[6] Source: http://www.fhwa.dot.gov/federalaid/120924.cfm.
[7] Source: http://www.fta.dot.gov/grants/13077_15783.html. Secretary Foxx announced the disaster relief resilience grant awards on September 22, 2014. Source: http://www.fta.dot.gov/newsroom/news_releases/12286_16152.html.
[8] Source: https://www.federalregister.gov/articles/2014/03/03/2014-04627/notice-of-funding-availability-for-the-department-of-transportations-national-infrastructure. Secretary Foxx announced the 2014 TIGER grant awards on September 12, 2014. Source: http://www.dot.gov/tiger/14awards.

Figure 3: Selected DOT Climate Adaptation Outreach and Education

2014

- The Volpe Center presented a webinar series on transportation climate adaptation for DOT personnel and interested members of the public.
- FTA to discuss lessons learned from completed pilots at US DOT Center for Climate Change Workshop.
- FTA conducts panel discussion on pilots at Transportation Research Board meeting.
- FHWA plans a webinar series to highlight results and tools available from the Gulf Coast Phase 2 Study.

2013

- In May and June 2013, FHWA held a webinar series for State and Local transportation officials on Climate Change and Extreme Weather Vulnerability Assessments.

2012

- In February, FHWA held two webinars on the results of pilot projects in San Francisco, New Jersey, Washington, Virginia, and Hawaii. In May, FHWA held a peer exchange with Metropolitan Planning Organization representatives from Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.
- In March, FTA held a workshop in Arlington, VA, on real-world approaches.

4. Description of Agency Response to Significant Climate Change Risk

It is useful to distinguish between the risks borne by the transportation sector in the United States, and the risks borne by Department of Transportation. Risks borne by the transportation system are discussed elsewhere in the plan. DOT directly operates two key pieces of transportation infrastructure:

- The National Airspace System, responsible for commercial air traffic control and aerial aids to navigation. This system is operated by the Federal Aviation Administration.
- The Saint Lawrence Seaway, connecting the Great Lakes with the Atlantic, is jointly operated by American and Canadian Government agencies. The U.S. partner, the Saint Lawrence Seaway Development Corporation, is part of U.S. DOT.

Both systems are necessary to the economic well-being of the United States. The FAA's mission is to provide the safest, most efficient aerospace system in the world and has set programs in place to ensure that this mission is met. At this time, the FAA anticipates that it will be able to manage any climate change related risks so that they do not impair the agency's mission or operations.

The Saint Lawrence Seaway is subject to two climate adaptation issues:

- The Seaway is closed and icebound in the winter, and milder winter weather will lengthen

the shipping season on both the Great Lakes and the Seaway;

- Water levels on the Great Lakes and the Seaway have frequently been low by historical levels in recent years, reducing the maximum draft of ships moving through the locks.[9] If low water conditions persist and continue, Seaway infrastructure may require extensive modifications to provide the same level of service. However, climate modeling gives ambiguous results on whether water levels may be expected to rise, remain the same, or fall, as a consequence of climate change. [10]

5. Description of How Agencies Will Consider the Need to Improve Climate Adaptation and Resilience, Including the Costs and Benefits of Such Improvement, with Respect to Agency Suppliers, Supply Chain, Real Property Investments, and Capital Equipment Purchases such as Updating Agency Policies for Leasing, Building Upgrades, Relocation of Existing Facilities and Equipment, and Construction of New Facilities

Transportation infrastructure is inherently long-lived. Bridges, tunnels, ports and runways may remain in service for decades, while rights-of-way and specific facilities continue to be used for transportation purposes for much longer. In addition to normal deterioration, transportation infrastructure is subject to a range of environmental risks over long time spans, including wildfire, flood, landslide, geologic subsidence, rock falls, snow, ice, extreme temperatures, earthquakes, storms, hurricanes and tornados. Infrastructure designers and operators must decide the magnitude of environmental stress that any particular project will be able to withstand over its service life. Adaptation to climate change can include adjusting how transportation infrastructure is planned, designed, built and operated. Mainstreaming consideration of climate in all activities related to planning, constructing, operating and maintaining transportation infrastructure and providing transportation services can ensure that resources are invested wisely and that services and operations remain effective.

Good project design balances both costs and benefits. It is important that infrastructure designers use the best possible information to assess all future environmental risks, including longer-term risks from climate variability and change, because many of the structures being built today will still be in use fifty or, in some cases, one hundred years in the future. If a project is overbuilt, it may cost too much and preclude other, more useful investments. If it is underbuilt, it is subject to risks of premature damage or destruction that require premature repair or replacement and impose an additional cost of being out of service to the public. Building resilience to climate change risk is common-sense management to protect current and future investments and to maintain safe operational capabilities. DOT and modal agencies will begin to consider the costs and benefits of climate adaptation and resiliency improvements, as appropriate.

[9] National Oceanic and Atmospheric Administration. "Great Lakes Water Levels." Great Lakes Environmental Research Laboratory. 2014. http://www.glerl.noaa.gov/data/now/wlevels/levels.html

[10] Kenneth Kunkel and James Angel. "The Response of Great Lakes Water Levels to Future Climate Scenarios." Journal of Great Lakes Research, 2010: 55.

DOT has a variety of other physical assets, including the ships and berths of the Maritime Administration's Ready Reserve Fleet, various test facilities for automobiles, aviation, and railroads, as well as office space and regional offices in many cities, including headquarters in Washington, DC. Sea level rise could at some point cause air draft constraints for vessels called into service in response to national security events or disasters. Air draft is commonly defined as the distance from the water to the highest point on the vessel. As water levels rise, there will be less clearance between vessels and structures such as bridges and cables. Modifying such structures to permit vessels to continue to pass safely under structures would add to navigation infrastructure costs. By 2095, the projected rise worldwide is 18-55 cm.[11]These assets are also subject to some level of risk from climate change and extreme events.

DOT will be working with modal agencies to determine which leased buildings from the General Services Administration (GSA) are vulnerable to the impacts of climate change and will then partner directly with GSA to address these vulnerabilities.

The Department's Generating Renewal, Opportunity, and Work with Accelerated Mobility, Efficiency, and Rebuilding of Infrastructure and Communities throughout America (GROW AMERICA) legislative proposal for authorization of surface transportation programs would require that state and regional long-range transportation plans take into account the need to reduce risks from extreme weather events and create more resilient infrastructure.

6. Highlights from DOT Accomplishments in FY 2012 and FY 2013 and Planned Future Goals

Federal Aviation Administration (FAA)

1. Planning

Airport Sustainability Planning (FY 2012 and 2013)

In FY 2011, FAA evaluated ways to make sustainability a core objective at every airport through the Sustainable Master Plan Pilot Program. The Pilot Program consisted of grants for comprehensive airport sustainability planning documents at 10 airports. These documents included initiatives for reducing environmental impacts and achieving economic benefits, while increasing integration with local communities. Three of the airports in the pilot program discussed climate adaptation and infrastructure resilience in their plans.

Based on encouraging initial results of the Pilot Program, 13 additional airports received sustainability planning grants in FY 2012. 15 additional airports received sustainability planning grants in FY 2013.

[11] National Oceanic and Atmospheric Administration. National Centers for Coastal Ocean Science "The Ecological Effects of Sea Level Rise Research Program". http://www.cop.noaa.gov/stressors/climatechange/features/SLR_fs.pdf.

Adaptation Guidance for Airports (FY 2014 and FY 2015)

The FAA will begin developing guidance on airport climate adaptation and infrastructure resilience in FY 2014. The guidance will include information on integrating climate adaptation and infrastructure resilience into airport improvement. In FY 2014, FAA will assemble an industry working group to design the scope for the guidance. The guidance will be completed in FY 2015.

