RSG INC.
RESOURCE SYSTEMS GROUP, INC.

SUMMARY REPORT

MPO PEER WORKSHOP ON PLANNING FOR CLIMATE CHANGE

SEATTLE, WASHINGTON

MARCH 6-7, 2008

Prepared for:

Federal Highway Administration

April 2008

60 Lake Street, Unit 1E ▪ Burlington, Vermont 05401

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LIST OF ATTENDEES

- **Harry Barley,** Executive Director, METROPLAN Orlando, *Orlando, Florida*
- **Ellen Beckmann,** Transportation Planner II, Durham-Chapel Hill-Carrboro MPO, *Durham, North Carolina*
- **Rosemary Brinson Siipola,** Transportation Planner/Manager, Cowlitz-Wahkiakum Council of Governments, *Kelso, Washington*
- **Fernando de Aragon,** Staff Director, Ithaca-Tompkins County Transportation Council, *Ithaca, New York*
- **Jesse Elam,** Senior Planner, Chicago Metropolitan Agency for Planning, *Chicago, Illinois*
- **Susan Hardy,** Air Quality Program Manager, Mountainland AOG, *Orem, Utah*
- **David Jackson,** Sr. Principal Planner, Atlanta Regional Commission, *Atlanta, Georgia*
- **Doug Kimsey,** Planning Director, MTC, *Oakland, California*
- **Maggie Martino,** Planning Program Manager, Tri-County Regional Planning Commission, *Peoria, Illinois*
- **Anne McGahan,** Chief Planner, Boston MPO, *Boston, Massachusetts*
- **Kelly McGourty,** Principal Transportation Planner, Puget Sound Regional Council, *Seattle, Washington*
- **Simon Montagu,** Customer Resource and Support Director, DRCOG, *Denver, Colorado*
- **Felix Nwoko,** Transportation Planning Manager, Durham-Chapel Hill-Carrboro MPO, *Durham, North Carolina*
- **Sara Tomlinson,** Environmental Planning Specialist, Baltimore Metropolitan Council, *Baltimore, Maryland*
- **Diane Turchetta,** Transportation Specialist, Federal Highway Administration, *Washington DC*
- **Peter Plumeau,** Facilitator, Resource Systems Group, *Burlington, Vermont*
- **Stephen Lawe,** Facilitator, Resource Systems Group, *Burlington, Vermont*

1.0 BACKGROUND AND INTRODUCTION

During 2007 and 2008, the Federal Highway Administration (FHWA), through its Transportation Planning Capacity Building program, is conducting a series of metropolitan planning organization (MPO) peer exchange workshops in partnership with the Association of MPOs (AMPO). Each workshop is focused on a specific topic of current or emerging relevance to MPOs, each of which was identified through a national panel process. The workshops seek to engage participants from MPOs representing a diversity of urban area sizes, MPO structures and expertise/experience in the topic area.

This report summarizes the results of the workshop held in Seattle, Washington on March 6 and 7, 2008, on planning for climate change. Representatives from 13 MPOs shared their experiences and challenges in this area. The ultimate goal of the workshop was to allow senior staff from a variety of MPOs to come together to share information and learn from each other in a facilitated open discussion setting. FHWA developed this report to summarize the workshop discussions and results for the use and benefit of MPOs and their planning partners across the country.

2.0 WORKSHOP SUMMARY

2.1 OPENING REMARKS

2.1.1 Peter Plumeau, RSG, Inc.

The workshop kicked off with opening comments from Peter Plumeau of Resource Systems Group, Inc. Mr. Plumeau, the lead facilitator for the workshop, stated that the purpose of the event was to gather together representatives from MPOs around the country, representing small, mid-size, and large metropolitan areas, to share experiences and collaborate on approaches to addressing the issue of planning for climate change. The workshop would begin with opening remarks from Diane Turchetta of the Federal Highway Administration. She would be followed by presentations from representatives from the Puget Sound Regional Council and the Boston MPO regarding their experiences related to this topic. With these presentations "setting the stage" for the remainder of the workshop, Mr. Plumeau would then move all participants into a facilitated discussion on experiences, issues and options. He noted that Ms. Turchetta of the FHWA was present to provide additional insights from the federal perspective as well as to obtain information from the participants that can help FHWA more effectively provide assistance and support to MPOs.

