

# **Transit Climate Change Adaptation Seminar**

**Wednesday, August 3, 2011, 8am-12pm**

Climate change brings risks to public transportation associated with more intense rain storms, flooded bus facilities and subway tunnels, and heat waves that can buckle tracks, stress materials, and threaten customer and worker health. These impacts from a changing climate threaten state of good repair efforts, safety, and mobility.

FTA sponsored the Transit Climate Change Adaptation Seminar, in collaboration with the American Public Transportation Association (APTA) and the Los Angeles County Metropolitan Transportation Authority (LACMTA). This was the first of three workshops that FTA is sponsoring on the topic of climate change adaptation in transit. The seminar is intended to share knowledge about climate change impacts to transit systems and recent experience in planning for transit system adaptation to climate change. FTA is also highlighting a new report on public transportation and climate change adaptation, entitled "[Flooded Bus Barns and Buckled Rails](#)". The seminar covered domestic and foreign transit agency climate change adaptation efforts, risk management tools and linking climate change considerations to transit agency functions, such as asset management and planning.

Public transit agencies from Los Angeles, New York, and London that have conducted their own climate change vulnerability and risk assessments and participated in state and local adaptation efforts shared what they have learned. Climate scientists also provided some of the most up to date science and how it applies to planning for climate change at the regional level. Attendees also participated in an interactive mock climate adaptation assessment. Participants joined discussions with transit professionals from across the spectrum of fields affected by climate change including: asset management, planning, engineering, safety, operations, maintenance, policy, and sustainability.

## Welcome and Introduction from FTA

The seminar opened with a welcome by Leslie Rogers, FTA Regional Administrator for Region 9. He stated that FTA was pleased to host the seminar in conjunction with APTA and LACMTA. He also highlighted the example that in Dallas this summer, the intense heat wave was attributed to concerns at the Dallas Area Rapid Transit about rail buckling.

On July 8<sup>th</sup>, the FTA issued a "Dear Colleague" letter to transit agencies that articulated its commitment to integrating climate change impacts and adaptation into its planning, operations, policies and programs. This letter also provided a policy statement from FTA on the impact and importance of climate change adaptation. Subway tunnels, busways, rail tracks, and maintenance

facilities are vulnerable to increased flooding from more frequent and intense rain storms, rising sea levels, and storm surges.

Therese McMillan, FTA Deputy Administrator followed with introductory remarks thanking all of the participants for attending. She announced that FTA was planning to sponsor at least two more workshops, and will be holding webinars and other presentations on the important topic. She indicated that FTA was committed to the topic of adaptation and highlighted its relation to important transit issues including state of good repair and maintaining safety standards. Climate change has both capital and operating impacts, and with transit agencies often already struggling to maintain a state of good repair, they are now facing additional burdens from environmental stresses. The impact of climate change is not just on infrastructure, but also affects workers and customers, and therefore has a very real human impact.

Climate Change Adaptation and Transit Expert Panel

Tina Hodges of the FTA introduced the panelists and also summarized the new FTA report, “Flooded Bus Barns and Bucked Rails.” This report examines the impacts of climate change and the adaptation strategies that relate to the public transportation industry. This subject is critically important to FTA, which has organizational goals that include ensuring both a state of good repair of transit assets and safety for both employees and the public. Both of these goals are impacted by climate change. FTA considers climate change adaptation to be an important part of responsible risk management given the substantial amounts of investments and assets for public transportation and infrastructure.

Global temperatures have increased in response to elevated carbon dioxide concentrations within the atmosphere. The average global temperature has increased 1.5 degrees Fahrenheit since 1900 and is projected to increase by another 2 to 11.5 degrees by 2100. The United States Global Change Research Program (USGCRP) concluded that global warming is occurring now and is primarily human-induced. Anticipated effects include:

Effect	Likelihood	Impacts
Intense Precipitation	Very Likely, >90%	Flooded track, bus ways, tunnels, lots, facilities Landslides
Very Hot Days & Heat Waves	Very Likely, >90%	Track buckling leads to slow order or derail Customer comfort issues Worker safety issues
Rising Sea Levels	Virtually Certain, >99%	Flooded track, bus ways, tunnels, lots, facilities Higher groundwater level floods tunnels

Increasing Hurricane Intensity	Likely, >66%	Flooding from storm surge and rain High winds – debris, wind damage Transit provision of evacuation service
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FTA also announced the availability of \$525,000 for pilot projects that will monitor different climate adaptation assessments and approaches for transit systems. The pilots will assess the vulnerability of transit agency assets and services to climate change hazards such as heat waves and flooding. The pilots will also assess initial adaptation strategies and link these strategies to transit agency organizational structures and activities.