2. Asset Management

Navigation Infrastructure Assessment (FY 2012 and FY 2013)

In FY 2012, FAA began analyzing select navigation infrastructure at 14 study areas along the East Coast, Gulf Coast, and in Hawaii for vulnerability to storm surge inundation from hurricane categories 1-4. The assessment process involved overlaying outputs of publically available climate models with FAA assets locations to identify those most affected by storm surge under projected climate scenarios, evaluating mean high water marks in relation to the existing elevation. In FY 2013, FAA refined the location data for the selected navigation infrastructure and continued and developed the analysis into an internal assessment.

Superstorm Sandy Case Study (FY 2014)

In FY 2014, FAA began a Superstorm Sandy Case Study project to evaluate the impacts of the 2012 storm on FAA navigation infrastructure. This case study builds off of the information gathered in the Navigation Infrastructure Assessment by contrasting the applicable findings with the actual results of the storm. This Case Study will also include information on the amount of time the select navigation assets were affected and the cost of repair. It will also highlight some of the lessons learned to form best practices for future extreme weather events.

3. Tools

Common Support Services-Weather (CSS-Wx) (FY 2013 - FY 2017)

Common Support Services – Weather (CSS-Wx), formally NextGen Network Enabled Weather (NNEW), will enable the efficient publication of high-resolution aviation weather data from the variety of producing systems to weather information users throughout the NAS. This solution will provide users with access to the NAS-wide weather information required for operational planning. It will also institute standard protocols for NAS systems and will be scalable to facilitate the addition of new systems. The CSS-Wx System will acquire weather information from FAA and other sources and provide these data to systems that consume weather data. It will publish weather information in standardized formats for use by the FAA's Air Traffic Organization (ATO), commercial aviation, general aviation, and other Federal agencies. The CSS-Wx System will publish aviation weather products provided by the NextGen Weather Processor (NWP), National Oceanic and Atmospheric Administration's (NOAA) NextGen Web Services, other FAA weather data sources, and non-FAA weather data sources for aviation users. This will ensure that all categories of aviation weather users will have improved access to timely

and accurate weather information to support improved decision-making which will facilitate enhanced aviation safety. This tool will allow air traffic management (ATM) to more easily adapt to changing weather scenarios by distributing a single, comprehensive picture of current weather to a wide variety of users and systems. FAA will continue to work in support of the Final Investment Decision Target Date in 2014. The CSS-Wx capability plans to achieve initial operating capability in 2017.

Federal Highway Administration (FHWA)

FHWA has several initiatives underway designed to develop information, tools, and procedures necessary to support the consideration of the impacts of climate change as transportation systems are planned and as transportation projects are developed.

1. Planning

FHWA strongly encourages consideration of potential climate change impacts in the transportation planning process. Building on a pilot program completed in 2011, FHWA has provided seed funding to State Departments of Transportation (DOTs), Metropolitan Planning Organizations (MPOs), and Federal Land Management Agencies (FLMAs) to pilot approaches to conduct climate change and extreme weather vulnerability assessments of transportation infrastructure and to analyze options for adapting and improving resiliency. The 19 studies are expected to be complete in FY 2015. State DOTs, MPOs, and other agencies will be able to apply the lessons learned from these pilots to their own vulnerability assessments and better determine potential climate impacts.

In addition, in collaboration with State and local transportation agencies in Connecticut, New Jersey, and New York, FHWA has launched a project that will leverage lessons learned from Superstorm Sandy and other recent storms, as well as future climate projections, to develop feasible, cost-effective strategies to enhance the resiliency of the region's transportation system to climate change and extreme weather events. FHWA is also working with the Albuquerque, NM metropolitan region on integrating climate change mitigation and adaptation analysis for the region into a land use and transportation scenario planning process.

2. Asset Management and Design

FHWA is developing a rule to implement the legislative requirement that state DOTs develop risk-based asset management plans. Climate change is one of multiple risks that impact asset management. The legislation also includes requirements to consider alternatives for facilities repeatedly needing repair or replacement using federal funding.

In late FY 2012, the FHWA Offices of Infrastructure; Planning, Environment, and Realty; and Federal Lands Highways jointly issued a memo clarifying that activities to adapt to climate change and extreme weather events are generally eligible uses of Federal-aid and Federal Lands

funds.[12] This document includes a memo and associated Q&A document to describe eligible adaptation activities for fund recipients.

This action has encouraged fund recipients to conduct a range of activities that helps them analyze the risks and start adapting facilities to make them more resilient to climate change and extreme weather. Over time, it is expected that increased awareness of this funding eligibility will help Federal Lands Management Agencies, State DOTs and MPOs better factor extreme weather and projected changes in climate into their transportation decision-making processes. The result will be improved safety, protected transportation investments, and promotion of economic growth. FHWA plans to update the memo in FY 2014.

In FY 2013, FHWA published *Planning for Systems Management & Operations as part of Climate Change Adaptation*.[13] The white paper presents various effects of climate change and how those effects will impact transportation system management and operations. It also presents various options for agencies to assess the vulnerabilities of transportation systems and proposed changes to make transportation operations more resilient to climate change.

In FY 2014, FHWA will complete the *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2*. This is a climate vulnerability assessment of the transportation system in Mobile, AL, managed by FHWA on behalf of the USDOT Climate Center. It includes a system-level vulnerability assessment and detailed engineering studies of 11 transportation facilities in the study area.

Also in FY 2014, FHWA is initiating a project to develop recommended engineering practices for identifying and evaluating project-level vulnerabilities from future extreme weather events and climate change, and designing solutions to respond and adapt to those vulnerabilities. Engineering analyses of a diverse set of transportation assets around the country will be performed in order to identify best practices for improving the resiliency of the transportation system to extreme weather and climate change. The result will be a cross-cutting set of recommendations for engineering practice to cover a wide range of facility types and locations, to be released in FY 2016.

In FY 2015, FHWA will release a guide documenting procedures and methodologies for incorporating climate change considerations into planning and design analyses for highway projects in the coastal environment. It will provide information on the state of the practice for addressing climate change in analyses related to sea level rise, storm surge, and wave action. The results will be used to support transportation decision-making by demonstrating ways to determine potential climate impacts on coastal highway infrastructure.

3. Tools and Resources

FHWA has several tools and resources available and under development to assist agencies with identifying climate change vulnerabilities of their transportation systems:

[12] http://www.fhwa.dot.gov/federalaid/120924.cfm.
[13] http://ops.fhwa.dot.gov/publications/fhwahop13030/index.htm.

Climate Change and Extreme Weather Vulnerability Assessment Framework (Complete FY 2013) – This is a comprehensive resource and guidebook for transportation agencies conducting vulnerability assessments and it includes discussion, resources, and in-practice examples of the major tasks involved. The Framework is an update of a draft version that FHWA released in FY 2010.

Assessment of the Body of Knowledge on Incorporating Climate Change Adaptation Measures into Transportation Projects (Complete FY 2014) - This report highlights adaptation actions that transportation agencies are pursuing and articulates a growing set of best practices for implementing adaptation. The report also discusses strategies, examples, and best practices for evaluating the costs and benefits of adaptation. The purpose of the report is to provide transportation practitioners with a guide to the current "state of practice" in this field.

Transportation Climate Change Sensitivity Matrix (Expected FY 2014) – This Excel file documents how different climate stressors affect several types of transportation infrastructure. The tool contains a macro-based user interface that allows users to generate reports related to specific stressor-asset combinations per their needs.

CMIP Climate Data Processing Tool (Expected FY 2014) – This tool processes raw climate data, which users download from a third party site. Outputs are projected temperature and precipitation changes in a local area. The tool provides a relatively quick and easy way for users to determine the potential magnitude of certain changes in their area.

Vulnerability Assessment Scoring Tool (VAST) (Expected FY 2014) – This Excel tool allows users to design and structure a score-based vulnerability assessment. Once complete, users will have a relative vulnerability score for each asset evaluated.