2.1.2 Diane Turchetta, Federal Highway Administration

Ms. Turchetta provided background on the workshop topic from a federal perspective. The following summarizes her comments:

- FHWA has focused to date primarily on research regarding climate change and transportation.
- FHWA recently issued a Broad Agency Announcement (BAA) that solicited research proposals related to transportation planning and climate change. There were approximately 25 climate change-related proposals submitted for funding consideration
- FHWA currently has a contractor researching how climate change considerations can be integrated into the transportation planning regulations. This work also includes documenting case studies and best practices.
- FHWA recently partnered with New York State Department of Transportation and PSRC to assist with necessary modeling research and improvements needed to incorporate climate change considerations into their transportation planning processes
- FHWA has recently held several outreach meetings with transportation stakeholder organizations and is coordinating activities and initiatives on climate change with AASHTO, NARC and AMPO. In addition, FHWA is working with the National Cooperative Highway Research Program (NCHRP), EPA, and several state DOTs to develop a Transportation and Climate Change Clearinghouse.
- With regard to "MOVES" – software that analyzes and predicts emission from both on-road and off-road vehicles – there have been a few data issues that FHWA has been working on with the Environmental Protection Agency (EPA). FHWA has encouraged EPA to finalize this software for implementation as soon as possible so that the transportation community has a more accurate tool to estimate vehicle-related GHG emissions.

2.1.3 Summary of Pre-Workshop Responses

Prior to this event, the participants each received a list of pre-workshop questions, the responses to which were used to identify similarities and differences between MPOs in climate change planning and to identify workshop discussion topics. Mr. Plumeau presented a summary of the workshop responses:

- Most of the participating MPOs are taking various types of action related to climate change. Some MPOs are trying to address climate change "quietly" through their existing planning processes, while others have put climate change prominently at the top of their list of priorities. Information sources vary widely, from national publications to data from the federal government. Some MPOs gather their own data, and many look to academia for information.
- Efforts among these MPOs to coordinate with other organizations ranged from establishing formal greenhouse gas mitigation organizations to more simple *ad hoc* efforts. Some participants are pursuing coordination with other MPOs in their states or regions. Although some MPOs have successful formal efforts, most MPOs are looking for opportunities to increase their role.

- Public involvement efforts on climate change range from issuing white papers and holding conferences to seeking speaking engagements and other indirect efforts to virtually none at all.

Appendix B contains a full summary of all participants' responses to each pre-workshop question.

2.2 OPENING PRESENTATIONS

2.2.1 Anne McGahan, Boston MPO, MA

The Boston MPO area encompasses 101 cities and towns and three million residents, which is about 48% of Massachusetts' population.

In the past, the MPO used several sources to identify the effects of climate change, including developing CO_2 emissions from transit projects for the Massachusetts Bay Transportation Authority (MBTA, the main transit agency in the MPO area), the MPO travel model, and outside sources such as the 2005 Massachusetts Climate Protection Plan. Although its efforts related to climate change had not moved forward due to other issues on which the MPO was working, in 2007 the topic returned to the MPO's planning agenda. A number of climate change initiatives had begun in the state that brought light to this issue:

- The governor committed Massachusetts to participating in RGGI,[1] a multi-state carbon emissions cap and trade program
- The courts found that the EPA has the right to limit greenhouse gas emissions
- Massachusetts environmental policy was enacted requiring any contractor with a project large enough to warrant an environmental review to estimate greenhouse gas emissions and reduce them as required
- Some cities in the Boston MPO area were developing climate action plans

These activities prompted the MPO to direct the staff to develop a white paper containing current policy context, an overview of climate change, current MPO policies and actions, and recommendations for future MPO actions. The white paper identified several ways that the MPO and its partners can work to reduce CO_2 emissions:

[1] The Regional Greenhouse Gas Initiative (RGGI) is a market-based cap-and-trade program to reduce carbon dioxide (CO_2) emissions from power plants in 10 Northeast states. Participants include the six New England states (Maine, New Hampshire, Vermont, Massachusetts, Connecticut and Rhode Island), New York, New Jersey, Delaware and Maryland. RGGI will be the first mandatory cap-and-trade program in the United States to reduce global warming emissions. (Source: Union of Concerned Scientists website, http://www.ucsusa.org/global_warming/solutions/regional_cap-and-trade_programs.html#The_Northeast_Regional_Greenhouse_Gas_In)