The workshop consisted of a panel discussion and an interactive exercise. The panel speakers consisted of:

Todd Delaney, President, First Environment

Paul Bunje, Executive Director of the UCLA Center for Climate Change Solutions

Cris Liban, LACMTA

Projjal Dutta, NY MTA

Helen Woolston, Transport for London (TfL)

Tod Delaney, the President of First Environment gave a presentation entitled, “Climate Change Adaptation: What the Science Tells Us and How Practitioners Can Use the Science.” He described what the science tells us and how practitioners can use the science. According to the USGCRP, science tells us that sea levels will rise and storm surge will increase, increasing the potential for flooding. In addition, there will be an increase in extreme heat and the intensity of hurricanes.

Paul Bunje, Executive Director of the UCLA Center for Climate Change Solutions, next gave a presentation entitled, “Climate Change Impacts and Adaptation in Southern California.” He stated that the baseline of normal climate is changing, that variability of climate is increasing, and that planning becomes increasing difficult and complex, because planners need to plan for the unexpected.

In Greater Los Angeles, the categories of consequences include impacts on public health, biodiversity and habitat, ocean and coastal resources, forestry, water management, agriculture, transportation and energy infrastructure. It is projected that there will be somewhere near a one meter sea level rise by the end of century for California, and that temperatures would increase as well. Economic impacts are difficult to estimate due to the unpredictability of events.

Dr. Cris Liban, of LACMTA next gave a presentation on the topic of “Los Angeles County MTA Climate Change Adaptation Efforts.” He described LACMTA’s progress toward a transit climate adaptation plan. Major legislative requirements in California provide drivers for climate

change planning. These include AB 32, SB 375, the 2009 CA Climate Adaptation Strategy, and Amendments to California Environmental Quality Act (CEQA).

- \* AB 32: Reduction in the state's global warming emissions to 1990 levels by the year 2020
- \* SB 375: Coordinated land use and transportation planning as a means to address climate change
- \* 2009 California Climate Adaptation Strategy
- \* Amendments to the CEQA Guidelines Section 15126.2

Currently, transit service disruptions occur during periods of extreme heat and heavy precipitation. Identifying portions of the transit system/particular services that are most vulnerable can help guide planning and operations. Large infrastructure projects, including those to be funded by Los Angeles County's Measure R, are being planned. Measure R is a \$40 billion voter initiative that would expand the Los Angeles County transportation system.

Information about impacts and adaptation can be incorporated into decisions about mode selection, siting, alternatives, and materials. There is a greater need to understand the nature and magnitude of risk associated with climate change. LACMTA is assessing both planning and operational options for reducing risks and evaluating relative costs and benefits related to the options. The LACMTA takes a screening approach for climate adaptation planning. The four steps in the screening process include:

- (1) Identification of critical assets and services
- (2) Analyze historical trends and changes in climate
- (3) Identify impacts upon the transit system
- (4) Consider alternative options for adaptation to climate change

Observed climate change impacts in Southern California include an increase in the frequency of extremely warm days. In terms of projections for future climate change, there is a projected warming of 2-6°F by 2050 and 3-10°F by 2100. The high end of the forecast range would make future spring and fall seasons appear to be at least as warm as current summers. Estimated precipitation changes vary by model, but the majority show slight overall drying. Large year-to-year variability (including the chance of heavy rainfall events) is expected to continue into the future. Despite being a "dry" place on average, Los Angeles has experienced episodes of 10-12" of rain within 5 days and winters with more precipitation than Seattle receives in an average year (~40").

Identified LACMTA impacts associated with climate change include:

Service/Asset	Climate Impact
Rail Operations	Equipment malfunction (electrical systems; air conditioning systems) during periods of extreme heat
	Railway buckling during periods of extreme heat
	Flooding of underground stations and tracks, at-grade railways, and bus rapid transit right-of-ways during heavy rainfall events
Bus Operations	Fleet breakdowns and increased maintenance demands during periods of extreme heat
New Construction/ Measure R Projects	Exposing new infrastructure to episodes of extreme heat and heavy rainfall events
	Labor interruptions or delays during periods of extreme heat

Climate change adaptation options that LACMTA is considering include combining weather/climate information with infrastructure monitoring and maintenance, exploring the use of more heat-resistant track materials and improving “flood defense” at sensitive locations, including underground stations.