Webinar Series on Planning for Climate Change Adaptation – (Complete FY 2013) FHWA held a four-session webinar series aimed at State and Local governments, which included sessions on:

- Determining assets to study and climate information;
- System-level vulnerability assessments;
- Applying vulnerability assessment results into decision making; and
- Lessons learned from Superstorm Sandy.

FHWA is planning an additional webinar series in FY 2014 focused on roll out of the Department's Gulf Coast Phase 2 study. Recordings of the FY 2013 webinars are available on FHWA's website.

Federal Transit Administration (FTA)

1. Pilot Studies on Climate Change Adaptation Assessments

FTA funded seven transit agency climate adaptation assessments pilots that were completed in December 2013. These pilots will increase knowledge of climate adaptation within the transit industry, improve practices, and allow the transit industry to better prepare for current and future

climate change impacts. The success of these assessments will encourage other transit agencies to begin adaptation assessments and benefit from lessons learned from the pilot program.

In FY 2014, FTA will publish the seven pilot project reports and prepare a synthesis report summarizing the findings from the pilots. FTA will communicate and disseminate this information through the FTA climate change adaptation website.

2. Workshops and Sessions

In FY 2014, FTA plans to conduct outreach on the seven pilot projects through a joint workshop with the U.S. DOT Climate Change Steering Committee. Also, in January 2014 the FTA Administrator moderated a session panel at the 2014 Transportation Research Board Annual Meeting to discuss resiliency efforts and the FTA climate change adaptation assessment pilots.

3. FTA Emergency Relief Program

As part of the FTA Emergency Relief Program, recipients may include projects that increase the resiliency of affected public transportation systems to protect the systems from the effects of future emergencies and major disasters. In response to Superstorm Sandy, FTA has approved integrated resiliency and local priority resiliency activities in recipients' grants.

4. Notice of Funding Availability (NOFA) for resilience projects

In FY 2014, FTA issued a NOFA for resilience projects to protect public transportation infrastructure that has been repaired or rebuilt after Superstorm Sandy or that is at risk of being managed or destroyed by a future natural disaster.[14] As part of the application process, FTA has developed a tool and training materials for a Hazard Mitigation Cost Effectiveness Analysis.

5. Transportation Planning Capacity Building (TPCB) - Planning Process

FTA will leverage its TPCB resources to build technical capacity for Metropolitan Planning Organizations (MPOs), Transit Agencies, and State Departments of Transportation (DOTs) in the area of planning for climate change adaptation. FTA will continue to work to build awareness of technical assistance offerings at industry events and encourage stakeholders to take advantage of TPCB resources such as peer exchanges and scenario planning workshops. FTA will also work with FHWA on supporting planning for climate change adaptation or similarly related topics as a focus area for the TPCB program by the end of FY 2014.

6. Notice of Funding Availability (NOFA) for Innovative Safety, Resiliency, and All-Hazards Emergency Response and Recovery Research Demonstrations

In FY 2014, FTA issued a NOFA for Innovative Safety, Resiliency, and All-Hazards Emergency Response and Recovery Research Demonstrations. FTA will engage the transit industry through

[14] Secretary Foxx announced the disaster relief resiliency grant awards on September 22, 2014. Source: http://www.fta.dot.gov/newsroom/news_releases/12286_16152.html.

cooperative research agreements to demonstration innovative technologies, methods, practices and techniques in three areas: (1) operational safety, (2) infrastructure or equipment resiliency and (3) all-hazards emergency response and recovery methods. Projects solicited by this NOFA are intended to develop and showcase promising innovations that improve public transportation systems.

Saint Lawrence Seaway Development Cooperation (SLSDC)

1. Planning

The SLSDC is continuing work to integrate Climate Change Adaptation into all aspects of its operations to ensure the continued safe and efficient transit of ships through the St. Lawrence Seaway as climatic conditions change. The SLSDC's specific emphasis has been on the operation of the Eisenhower and Snell Locks and on the navigation channel in U.S. waters for which the SLSDC is responsible. The primary focus has been on the work of the Offices of Engineering and Maintenance and Lock Operations and Marine Services The Bi-National component of the SLSDC's mission makes it imperative to cooperate and partner with our Canadian counterpart, the St. Lawrence Seaway Management Corporation (SLSMC). The SLSDC plans to formally roll out the plan for partnering with the SLSMC in 2014.

2. Engineering and Maintenance

The Office of Engineering and Maintenance has completed its internal review of the mechanical, electrical and hydraulic systems at Eisenhower and Snell Locks. Improvements have been implemented, are planned and are being implemented to safeguard all of these systems from the impacts of extreme high and low water levels and temperature extremes that could result from climate change. The SLSDC is currently entering the sixth year of its Asset Renewal Program (ARP) during which it will be renewing the equipment/components that are essential to safe and efficient lock operations. Several projects are being designed and/or constructed to minimize possible impacts to lock operations from extreme conditions as follows:

- Commissioning of an ice flushing system at Snell Lock.
- Upgrading the miter gate operating equipment – the miter gate operating equipment will be replaced with equipment that is more tolerant of operating when there is ice in the lock so as not to damage the gates.
- Upgrading and installing new heating systems to ensure that lock equipment and structures are not affected by severe cold temperatures and ice buildup.
- Improving drainage systems in the galleries and machinery recesses at the locks to ensure that equipment is not flooded if there are periods of high water.

In addition, roofs are being replaced with new roofs rated for higher wind speeds and buildings are being constructed to protect lock spare parts and equipment from weather extremes.

2. Lock Operations and Marine Services

The work of the Office of Lock Operations and Marine Services was recently challenged by extreme conditions. Record cold and ice conditions were encountered during the closing of the

2013 Navigation Season and the opening of the 2014 Navigation Season. Operating procedures had to be adjusted to ensure the safety of vessels transiting the Seaway. It was necessary to transit ships between anchorages in convoys led by icebreakers and to use additional equipment and modified procedures at the locks to ensure that the locks were clear of ice so the ships did not get stuck in the locks. In addition, two of the major Laker fleets on the Seaway are utilizing Draft Information Systems (DIS) developed specifically for the Seaway. The DIS is an innovative technology that provides real time projected under keel clearance information to vessel Masters which is critical especially during low water conditions. Finally, the SLSDC is proceeding with a design for an icebreaking tug and has just completed a project that made improvements to the buoy-tending barge which included heating improvements to minimize the buildup of ice on the work decks during buoy tending operations.

3. Outreach

The SLSDC will continue to work with its Canadian counterpart, the St. Lawrence Seaway Management Corporation, to ensure that all of the locks and navigation channels in the Seaway are able to remain in service or to be quickly returned to service after extreme climatic events. The SLSDC will also continue to work with the U.S. Army Corps of Engineers and the U.S. and Canadian Coast Guards to share information and resources to ensure the continued safe operation of the Seaway during such events.

An effort to keep the SLSDC's customers informed about the work that has been and is being undertaken to ensure the safe and dependable transit of the vessels through the Seaway as climate changes occur has been initiated and will continue in 2014.

Federal Railroad Administration (FRA)

1. Rail Planning

FRA will consider potential climate impacts and adaptation during rail planning and corridor program development. This effort includes developing language for future FRA grants regarding infrastructure planning and development that requires the requestors to consider the impacts of climate variability and change in project planning and design.

FRA is incorporating programmatic procedures regarding infrastructure planning and development that requires the requestors to consider the impacts of climate variability and change in project planning and design.

2. Risk and Vulnerability Assessments

The Northeast Corridor high speed rail study, called NEC FUTURE, includes a Tier 1 Environmental Impact Statement (EIS). For the EIS, FRA will assess the risks of climate change and related factors including sea-level rise and storm surge, increased storm frequency and severity, and more frequent and severe heat events. The EIS will identify data sources, metrics, and methods used to document existing conditions and analyze environmental consequences. This approach potentially could become a model for assessing climate change

impacts for other projects through the NEPA process within FRA.