- Funding projects that provide transportation alternatives to SOV travel
- Investing in projects and programs that reduce vehicle miles traveled (VMT) and roadway congestion
- Fund the use of alternative fuels when appropriate

Public transit is a substantive transportation alternative in the region, with a current daily (weekday) ridership of 1.2 million. The MPO allocates a large proportion of regional transportation funds to transit including for the purchase of new vehicles. In addition, the MPO provides funding for bicycle and pedestrian programs as well as signalization projects and transportation demand management (TDM) programs. Also, because trucks carry most of the freight moving in and out of the urban core, the MPO can facilitate more efficient (and therefore less polluting) routing for trucks by addressing bridges with weight restrictions.

Regarding land use planning and decision-making, the MPO works with the regional planning agency to develop demographic forecasts. The forecasts have been developed to focus new growth in population centers around existing infrastructure including transit. However, the MPO has no direct authority to pursue changes in land use patterns necessary to make the region's carbon footprint smaller.

There are other climate change-related planning activities underway in the Boston MPO region. For example, the MBTA is working to estimate the levels of greenhouse gas emissions from busses and commuter rail as part of their long-range transit plan – the Program for Mass Transportation. In addition, two major projects – a subway extension and a commuter rail extension – are both undergoing MEPA review. Both will also be required to go through the state's new greenhouse gas emission review process. The MPO is being asked to participate in many of these external activities because their travel model can provide critical analysis support data.

Appendix B includes the Boston MPO's report, "Carbon Dioxide, Climate Change, and the Boston Region MPO – A Discussion Paper."

2.2.2 Kelly McGourty, Puget Sound Regional Council, Seattle, WA

Kelly McGourty framed her presentation on the PSRC's climate change planning activities by discussing "adaptation" versus "mitigation," and the importance of both. She noted that the PSRC's charter directs them to perform transportation, land use, and air quality planning in concert with each other. This broadly defined mission gives PSRC a somewhat unique perspective on and ability to address complex challenges such as climate change planning.

PSRC has incorporated climate change in the update to their overarching growth, transportation and economic strategy document, VISION 2040, which is to be adopted in April 2008. This document includes a regional climate action plan as future work. On the technical side, the MPO performed a simple analysis of CO_2 as part of the VISION EIS, but was unable to perform a more sophisticated

analysis due to constraints within the models available at the time. Since then, they received a federal grant to improve the travel demand model for various parameters, including mode choice, vehicle tours and the costs of driving. The MPO is also updating their long-range transportation plan, Destination 2030, and realized that in order to provide the best data possible related to transportation strategies and their impacts on GHG emissions, they would need the abilities of the upcoming MOVES model. Since the current release of the model had some constraints, PSRC was able to work with FHWA and EPA and it was agreed that PSRC would be a useful pilot test site for the pending updated version of MOVES.

The Appendix to this report includes a summary of Ms. McGourty's presentation.

2.3 ROUNDTABLE DISCUSSION

After the opening presentations, Mr. Plumeau began the facilitated segment of the workshop. He posed the question, "What are you hoping to do in your MPO, and how?" Participants were each given a chance to answer this question, and their responses were open for further discussion. Below is a summary of each participant's comments, which may include general comments from other participants on the particular conversation topic.

2.3.1 Maggie Martino, Tri-County Regional Planning Commission, Peoria, IL

The Tri-County Regional Planning Commission is focused on identifying reasonable measures of success for their climate change planning effort. The regional planning commission has no regulatory authority over land use planning. Educating the region's elected officials and residents has become a priority for the MPO in order to assist with the local planning process.

Because the Tri-County Regional Planning Commission struggled with finding a niche in climate change planning, other MPOs volunteered initiatives that they are developing. These efforts include:

- Influencing land use change through transit oriented development
- Encouraging "livable communities" as a means for incorporating regional planning into transportation
- Assisting in finding novel ways of funding

2.3.2 Harry Barley, METROPLAN Orlando, FL

METROPLAN Orlando is currently reviewing its options for allocating federal planning funds to activities focused on climate change-related planning. The MPO is currently determining how best to take advantage of federal funding to conduct climate change planning. As it stands, METROPLAN Orlando believes they do not have enough control of land use and other measures to facilitate a substantial change. Furthermore, the MPO's experience is that they have little flexibility to

spend federal metropolitan planning funds on "non-traditional" activities such as land use planning and believe this lack of flexibility makes having a tangible impact on climate change difficult.