Important questions remain about how to evaluate and pursue options. For example, how can the costs of adaptive actions (or lack of action) be estimated? How can adaptation be made iterative? How can we monitor the impact of weather events and best update/adjust operations and planning? How can we best integrate adaptation into management/planning? What are we already doing that could be considered adaptation? How might adaptation help us achieve existing management goals?

Projjal K. Dutta, the Director of Sustainability Initiatives for the New York MTA next gave a presentation entitled “New York MTA’s Climate Adaptation Efforts.” He stated that he wanted transit agencies to see climate change as an opportunity, since transit is a climate change solution. He emphasized that representatives of transit agencies should express this view so that society will invest more in public transportation.

Mr. Dutta described a case study from August 8, 2007, where there was an intense rain caused between 1.4 to 3.5 inches over a 2 hour period. The first tornados in 100 years were seen in

Brooklyn. The storm coincided with the morning rush hour and there were reports of flooding throughout the transit system region. Pockets of intense, sustained rain overwhelmed the regional drainage systems. The flooding of the tracks and third rail forced the shutdown of much of the New York City subway system, affecting over 2 million customers.

Since New York City lies along the water, there is a high risk from rising sea levels, increased flooding, and high intensity storms. The subway system is at risk of flooding since it lies at such low elevations with subway tracks typically 20 feet below the street level. The critical areas include the lowest points of entry to tunnels, subways or ventilation shafts.

The NY MTA is attempting to identify options for protecting vulnerable rapid transit infrastructure, considering both the level of risk and the value of facilities/components. The agency is following a series of recommendations developed during a planning process to implement an operational climate change database, complete a quantitative vulnerability and risk assessment, develop a Climate Change Adaptation Master Plan, and produce climate adaptation resilience evaluation procedures.

Helen Woolston, from TfL, next gave a presentation entitled “Transport for London’s Climate Adaptation Efforts”. She described the responsibilities of TfL and summarized the legal and political requirements related to climate change adaptation. She further summarized the TfL climate change risk analysis process, which includes workshops, specific risk assessments, an asset management plan, and public communications efforts.

The United Kingdom’s Climate Change Act of 2008 requires government agencies, including the publicly owned transit authorities, to report on how they have evaluated and planned for climate change impacts. The UK government also provided climate change projections in 2009 that included a range of scenarios and confidence levels. The Mayor of London is also undertaking the development of climate change strategies.

For TfL, some of the initial actions include simple interventions, where possible. For example, TfL has painted the roofs of buses white in order to better reflect rather than absorb heat. Tube cooling represents a major challenge, with different strategies being undertaken including groundwater cooling at Victoria station, air-conditioned sub-surface trains, and testing of new systems for deep Tube lines. The London Underground has been incorporating climate adaptation into a comprehensive asset management system. London Underground has gone through a process to map assets against climate risks, identify critical points, and conduct financial analyses.

### Interactive Mock Risk Assessment Exercise

The participants in the workshop broke out into smaller groups to take part in an interactive mock risk assessment exercise. The goals of the exercise were to gain experience in climate change risk assessment, to stimulate thoughts on the main risks to transit agencies and to

stimulate thought on potential adaptation strategies and linkages to organizational structures and processes. In addition, the exercise was a means to share information between representatives of other agencies in a workshop format so that it might be brought back to individual transit agencies for potential use.

Each of the breakout groups completed a risk matrix that considered two dimensions of climate impacts – likelihood of risk and magnitude of potential impact. Those climate change impacts and risks that scored higher on these two dimensions would be considered higher in priority for adaptation action planning and implementation by a transit agency.

The types of climate change impacts that the breakout groups found to be both ‘high likelihood’ and ‘high impact’ included both heat related and water related impacts. The impact of increased storms, with associated high winds, increased precipitation, flooding, and storm surge were of major concern. In addition, the potential for increase in power or other utility failures due to fires, downed power lines, or other storm related impacts were discussed.