3. Stakeholder Outreach

With the publication of the Draft EIS, the public will be able to comment on the assessment of climate change impacts on the vital transportation corridor and may provide FRA with additional information or suggestions for improving the strategy.

Federal Motor Carrier Safety Administration (FMCSA)

Based on the requirements of Executive Orders (EO) 13514 and 13653, the Federal Motor Carrier Safety Administration (FMCSA) submits its Climate Change Adaptation Plan. E.O. 13514 and 13653 require each agency to evaluate agency climate change risks and vulnerabilities and to identify and manage the effects of climate change on the agency's operations and mission in both the short and long term.

FMCSA has a low-risk profile regarding climate change impacts compared to most agencies. The agency does not have authority to own real property, therefore it leases all real property through the General Services Administration (GSA). And as a practical matter, it is rare that any of FMCSA's funding or actions affect existing infrastructure. As noted below, FMCSA is working with GSA to improve facilities, especially along the southern border to provide better working conditions for the agency's border inspectors. The agency is planning to replace temporary facilities and increase the use of canopies to provide shade from the hot summer sun. As discussed in additional detail in this document, FMCSA principally analyzes climate change through safety studies, as well as through the NEPA process of reviewing various regulatory actions related to monitoring and enforcing the Federal Motor Carrier Safety Regulations. FMCSA ensures that its climate adaptation and resilience policies and programs reflect best available climate change science.

FMCSA actions include:

- The agency is updating agency emergency response procedures and protocols to account for projected climate change, including extreme weather events. Specifically, during FY 2014 and 2015, FMCSA plans to initiate a study on the Risk of Severe Weather on Commercial Motor Vehicle Safety. During weather emergencies, Governors are allowed to suspend the Federal Motor Carrier Safety Regulations (FMCSRs). FMCSA will determine at a national level if these suspensions create a higher crash risk and what actions are appropriate. To implement this action, outreach opportunities to other USDOT modal administrations, federal agencies and other stakeholders are being considered. In addition, outreach to state safety and motor carrier enforcement groups (e.g., the Commercial Motor Vehicle Safety Alliance) are being evaluated. A better understanding of the nature, scale and intensity of extreme weather would aid FMCSA in better planning for such emergencies.
- The agency is committed to ensuring that workforce protocols and policies reflect projected human health and safety impacts of climate change. FMCSA is analyzing how changes in

weather patterns affect motor carrier safety operations in interstate commerce at a national level.

- FMCSA is working to ensure that the design and construction of new or modified existing agency facilities account for the potential impacts of projected climate change. FMCSA is working with GSA to upgrade the border facilities. Upgrades include increased use of canopies to provide shade for our inspectors and the truck drivers while performing inspections. Feasibility studies will be completed in FY 2014. Construction is expected to begin later in the FY and continue for multiple years.
- Agency leadership is incorporating climate preparedness and resilience into planning and implementation guidelines for agency-implemented projects and regulatory initiatives. This action may be best accomplished by requiring climate adaptation and mitigation measures to be addressed in the NEPA review process conducted for FMCSA actions. FMCSA has developed internal guidance for incorporating climate change impacts into its NEPA process, but that guidance also allows for changes by the DOT NEPA Order and CEQ guidance, as needed.

In implementing agency actions, FMCSA leadership is ensuring that agency climate adaptation and resilience policies and programs reflect best available climate change science, updated as necessary.

Maritime Administration (MARAD)

1. Planning

MARAD will continue to participate in the National Ocean Council and interagency policy committees to develop best practices for climate change vulnerability assessments with regard to marine transportation and navigation.

MARAD will incorporate climate change adaptation considerations into internal reviews, particularly port infrastructure projects, shipyard grant application evaluations, and Agency facility modifications as and when appropriations are received for these activities.

A recent MARAD report that examines the consequences of the expansion of the Panama Canal[15] also considered the consequences of improved navigability of the Northwest Passage, and concluded that the Panama Canal will remain the route of choice for freight over the next ten-to-twenty years.

2. Stakeholder Outreach

MARAD will continue stakeholder outreach efforts to aid adoption of climate change considerations, and will complete these initial activities by the end of FY 2015. MARAD's outreach approach will include industry and advocacy groups to obtain the widest consideration of perspectives when making policy decisions regarding climate change adaptation.

[15] http://www.marad.dot.gov/documents/Panama_Canal_Phase_I_Report_-_20Nov2013.pdf.

Pipelines and Hazardous Materials Safety Administration (PHMSA)

1. Stakeholder Outreach

PHMSA will increase awareness among its industry stakeholders regarding the potential impacts of climate change. PHMSA will conduct outreach via the web and in meetings to assist stakeholders in understanding the implications of climate change. While PHMSA's pipeline safety mission is not directly affected by climate change factors, the potential impact on related systems could affect PHMSA's mission area. The outreach program began in September 2011 and continues today.

PHMSA will continue to increase awareness among its industry stakeholders regarding the potential impacts of climate change in FY 2014. PHMSA will remain vigilant in conducting outreach via the web, in meetings, at conferences, workshops, and seminars to ensure focus and cognizance of stakeholders, customers, and employees as well as facilitate a greater understanding of the implications of climate change through FY 2014.

2. Employee Safety

To ensure the safety of Agency employees, PMHSA will identify climate change impacts and incorporate them into the Agency Continuity of Operations (COOP) plans. In addition, PHMSA will ensure climate profile and projections for PHMSA Regional Offices are incorporated into the Regional COOP Plans' current and 10-year weather forecasts.

Further, PHMSA is committed to ensuring the highest level of safety relative to its mission related duties and functions, specifically as relates to the Agency's inspector and investigator employees. In FY2014, PHMSA will continue to explore and research climate change adaptation and projections necessary to address the impacts on Agency inspection and investigative activities. In particular, the Agency will communicate and develop safe guards where climate change concerns and realities may affect inspector and investigator safety and well-being as relates to inspections of pipelines and hazardous material incidents. PHMSA is hereby dedicated to monitoring and addressing climate change and performing and exceeding the goals set forth by DOT's Climate Adaptation Plan.

3. Design Reviews

PHMSA conducts design reviews of pipeline projects. During these reviews, PHMSA will raise the issue of whether adaptation to climate change was incorporated in the design considerations. While PHMSA's pipeline safety mission is not directly affected by climate change factors, the potential impact on related systems could affect PHMSA's mission area. The program began in September 2011 and continues today.

The pipeline safety program has implemented integrity management requirements for gas and liquid pipelines, requiring pipeline operators to assess and mitigate the most serious risks to their pipelines. The operator must implement an integrity plan that prevents/mitigates those risks.

PHMSA is dedicated to ensuring continued integrity assessment and enactment of integrity management requirements and modal support.

Office of the Secretary of Transportation (OST)

OST issued a comprehensive suite of Departmental Policy Orders that address a broad range of climate and sustainability-related issues for its own operations and infrastructure such as greening buildings, incorporating climate resilience considerations in building design, and reducing the Department's own water, energy and petroleum footprint.

OST is actively taking steps to implement win-win solutions that have benefits related to both climate mitigation and climate resilience through its sustainability program. As part of these policies, OST is actively promoting installation of onsite renewable energy capacity, which both reduces the need for fossil fuel and helps critical operational sites be less reliant on the grid in the face of power outages. In addition, OST is actively working with Department of Energy's Federal Energy Management Program and FAA to incorporate considerations of climate resiliency into the design of new buildings such as air traffic control towers as well as make them more energy and water efficient.