The question for METROPLAN Orlando is, "what has to happen for people to change their behavior?" This MPO believes that transit needs to become more competitive with the automobile for daily transportation needs. Despite current land use and transportation trends in Florida, this MPO holds firm that there is hope for public transit. For example, in Walt Disney World (which is within the MPO's planning area), visitors pay a premium to leave their cars behind. This can be interpreted to show that people are willing to actually pay to give up their car if a viable alternative is available.

2.3.3 Ellen Beckmann, Durham-Chapel Hill-Carrboro MPO, NC

In the Durham region, the various municipalities each have their own local GHG plans and targets. This MPO would like to develop a regional-level climate change plan that would build upon and be consistent with the local plans, but has yet to identify a workable approach for this. The MPO has used some consulting services to develop a plan for addressing energy issues related to transportation.

2.3.4 Simon Montagu, DRCOG, Denver, CO

DRCOG questions whether or not the U.S. is being too reactive to the problem of GHG emissions, since there are still so many unknowns. Fundamentally, however, DRCOG believes that land use and transportation should be tied closely together, and that climate change adaptation strategies should be framed by this belief.

DRCOG's current issue is dealing with the question of the appropriate role for the MPO in climate change planning. Due to the perception of the speculative nature of the climate change topic, it has been challenging for DRCOG to get buy-in from the public with regard to making climate change a focus of the long range transportation plan. Specifically, because the MPO is empowered to work primarily on transportation, they have faced challenges in their ability to affect change in related areas such as land use and air quality planning.

2.3.5 Doug Kimsey, MTC, Oakland, CA

For the MTC, the primary topic is identifying how to set up a framework for the regional investment plans that will adequately support GHG reductions. Based on prior experience, the MTC has found that land use and pricing are the two key leverage points in this process. In addition, the MTC has found little if any significant impact on GHG emissions resulting from either Transportation System Management (TSM) or Transportation Demand Management (TDM). It was pointed out that this may be the result of the insensitivity of the travel model to these types of initiatives, rather than a indication that they have no appreciable impact on emissions.

2.3.6 Sara Tomlinson, Baltimore Metropolitan Council, MD

The Baltimore Regional Transportation Board (BRTB) is the MPO for the Baltimore, Maryland region. Some of the local jurisdictions in the region have adopted GHG goals. In addition, the State of Maryland has a Climate Change Commission that has been tasked with developing a plan to address both climate change causes and effects, and to establish benchmarks and timetables for plan implementation.

The work plan for the BRTB will include a project to determine appropriate ways to model transportation-related carbon dioxide emissions.

2.3.7 Rosemary Siipola, Cowlitz-Wahkiakum Council of Governments, Kelso, WA

The Cowlitz-Wahkiakum Council of Governments' region has undergone a significant economic change in recent years. Historically based primarily on the lumber industry, the region's economy has been diversifying, with an inflow of new residents. Many of these people desire to have a set of multimodal options for moving around the region. However, this region lacks an extensive public transit system and its roadways have traditionally been "overengineered" to accommodate large trucks and an automobile-oriented travel demand.

This MPO is not directly focused on GHG issues, but rather on quality of life measures. Generally, this MPO feels there are issues of concern that take a higher priority to GHG emissions, such as safety costs, high accident locations, and other topics. Specifically, this MPO feels that they are just one small piece of the larger picture and cannot make a significant impact if their global partners do not also make an effort.

2.3.8 David Jackson, Atlanta Regional Commission, GA

Reducing congestion remains a high priority for the ARC, even with a recent transportation funding cut of $4.5 billion to fiscally constrain the Envision6 2030 RTP. Plans for transit expansion suffered disproportionately from these cuts because utilization of existing transit has been perceived to be providing an inadequate return on investment to the region. A regional Transit Planning Board (TPB) has been created in order to develop a comprehensive transit strategy for the region. A major question for the TPB is how the Atlanta region can develop an organized institutional framework and funding strategy for expanding its regional transit system. ARC continues facilitating creation of "Livable Communities" and is expanding its role in encouraging development of "Green Communities."