Some of the direct and indirect consequences of these impacts that were discussed included both impacts upon the larger infrastructure in the community and the specific assets that transit agencies are responsible for. Storm and flood impacts could potentially raise major concerns, including long term flooding on coastal areas, erosion, landslides and mudslides. The risks to the electrical system were associated with increased demand for electric power during high heat, potential failure of catenary wires, and system impacts.

Specific potential impacts to transit systems included overheating of equipment, vehicles, and infrastructure; rail track deformation; and potential failures to vehicle operations. All of these could potentially affect service reliability. Some larger impacts on transit operations would include the buckling of roads and rails from heat and large infrastructure damage.

Concern about the potential specific consequences for transit agencies focused on service interruptions and the quality of service that was being provided to the users of the system. Some of the service interruptions might be associated with availability and use of transit vehicles and infrastructure, but other services might be limited by the availability of transit staff. Other risks to the transit system that were discussed included health related impacts to the users of transit systems, increased vehicle accidents on road and rail systems, and potential fuel supply disruptions.

The participants discussed various potential adaptation strategies related to these climate change impacts and risks. The range of potential adaptation strategies discussed varied widely. Some discussions focused on changes to standards and design specifications for equipment and infrastructure so that it would have higher tolerances for climate variation. One example of this was consideration of larger expansion joints to adapt to greater temperature extremes. These specifications apply to both new equipment as well as the retrofitting of existing equipment.

When considering of potential adaptation strategies, the participants discussed potential changes to improve user experience in light of climate change. Some examples of this included:

- (a) Making use of natural ventilation and shading in high heat areas
- (b) Alternative transit station and transit stop designs
- (c) Increased use of passenger shelters to protect from inclement weather

Other discussions focused on changes to employee training and regular practices within agencies. Some suggested increasing fuel reserves and other necessary items to help ensure continued operations during emergencies. Others discussed the development of staff training for extreme climate events. Other strategies discussed included increased inspections of rails and other assets that might be affected by climate change, and adjustments to service and maintenance schedules for vehicles and equipment.

Finally, the discussion of adaptation strategies included larger scale equipment and infrastructure investments, and even major changes to locations of operations. Some participants discussed the potential for relocation of tracks and facilities away from more vulnerable locations, such as floodplains. Others noted the need for increasing the availability of storm pumps and for improved drainage systems.

#### Workshop Closing Discussion

During the discussion of climate change adaptation, four major themes emerged. The first theme that arose was that various challenges arise when adapting to climate change and its associated impacts. Despite these challenges, participants secondly agreed that it was important to move forward to prepare for and manage the expected impacts and consequences associated with climate change. Third, in the course of preparing for these changes, many pointed out the importance of the collaboration of multiple organizations planning and preparation. Finally, a number of participants noted the importance of good communications were to climate change adaptation

In terms of the first discussion theme of challenges to preparing for climate change adaptation, one of the greatest challenges was the uncertainty in predicting the future. One participant summarized the situation by noting that climate change indicates that something is going to happen and change will occur, but it is uncertain what specifically is going to happen, or when it is going to happen. In terms of considering the anticipated impacts, one person noted that there are multiple lenses for looking at the impacts – they may be considered in terms of agency impacts, financial impacts, and customer performance impacts. One of the uncertainties associated with climate change was that the population to be served by public agencies could be changing since some migration between cities would likely occur as a result of climate change. Just as some of the population of New Orleans migrated away from that city and toward other cities including Houston, there was uncertainty associated with incoming and departing populations in other cities and regions. Finally, other participants noted the continued and

critical challenge of limited funding that was currently available for climate change adaptation programs and efforts.

Participants agreed that in spite of the challenges, it was important to move forward in preparation for climate change. Many participants stated that it was critical to prepare for and manage the impacts and consequences associated with climate change. A range of ideas were discussed and many found the risk analysis approach used by TfL to be useful, and found it helpful to undertake the interactive exercise as part of the workshop breakout group.

Participants agreed that some future actions were clearly useful in climate change adaptation for transit agencies. Certainly there is a need to incorporate climate impacts planning into asset management plans. People also agreed that is important to organize emergency operations so that they are prepared when the power goes out and when flooding occurs. One participant pointed out that it is important to work this topic into budget planning, in order to fund ongoing activities in preparation for these changes.