The Office of the Assistant Secretary for Research and Innovation, within OST and formerly known as the Research and Innovative Technology Administration, supports the modal administrations in their efforts to expand knowledge and resources available to State and local transportation agencies to better prepare for climate impacts and build more resilient infrastructure. This office also serves as the secretariat for the Department's Center for Climate Change and Environmental Forecasting.

The Office of the Under Secretary for Policy, along with the Office of the General Counsel, coordinated with modal administrations to draft a surface transportation reauthorization legislative proposal, transmitted by the Secretary and President Obama to Congress as the Generating Renewal, Opportunity, and Work with Accelerated Mobility, Efficiency, and Rebuilding of Infrastructure and Communities throughout America (GROW AMERICA) Act. The GROW AMERICA Act would increase funding for transit by 70 percent, invest $19 billion over four years to improve rail infrastructure, and establish a $1 billion Fixing and Accelerating Surface Transportation (FAST) grants program to incentivize innovative strategies and best practices in transportation that include those that reduce energy use and emissions. The GROW AMERICA Act would require state and regional long-range transportation plans to take into account the need to reduce risks from extreme weather events and create more resilient infrastructure, leveraging increased investment in infrastructure to improve the resiliency of the nation's transportation system.

Finally, OST continues to seek opportunities to partner with other agencies and organizations to assess and address vulnerabilities to its own operations, fleet, and infrastructure.

7. Comments Received on the DOT 2012 Adaptation Plan

The Department of Transportation received six public comments about our Adaptation Plan. Comments were received from the Georgetown Climate Center, the Nature Conservancy, the Natural Resources Defense Council, the American Association of State Highway and Transportation Officials (AASHTO) and the Environmental Defense Fund. DOT is grateful to the commenters for their thoughtful feedback and useful insights and is considering those comments.

The Nature Conservancy indicated that it was important to continue to identify the knowledge and data gaps to guide future Plans. In particular, they assert that it is critical to emphasize ecosystem-based management and natural infrastructure as key adaptation solutions. They also advocated placing more attention on collaboration that occurs outside of the DOT agencies. FHWA, for instance, has been a leader in developing and implementing the Eco-Logical approach to early integration of ecological and transportation planning. Eco-logical is a collaborative approach supported by eight agencies including the Department of Interior's Bureau of Land Management and Fish and Wildlife Service, and the Forest Service.

We agree that identifying knowledge and data gaps are important for the development of transportation and adaptation and resiliency plans, and also that ecosystem-based management is important and useful. However, adaptation planning is fundamentally place-based and hence local. Different kinds of social systems require different kinds of data, and hence data gaps are often location specific.

Georgetown Climate Center wrote that the DOT Plan could also be improved through the addition of specific agency-level plans for communication and integration of efforts among the modal administrations and to state and metropolitan partners.

DOT will work to communicate and integrate its adaptation efforts across modal administrations, through the Department's Center for Climate Change and Environmental Forecasting, and to state and metropolitan partners through the programs of FTA and FHWA, as well as to ports through MARAD, airports through FAA, pipelines through PHMSA, and railroads through FRA.

The Natural Resource Defense Council stated that they want DOT to create incentives and requirements for road and highway projects to incorporate green infrastructure techniques as a climate preparedness strategy. Specifically, they felt that such incentives could be created through the TIGER grant program by establishing a preference for projects using green infrastructure, for instance. Green infrastructure and low-impact development should also be featured in FHWA's planned guidance document describing qualifying adaptation activities. They also argued that "DOT must find ways to bolster preparedness for important facilities outside of the federal network, especially in major coastal metropolitan areas that own many miles of roadway and that may not be prioritizing and supporting adequate planning for inevitable climate change."

DOT shares the NRDC's view that green infrastructure strategies can be an important component to transportation infrastructure protection.

We agree that DOT should find ways to bolster preparedness for important facilities outside of the Federal network, which can be accomplished primarily through the Department's educative capacities: pilot projects, training, adaptation grants, and technical assistance.

AASHTO wrote that DOT should commit to interagency efforts to develop downscaled climate science and probabilities. They recommend that the plan highlight the need for better downscaled climate data and information to assess the local and regional impacts of climate change. They also commended DOT's current approach to climate adaptation, stating it has been optimal in its emphasis on technical assistance, pilot projects, and partnering with AASHTO and other organizations.

DOT agrees with AASHTO on the importance of developing better downscaled climate models and estimates of the probabilities of various weather conditions and extreme events. Such information is central to a proper risk analysis of transportation infrastructure or operations. The Department is working with the science agencies to develop the necessary tools. However, while climate models are improving in their spatial resolution, there are limits to what is known, or even knowable, about future frequency distributions of weather phenomena at particular locations. There is an ever-present risk of manipulating the models into delivering very specific and entirely spurious predictions.

Environmental Defense Fund (EDF) suggested that DOT and FAA undertake a careful, transparent process to develop more robust adaptation plans that address the national, regional, and local costs of addressing the risks of climate change for aviation, and fully engage industry, municipal, state, business, environmental, and other stakeholders. EDF encouraged DOT and PHMSA to consider implementing performance standards for new and replacement pipelines to require the use of pipes and components that result in the lowest possible emission of methane. Finally, EDF argued that DOT's Adaptation Plan should include estimates of the costs of climate change on each portion of the transportation sector.

DOT, including all the modal agencies, recognizes the need to develop robust adaptation plans that consider regional, national and local costs of addressing the risks of climate change for stakeholders. DOT will continue to ensure that that adaptation planning is transparent by continuing to make the updates to Adaptation Plans public. Developing estimates of the costs of climate change in the transportation sector is a difficult and complex process, since it would require good quality datasets describing the operations of the U.S. transportation system. DOT is aware of this evolving challenge and will incorporate cost/benefit estimates into future planning, as appropriate.

With respect to performance standards for new and replacement pipes, this is more a climate mitigation and perhaps a safety issue than an adaptation issue, which PHMSA will consider.

Appendix A: FY 2016 Operational Climate Resiliency Plan

U.S. Department of Transportation - 2016 Operational Climate Resiliency Plan

April 2016

The U.S. Department of Transportation Operational Climate Resiliency Plan is an addendum to the 2014 DOT Climate Plan (https://www.transportation.gov/sites/dot.gov/files/docs/2014-%20DOT-Climate-Adaptation-Plan.pdf) This Plan addresses internal actions that the Department is taking to improve resiliency for its own assets which includes personnel, buildings, data systems, ships, and vehicles.

Table of Contents

A. Introduction

Under Executive Order (E.O.) 13693, *Planning for Federal Sustainability in the Next Decade*, the Department must prepare for the impacts of climate change by identifying and addressing the projected effects of climate change on mission critical assets and to consider those climate impacts in operational preparedness planning for major agency facilities and operations. Similarly, a goal of E.O. 13653. *Preparing the United States for the Impacts of Climate Change,* is to "prepare the Nation for the impacts of climate change by undertaking actions to enhance climate preparedness and resilience." The Council on Environmental Quality (CEQ) is providing guidance to agencies for implementing the requirements of these executive orders.

The mission of the U.S. Department of Transportation (DOT or the Department) is to ensure a fast, safe, efficient, accessible and convenient transportation system. As such, the Department has taken several steps to integrate consideration of climate change impacts and adaptation into the planning, operations, policies, and programs of it operation. In 2011, former DOT Secretary LaHood issued a department-level policy statement, *Policy Statement on Climate Change Adaptation* which emphasized the need for the organization to address climate adaptation. The Policy Statement said each Operating Administration (OA) must analyze how climate change may impact its ability to achieve its mission, policy, program, and operational objectives; report annually on its accomplishments in implementing climate adaptation strategies; coordinate actions with the Senior Official responsible for implementing climate adaptation; and implement climate change adaptation implementing instructions issued by CEQ. This 2016 DOT Operational Climate Resiliency Plan (Plan) is responsive to the executive orders and to the related DOT Policy Statement.