ARC is starting work on a new regional plan, and is talking with regional leaders and national experts to help them bring sustainability and energy issues to the forefront. This is being achieved through a visioning initiative called 50 Forward. At present, the MPO has found it difficult to prioritize climate change problems when there are larger looming issues, such as low population density, high population growth, restrained transportation funding and the subsequent problems, such as

congestion and air quality impacts caused by continued growth and a lack of funding. Bringing in outside objective experts may help move climate change towards the top of the priority list for elected and policy officials.

2.3.9 Fernando de Aragon, Ithaca-Tompkins County Transportation Council, NY

This MPO is very small and encompasses one county of just over 100,000 people, which is also the greater region's growth and employment center. Despite its small population, the region's transit system is tremendously successful. There are several new initiatives underway at this time, including short-term implementation of a vanpool program, online rideshare and car share. The MPO is also cooperating with local groups in the analysis of various mobility enhancing technologies including flexible transit, regional (multi-county) transit applications and personal rapid transit (PRT).

The biggest obstacle for this MPO is a lack of consistency among the various local plans and decisions, which is further exacerbated by the lack of a well-articulated and compelling regional vision. This MPO firmly believes there are sufficient funds nationally to resolve the problem of climate change; however, a reorientation of these funds within federal priorities is required.

This MPO does not rely on a regional transportation model and, therefore, would not be performing forecasts of transportation emissions with conventional methods.

2.3.10 Jesse Elam, Chicago Metropolitan Agency for Planning, IL

This MPO is governed by a very large committee structure and is working on defining the MPO's priorities and vision for climate change planning. They have used both the Envison Utah process and the Boston Indicators project as possible models for identifying a local vision and appropriate climate change indicators. CMAP is about one year into a three year planning process, and thus far has focused on establishing a regional vision, which includes climate change mitigation, and identifying indicators. CMAP will be undertaking a major modeling exercise but is not certain of the reliability of the model outputs as they relate to setting climate change-related priorities. CMAP also held a major conference in 2007 with approximately 300 people in attendance to help define regional priorities for mitigating and adapting to climate change, including transportation and land use strategies.

CMAP will be using scenario planning methods to develop its long-range transportation plan. While this will be a "what-if" exercise focused on potential policy and investment choices, it is also expected to include a measure of "robustness," i.e., sensitivity to changes in future conditions. Consequently, the MPO is looking at how and whether to build its plans on an expectation of incremental changes in behaviors and patterns or more "revolutionary" changes. CMAP is concerned that the projected changes in land use and travel behavior from implementation of the LRTP might not be enough to have a significant impact on GHG emissions. While CMAP has explicitly highlighted concerns over climate change, it has also been wrapped into a more general approach to "sustainability," as this is a broader theme of planning for the future and can also be more appealing to constituents .

2.3.11 Discussion

General comments and questions followed the roundtable discussion, with several key themes emerging:

- Are we doing enough to address climate change? How do we know?
- How will the federal government support an MPO focus on climate change in the near and distant future?
- What does a "national goal" of an 80% GHG reduction by 2050 really mean? How can we achieve this? Is it realistic?
- How can we get the public and policy-makers to agree that climate change is a legitimate and urgent problem?

Some participants believed that climate change concerns have placed a new spotlight on the appropriateness of the traditional MPO role. Some also recognized that in recent years, transportation infrastructure has become less about roadway capacity and more about alternative modes, which are underutilized and hold much promise for addressing the greater climate change problem.

Many felt that there is significant public uncertainty or skepticism regarding climate change. Consequently, it has been difficult for many MPOs to facilitate consensus among policy-makers regarding new transportation policies intended to address climate change. One idea that emerged from the discussion is to express the impacts of GHG emissions and climate change in monetary terms, thereby representing those impacts using a common and tangible frame of reference.

Several participants believed that what federal funding is available specifically for either planning or implementation of climate change mitigation strategies is inadequate. Most agreed that this lack of funding is a significant obstacle to realizing substantive change in policies and travel behavior that could help mitigate GHG emissions. Partly in response to this reality, several of the participants said their MPOs have decided to focus on climate change adaptation strategies rather than mitigation actions.