Some participants pointed out that there were important lessons to be learned and shared to help other organizations. It may be helpful to learn from other regions of the country in terms of working with different climate environments. For example, areas in the southwest that experience a large number of high heat days per year may provide lessons to other regions of the country that have or will see an increase in high heat days. For example, many of the impacts are expected to be similar in terms of heat consequences and water damage. Agencies affected by heat impacts to rail systems, have highlighted the importance of identifying micro-fracturing that may be occurring early on before it worsens. Other agencies have learned that it is important to question how to plan for continued use of the transit system by transit dependent persons.

A number of workshop participants highlighted the importance of cooperation and planning among different organizations. Several people pointed out that it may be useful to have more examples of regional climate compacts, such as those that have been developed in south Florida, in the Los Angeles region, and in the Portland/Lower Willamette Valley region. These regional climate compacts have highlighted the importance of interagency communication and cooperation. In particular, it is important to work with other agencies that deal with emergencies, including the Federal Emergency Management Administration (FEMA) and the Department of Homeland Security.

The discussions between organizations will improve the likelihood that planning for emergencies and evacuations be handled carefully and with forethought. For example, one person noted that in areas of the country where the power supply is linked to hydropower, there may be some additional vulnerability in the power supply system. Many agreed that for planning purposes, it would be important to consider linking planning with a funding conversation with metropolitan planning organizations (MPOs). Some suggested that MPOs might consider changing the

criteria and parameters for the assignment and allocation of funding. Many agreed that in the spirit of good planning and cooperation, it is important to share best practices and information across traditional and nontraditional boundaries

The fourth theme of the discussion was the importance of good communications around climate change. This communication is key both within the organization as well as with outside parties, including customers and users of the transit system. Within an organization, some commented that in terms of communicating with policy makers, it is difficult to present information related to future events that have a low probability of occurring. For example, it is difficult to explain monte carlo simulation to these policy makers, so instead it may be more helpful to have stories that better illustrate the important issues at hand. In terms of communications outside of the organization, many indicated that customer communications is an important aspect of dealing with climate change. In communicating to the public, it is important to frame the issues in a way that the community being served understands what is at stake and to position the agencies to be part of the solution to the expected future occurrences.

### The Path Forward

In the closing portion of the climate change workshop, participants discussed steps forward and specific suggestions they had following their participation in the half day workshop. Participants agreed that it would be useful to have more workshops and webinars in order to share information on the important topic of climate change adaptation. It is also important for more linkages to be made between asset management, safety, security, and environment, so that the traditional ‘stovepipes’ of organizations do not limit the progress that can be made in the future. Several representatives of transit agencies felt that it would be helpful to have more than one round of applications for the FTA Climate Change Adaptation Pilot Projects, so that agencies that may not be submitting applications to this first round would have an opportunity to apply in the future.

For associations and groups, such as the APTA Climate Change Standards Working Group and other cooperative working groups, participants noted that the focus has been on the mitigation side, and that it would also be helpful to have discussions on the adaptation side. These groups could play an important role in identifying gaps in information and practices serve as a forum and resource for identifying where future efforts should be focused.

Participants pointed to the numerous future needs related to climate change impacts and adaptation--including operating needs, capital needs, and needs for new and additional procedures, and encouraged the federal agencies to consider climate change adaptation as a new area for the annual federal condition and needs report. Perhaps another chapter may be added to these reports to consider these issues more fully, including the specific needs for and expected costs associated with climate change adaptation.

Finally, participants agreed that there was a need for further communication on the topic, both in terms of sharing information with the wider community and world, as well as internally within organizations. Specifically, there was a need for sharing effective models for planning and preparation and case study examples. For example, it would be helpful to illustrate stronger connections between science and probability, since there appear to be large bands of probabilities for flooding and temperature increases. It would also be helpful to come up with strategies for communicating and translating this information to other people in a way that would be understandable and actionable. It would be useful to share information and data and capabilities, particularly GIS and map based data and information. For example, the Volpe Center capabilities related to GIS mapping may be useful to many parts of the country. Some of the floodplain information should be linked to the probability of floods, so that there is better understanding of where the water is likely to go in cases of heavier rain and flooding.

### Survey Results

The results of the survey indicated that participants thought the workshop was valuable, especially the interactive exercise. Many indicated that a longer workshop would be valuable in the future. There were also requests for more specific “how-to’s” in terms of solutions and action items to deal with adaptation. Many people are familiar with the background information on climate change science and felt that more concrete examples of how various agencies can approach climate change adaptation would be beneficial in the future.