The Office of Sustainability and Safety Management (OSSM), within the Office of Facilities, Information and Asset Management, is responsible for assisting the Department in achieving its sustainability goals by establishing policy, programs, and metrics to ensure compliance with environmental, energy, and safety laws, regulations, and E.O.s, emphasizing innovative approaches that result in a positive return on investment. OSSM has developed governing documents that address climate change, adaptation, and sustainability. Together they form the DOT's internal agency policies on climate change adaptation, GHG emission reduction, and other sustainability goals. Additionally, OSSM is responsible for updating internal climate change and other sustainability policies on a regular basis.

B. Overview

The Department is committed to reducing vulnerabilities agency wide and improving resiliency in the face of a changing climate. For example, the Department provides grants through the Federal Highway Administration (FHWA), Federal Transit Administration (FTA), and other OAs to assist with climate resiliency planning external to the Department (more information can be found at www.transportation.gov\sustainability). This Plan addresses internal actions that the Department is taking to improve resiliency for its own assets which includes personnel, buildings, data systems, ships, and vehicles.

To develop this Plan, the Department used the 2014 National Climate Assessment. The 2014 National Climate Assessment identified eight distinct anticipated climate impacts on different U.S. regions: temperature increase, precipitation changes, extreme storms, sea level rise, changes in snowmelt, ecosystem degradation, human health, and land change.[1] Based on the National Climate Assessment, this Plan assumes the Northwest region of the U.S. will experience greater precipitation, inundation of land, and other impacts. In the Great Plains, increasing temperatures, desertification, and increased drought are predicted. The Southeast will experience coastal erosion, while the Midwest is expected to experience greater frequency of extreme storms. The Southwest could experience more severe wildfires. Each of these changes may increasingly affect the operation of DOT and create vulnerabilities in DOT assets. For example, without resiliency planning, sea level rise and storm surges could compromise DOT facilities and damage important communication and safety infrastructure. Wildfires could damage or destroy DOT properties.

In the development of this Plan, the Department's OAs were consulted and provided input. The list of assets and strategies identified in this Plan reflect a collective summary of the DOT assets that could be considered mission critical, including personnel or equipment located in highly vulnerable areas. Since this summary is an initial step toward preparing a comprehensive plan, there are likely opportunities for improvement which the Department will strive to address in future years.

C. Existing Operational Infrastructure

The Department aims to proactively integrate climate resiliency into its critical assets and operations. As a first step in this effort, the Department evaluated its major mission critical agency facilities and operational assets that are most vulnerable to the impacts of climate change, and each of the OAs provided information on their existing operational infrastructure.

The OAs' existing operational infrastructure comprises a wide range of assets located across the United States. Summarized in this report are facilities managed by eight of the nine OAs, including the Federal Transit Administration (FTA), the Maritime Administration (MARAD), the Pipelines and Hazardous Materials Safety Administration (PHMSA), the Federal Aviation Administration (FAA), the National Highway Traffic Safety Administration (NHTSA), the Federal Highway Administration (FHWA), the Federal Railroad Administration (FRA), the Federal Motor Carrier Association (FMCSA), the Saint Lawrence Seaway Development Corporation (SLSDC), along with the Office of the Secretary (OST). FAA's facilities, which represent a significant percentage of DOT's overall assets, are being evaluated in 2016 and will be included in the 2017 Operational Climate Resiliency Plan.

[1] National Climate Assessment (http://nca2014.globalchange.gov/)

The major mission critical agency facilities and operational assets identified within the DOT include, personnel, research facilities and laboratories, ship fleets, academic buildings, heavy machinery, vehicle fleets, electrical substations, safety test tracks, data centers, facilities and associated communication assets, and office buildings.

Table 1 provides a summary of DOT mission critical assets that are the most vulnerable to climate change as identified by the OAs. Column one of the table lists the type of asset held, and column two describes how the asset is critical to DOT's mission.

Table 1: Summary of DOT Mission Critical Assets

Type of Asset	Why This is Mission Critical
Control/Communication Centers and Continuity/Alternative Facilities	Maintain radio, internet, telephone, and computer network connections.
Data Centers, Records Storage, and Continuity/Alternative Facilities	House essential data and record keeping.
Dining Facilities	Maintain operations at facilities in addition to providing meals and shelter during on-site emergency situations
Dormitories and Academic Facilities	Dormitory and academic facilities for students
Facility Access Ways, Borders, Parking Lots, and Continuity/Alternative Facilities	Provide mission critical facility access/egress, security, and equipment storage.
Locks and Related Equipment	Maintain clear passage for ships traveling from the Atlantic Ocean to the Great Lakes.
Locomotives owned by FRA	Research and Development: Conduct testing of trains for functionality, safety research, and maintenance
Offices	Provide space and resources for personnel to conduct mission-critical activities.
Personnel	Personnel must be able to work in order for DOT to fulfill its mission. Personnel ensure continuity of operations at offices, locks, TRACONs, Reserve Fleet berths, and laboratories.
Power Stations/Assets (Supply and Transmission)	Maintain power for DOT offices, transportation facilities, and research centers.
Research Centers	Laboratories and support services provide critical research.
Ship Fleets and Related Equipment/Craft	Maintain readiness of The National Defense Reserve Fleet ships, which are a critical part of National security.
Training Centers	Hazmat and other training
Warehouses/Storage Facilities	Secure location to house shipping, maintenance, rail, and other equipment/vehicles

Water Treatment System	Treatment and distribution of clean water for facilities

The table categorizes the reported assets from all of the OAs into 16 types of assets. There is a great diversity of asset types held by DOT OAs, and therefore multiple strategies will need to be developed to ensure climate resiliency at DOT facilities.

The assets detailed in Table 1 are located in the following six regions identified by the 2014 National Climate Assessment: Northeast, Southeast, Northwest, Coasts, Great Plains, and Southwest. In addition, some facilities are located in the Caribbean Islands.

Maintaining the continuity of operation of these assets is critical given the essential functions performed by the OAs. For example, operation of the Snell and Eisenhower Locks ensure continuity of shipping traffic along the Saint Lawrence Seaway. Additionally, the reserve fleet of ships maintained by MARAD provides surge and sea lift during war or other emergencies and readiness of the fleet needs to be ensured. Finally, research and development facilities provide research into safety and new technologies for all modes of transportation.

As mentioned above, FAA provided a comprehensive narrative on the steps it is taking in FY 2016 to identify its existing and planned major mission critical operational assets most vulnerable to climate change including examples of the types of assets and facilities they expect to evaluate. To that end, FAA has established a working group to identify the existing and planned major mission critical operational facilities most vulnerable to climate change. The FAA working group will assess facility design standards to determine specific vulnerabilities. FAA has set forth the two main requirements that it will address in FY 2016:

- Determine major operational facilities and mission critical facilities.
- Begin analyzing ways to determine projected climate vulnerabilities of those facilities.

The FAA will apply the best available science and projections to assess facility design standards to determine specific vulnerabilities. Depending on how many major facilities are deemed mission critical in FY 2016, FAA may prioritize vulnerability assessments to maximize the effectiveness of these assessments to areas that are expected to experience climate changes of greater magnitude or at faster rates than other parts of the U.S. (e.g., Alaska).

D. Identification of Key Vulnerabilities

Each OA identified the specific climate change-related vulnerabilities for the assets listed in Table 1 and their related operations. To develop this list, DOT used the summary of key regional

climate impacts identified in the 2014 National Climate Assessment projection scenarios.[2] For example, extreme storms and weather resulting from climate change will cause vulnerability in terms of energy, communications, transportation, and safety.

Table 2 provides a summary of climate change-related vulnerabilities at specific types of DOT facilities and provides an overview of the asset vulnerabilities DOT is anticipating in this Plan. Column one lists the category of asset (from table 1) and column two details the type of vulnerability experienced at the facility.

Table 2: Summary of Climate Change-Related Vulnerabilities at DOT Facilities

Type of Asset	Description of Vulnerability
Control/Communication Centers and Continuity/Alternative Facilities	High heat or storms may hinder communication systems on site (e.g., radio, telephones), halting activities and increasing safety risks.
Data Centers, Records Storage, and Continuity/Alternative Facilities	Some data centers are located below sea level and are susceptible to flooding.
Dormitories and Academic Facilities	Academic hall lower levels are subject to water intrusion during high tides.
Facility Access Ways, Borders, Parking Lots, and Continuity/Alternative Facilities	Extreme precipitation may cause flooding and block access to facilities. Extreme weather may halt emergency response. Seawalls need reinforcement in preparation of sea level rise. Hazardous waste accumulation areas are located in areas vulnerable to flooding, and their integrity may be compromised.
Locks and Related Equipment	Increase in intensity and frequency of storms could impact access to/passage through locks and could also result in damage to lock equipment.
Offices	Heat waves and extreme storms could affect the reliability of facility power and could cause fires and other disruptions. Facilities located near water sources are expecting significant flooding risk due to sea level rise and increased frequency of storms. Lack of potable water could interrupt normal operations and training.
Personnel	Inclement weather or other climate-related events could hinder personnel in doing their jobs, or it could expose them to personal health and safety risks.
Power Stations/Assets (Supply and	Power distribution lines located above ground are susceptible to extreme heat, intense storms, flooding, and wind, as well as snow

[2] Summarized at http://scenarios.globalchange.gov/node/1155

Transmission)	and ice storms.
Research Centers	Reduced reliability of equipment and lack of access could result in cancellation or delay of research. Very high temperatures, power outages, flooding, or lack of rainfall (reduced well water levels on-site) can all cause these interruptions.
Ship Fleets and Related Equipment/Craft	Sites located in flood plains or near wetlands are subject to water intrusion or inaccessibility during storm surges tides or with sea level rise. Rising temperature may affect computers, and network equipment functionality. Warmer water temperatures may result in increase of insect populations and vulnerability to personnel from disease. Ship fleets may be vulnerable to extreme storms. Heat wave may cause equipment to leak petroleum products.

Climate change has the ability to cause "ripples" of consequences, with effects in one category leading to effects to another, for example include extreme heat or cold that can lead to increased use of HVAC systems. In cases of these extremes, systems experience increase in temperature, causing systems to fail. DOT systems rely heavily on power supply to buildings, ships, and equipment, which means that interruptions will impact continuity of operations. Extreme heat, drought, or precipitation can cause power outages or curtailment in grid provided electricity. In addition to vulnerabilities in power supply related to the electrical grid, some DOT facilities have electrical substations co-located with laboratories or other buildings where voltage is transformed from high to low or vice versa. Flooding, high winds, inundation, and other effects detailed in the 2014 Climate Assessment could adversely impact electrical supply and electricity transformers at DOT facilities, thus disrupting normal operations.

Climate effects could make it difficult for mission-critical personnel to accomplish their work, which could have broad consequences for the DOT mission and programs. If personnel are able to continue working, their personal health and safety may be compromised under certain conditions. For example, if operations are able to continue during extreme weather or flooding, personnel are often required to continue working which can result in unexpected and longer operating shifts in adverse conditions. Personnel that work in outdoor settings are susceptible to exposure to extreme heat. The integrity and safety of systems may be compromised with climate change related conditions. For example, low availability of water in extreme heat may lead to cancellations of emergency testing or system maintenance due to lack of water for personnel or if testing itself requires significant amounts of water. Communication between DOT personnel at different locations with emergency responders and Headquarters could be hindered. Thus, operations continuity and repair of system damages could be delayed and impaired.

Transportation hubs near facilities by coastal areas are anticipated to experience road flooding, inhibiting safety of commuting. The movement of ships and equipment that maintain transportation facilities could be hindered, thus reducing the operational capabilities of the facilities. The most notable DOT assets that will be vulnerable to sea level rise are fleet operations. Ship power supply cables and transformers may be damaged if water levels rise too high. The facilities by coastal areas are experiencing sea level wall deterioration that will need repairs and reinforcement. Vessel mooring plans near reserve fleet sites more susceptible to

hurricanes and other extreme storms will be vulnerable and compromise their functionality. Further, some DOT service crafts may not be accessible due to intense rising tides.

In addition to identifying climate-change related vulnerabilities to agency assets, the OAs completed a GAO survey, "Survey of Senior Sustainability Officers: Climate-Related Risks to Federal Supply Chains." The survey was distributed government-wide and its purpose was to gather information on agency efforts to develop climate change adaptation plans, identify climate-related risks to agency supply chains, incorporate such risks into the adaptation plans, and gather information on any challenges Federal agencies may face in these efforts. DOT OAs responded to the survey and described efforts to identify critical supply chains and provided information on which supply chains are considered mission critical. In addition, OAs listed examples of disruptions to supply chains (such as Hurricane Sandy) and the resulting impacts to OA operations, as well as actions taken to manage climate-related risk to supply chains. OAs also compiled information on efforts taken to carry out the requirements of E.O. 13653.

As noted earlier, this is the first time DOT has assessed its operational assets and as such, there are some assets that are still being identified and evaluated, including FAA assets and one location for MARAD. New assets identified during this process will be included in future updates to DOT Operational Climate Resiliency Plan.

E. Resiliency Plans

The survey of OAs found that preliminary work to develop operational preparedness plans for major agency facilities and operations is underway to address the projected impacts of climate change. OAs are aware that location and inclement weather will have impacts on major agency facilities and operations. Procedures that are currently in place can compensate for hindered operations. An example is a 2015 flood that occurred at an air traffic control tower (ATCT) and terminal radar approach control (TRACON) facility in Austin, TX. FAA successfully transferred responsibility for low-altitude airspace in the area to a nearby TRACON. The TRACON assumed control of the airspace, after the low-altitude radar data and radio frequencies were transferred to San Antonio by FAA technicians, and was able to provide air traffic control services at 90 percent of normal capacity within days of the flood.[3]

Other sites have similar contingency processes, specifically with emergency and existing preparedness plans. However, the consensus reported among the OAs is that climate resiliency considerations were not specifically included in the plans when they were developed. Nonetheless, several of the operations and plans include actions that will improve resiliency. The Reserve Fleets have various contingency plans in place, such as Hurricane Bills/Contingency Plans and Heavy Weather Mooring Plans, which outline measures in case of severe weather. These plans provide guidance to protect infrastructure at risk due to storm surge from hurricanes, but may be applied to higher than normal water conditions from other causes, such as increased

[3] See https://www.faa.gov/news/press_releases/news_story.cfm?newsId=19674

flooding as a result of climate change. Some major facilities also have similar plans that include processes to follow in the case of blizzards and hurricanes.

DOT has already identified actions that integrate climate change considerations into new and revised operational preparedness planning for major agency facilities and operations based on identified mission critical vulnerabilities. Data and technology safety is a major concern. For some OAs, technology located in areas most vulnerable to sea level rise, such as computers located in basement levels, is being transferred to different locations. Table 3 describes OA plans to further integrate climate change considerations into new or revised operational preparedness planning for major agency facilities and operations based on mission critical vulnerabilities identified previously. Column one of the table lists the type of asset and column two shows the climate resiliency action planned.. The table shows that a significant number of programs are currently planned or in place to address climate resiliency. However, OAs stated that 95 to 100 percent of the critical operational assets identified could be affected by climate change and thus, significant additional work and funding is likely necessary in coming years.

Table 3: Asset Specific Planned Actions

Type of Asset	Description of Current & Planned Climate Resiliency Action
Control/Communication Centers and Continuity/Alternative Facilities	Use back-up generators to maintain communication systems in the event of a power outage.
Data Centers, Records Storage, and Continuity/Alternative Facilities	Move high value items from the floor level to reduce the potential for preventable damage. Plan to move all such assets out of flood-prone areas.
Dormitories and Academic Facilities	Address flooding risk and improve resiliency in the context of periodic renovations.
Facility Access Ways, Borders, Parking Lots, and Continuity/Alternative Facilities	Incrementally renovate seawalls to incorporate new flood plain levels.
Locks and Related Equipment	Construct a new ice flushing system for select lock systems.
Offices	Complete renovations/refurbishment of buildings to follow High Performance Sustainable Buildings Federal guidance.
Other/General	Some OAs plan to evaluate additional assets to determine whether they are mission-critical and vulnerable.
Personnel	Utilize telework and COOP protocols. Test telework capabilities, to support telework options during a continuity event.
Power Stations/Assets (Supply and Transmission)	Use alternative emergency power systems to ensure uninterrupted operation of critical equipment. Renovate the USMMA campus electrical grid. Implement renewable energy projects to provide independent utility sources of

	energy. Utilize temporary aboveground boiler connections.
Research Centers	Rail testing schedules will be adjusted to more night schedules than day schedules to take advantage of cooler evening temperatures.
Ship Fleets and Related Equipment/Craft	Enact Heavy Weather Mooring Plans designed to withstand 100 year storm events. Retrieve submarine cables that provide power to vessels in the anchorage to prevent damage to cables and transformers on the vessels. Remove small craft at the shore side facility from the water and stow at higher elevation. Replace aging tug boats with higher efficiency tug boats.

As can be seen from Table 3, in FY 2016, DOT plans to take actions to protect critical assets. Assets exposed to severe weather will be stowed and secured if possible. Some sites plan to standardize the use of 30-year roof systems to withstand more severe wind and rain loads. DOT sites in areas that are likely to experience extreme heat and drought due to climate change will drill new wells on-site. Sites that have not incorporated extensive climate resiliency measures will complete analyses of their operations to determine viability of them at the sites. Across DOT, sites will update emergency preparedness plans to integrate consideration to effects of climate change. Such measures include review of viability of communication systems, promotion of teleworking, and testing of system recovery strategies.

In FY 2017, some DOT facilities may ensure backups to their data by saving it to the Cloud, with coordination and guidance from DOT Headquarters and the Chief Information Officer. Appropriate working groups will analyze ways to determine projected climate vulnerabilities of the identified major mission critical assets by first sourcing for the best available science, including downscaled projections, for localities with major mission critical facilities. Following this research, design standards will be identified for major facilities to determine whether designs may be vulnerable to climate impacts.

Costs were not estimated for the above described activities. Nor were costs estimated for potential disruptions and damage to DOT facilities and operations resulting from climate change related events. This may be an area for consideration in future Operational Climate Resiliency Plans.

F. Planned and Operational Infrastructure

For facilities in the planning stage, the DOT OAs are taking measures to ensure the resiliency of these new assets. These efforts fall into three categories:

1) **Incorporation of materials, designs, and processes demonstrated to improve resiliency.** Strategies that have been shown to improve resiliency are being incorporated into new facility design. An example is the adjustment of building foundation heights and materials to reduce flooding in facilities vulnerable to sea level

rise. Data centers that were previously located in rooms below sea level are being re-located to higher floors when new buildings are constructed. Roofing systems are being upgraded in new properties where warranted.

2) **Contractual language changes.** New buildings in the planning stages include language in design and construction contracts specifying that architects and civil engineers will evaluate climate change risk reducing strategies and materials. In addition, contracts specify that DOT-identified resiliency strategies be incorporated into new building designs. For example, cables that previously would not be specified as salt water resistant may be specified as such in new building designs to prevent damage resulting from salt water intrusion.
3) **Development of new design processes.** Design processes are being revamped to evaluate new information, strategies, and materials that enhance the climate resiliency of operational infrastructure.

G. Training Needs

In order to help DOT operational managers understand climate risks and how to address these risks, training will be needed. DOT assessed the current state of training at OAs and future needs. These are summarized below.

OAs reported having offices or committees in place that address and educate personnel on environmental-related topics, including climate resiliency. For example, one OA began compiling and distributing climate science summaries to personnel that were based on the National Climate Assessment and the supporting National Oceanic and Atmospheric Administration (NOAA) Technical Reports in FY 2015. Other administrations offer trainings to their personnel on leadership and sustainability, including public health, climate, and environmental practice. Another administration locally sourced training opportunities for its personnel through local community emergency response planning drills and annual employee education workshops.

OAs indicated interest from personnel and a desire for management to share information about climate change. One OA tailored training on decision-making and specifications for engineers and planners to include climate change considerations. Others are in the discussion phase of scoping applicable climate training to provide for operational managers and supervisors to employ to their respective sites.

A common concern among personnel was lack of information on how to determine what actions would effectively make an impact in improving climate change resiliency. In addition, concerns about the constantly shifting information landscape with regard to climate change information will undermine attempts to put plans in place. DOT personnel continue to look for clear, feasible actions they can take to effectively result in progress. Another concern noted was that as the Administration changes, priorities may change, thus resulting in inconsistent funding. Further, because of the differing views on climate change, personnel are finding site support to conduct climate resiliency analyses a challenge.

H. Summary of Department Level Actions

OAs are taking a number of steps to address vulnerabilities associated with climate change. First, they are conducting thorough analyses of mission critical facilities and determining whether operational changes, such as updating emergency procedures, are needed. Second, changes in building design are being introduced at the time of new construction. Examples include locating data centers on higher floors to avoid possible flooding and the use of different, more resilient construction materials. Structural elements including sea walls and mooring systems are being upgraded to withstand greater force from surging seas. Electrical wiring and cables are being replaced with more durable variations. In addition, alternative and back-up power systems are being developed to address potential power outages. Renewable energy and diesel generators are being installed at some facilities as a safeguard measure.

Moreover, preliminary work to develop operational preparedness plans for major agency facilities and operations is underway to address the projected impacts of climate change. Additionally, OAs reported having offices or committees in place that address and educate personnel on environmental-related topics, including climate resiliency. However, more training will be needed to fully understand climate risks and how to address these risks.

I. Conclusion

The 2014 National Climate Assessment identified eight distinct impacts associated with climate change, all of which could adversely affect DOT operations. The DOT is committed to both climate change mitigation and resiliency planning. With this first Operational Climate Resiliency Plan, the agency has taken an important initial step to assess which agency assets are vulnerable to the effects of climate change. In addition, the agency has researched the state of current efforts to improve resiliency within the DOT's OAs. This initiative will need to be followed by significant additional work. The work will focus on further identifying, prioritizing, and implementing climate resiliency measures required to ensure the agency's critical operations remain in place in the face of the types of disruptions anticipated by the 2014 Climate Change Assessment. As this work progresses, the agency will provide updates and status reports.

Appendix 1: Resources for Estimating Climate Related Impacts

The following resources were developed by DOT and by NOAA to help agencies plan for climate change resiliency:

A) FHWA – Virtual Framework for Climate Vulnerability Assessment

http://www.fhwa.dot.gov/environment/climate_change/adaptation/adaptation_framework/

B) Volpe Center - “Climate Change Adaptation Support for Transportation Practitioners”

http://ntl.bts.gov/lib/56000/56100/56192/IC2013_Adaptation_Support_Practitioners.pdf

C) NOAA – Climate Explorer (visualize impacts to specific locations)

http://toolkit.climate.gov/climate-explorer/?tp=g_a&center=-10500000.0,4500000.0&zoom=4&p=L

D) 2014 U.S. National Climate Assessment “Climate Change Impacts in the U.S.”

http://nca2014.globalchange.gov/