Participants generally agreed that the current state of the planning tools available to MPOs to address climate change is not adequate. It was noted that many travel demand models are based on the premise of highway expansion and may not be sensitive to the range of policy options being considered to combat climate change. It was also noted that both the science and techniques for estimating GHG emissions are not as far along as those for criteria air pollutants. These limitations can lead to a credibility gap with MPO board members and the general public and inhibit the MPO staff's ability to understand and plan for responses to global climate change.

2.4 ISSUES OF COMMON CONCERN

Six key issues of common concern emerged from the two days of workshop discussions:

- Making climate change a national planning priority
- Planning for adaptation to climate change
- Educating the public and policy-makers about climate change and transportation
- Articulating the relationship of land use patterns to climate change
- Need for tools to address climate change planning challenges
- Need for continuous communication and information sharing among planning partners

2.4.1 Making Climate Change a National Planning Priority

Participants generally expressed varying levels of frustration that there currently exist no clear national goals or priorities regarding climate change. They concurred that without such goals, it is difficult to establish climate change planning priorities at the metropolitan level that make sense and are compelling to policy-makers and the public.

There was concern as well, however, that a federal response to the need for concerted climate change planning not be overly "heavy handed," and allow MPOs flexibility in how they respond to federal goals and priorities. Participants advocated for an approach that would allow MPOs to develop climate change plans and strategies that are as sensitive to local conditions as possible.

Regarding the topic of GHG emissions targets, there was general concern about how to define reasonable goals. Most participants believed that the MPO should work with its state to set the goals and to support a regional plan; however, few participants had an understanding of how their state or region's current GHG emission goal, if one exists, was derived.

Participants made several suggestions for modifying current federal programs to enable MPOs to do more on climate change planning. For example, it may be useful to modify the Congestion Mitigation and Air Quality (CMAQ) program to encompass GHG and climate change-related actions as eligible for funding.

2.4.2 Planning for Adaptation to Climate Change

Participants generally believed that MPO and related efforts should be focused on adaptation strategies as least as much as on mitigation strategies. In this workshop, participants discussed "adaptation" mainly in the context of how policy decision-making and human behavior can or will adapt to climate change realities. While certainly a major aspect of the climate change arena, adaptation of physical transportation facilities and systems to climate change impacts did not emerge as a focus of the workshop discussion.

For the most part, participants believed that policies implemented today would take a significant amount of time to have an appreciable impact on GHG emissions and the climate. Furthermore, the ability to effectively plan for adaptation to climate change likely will be challenged by continued sprawl-based land use patterns in metro areas in the near-term. Some participants, however, believe

the retirement of the baby-boom generation over the next 10-20 years will have significant implications for adaptation planning, since there is growing evidence that these people may be inclined to downsize their homes and locate in mixed-use urban areas with non-driving options. Again, this trend would take many years to have an appreciable impact on adaptation strategies.

Some participants thought that MPOs need to pursue both climate change adaptation and climate change mitigation plans, particularly as they pertain to more aggressive integration of transportation and land use planning. It was suggested that the federal government should put forth major incentives to facilitate more effective land use planning.

Participants were generally uncertain regarding whether and how MPOs and the metropolitan planning process may change in response to climate change. Some believe that political and institutional inertia will essentially drive MPOs along the same path they have been on for decades, with the focus on current issues such as congestion management and fiscally-constrained planning continuing. Participants generally agreed that if the federal government imposes new climate change-related planning requirements on MPOs, such requirements may have limited positive impact unless they are accompanied by new funding, technical assistance and significant flexibility provisions.

2.4.3 Educating the Public and Policy-Makers about Climate Change and Transportation

Most participants agreed that educating the public and policy-makers about climate change is a major challenge because of the difficulty associated with translating complex and sometimes obscure climate change information into tangible, meaningful and compelling stories. Most participants believed that the complexity of and shortcomings in climate change data and information poses a significant obstacle to effective public education. In some locations, the public perceives that information sources are incomplete, unreliable and/or contradictory. Participants further agreed that one of the greatest challenges in this regard was the limited expertise of the MPOs themselves on the topic. In addition, even if MPO policy-makers and others understand the science behind the problem and the established goals, they often do not understand how to achieve those goals.

Most participants agreed that the focus of public education on climate change should be on changing individual behaviors. To do so will require helping people to understand how their individual behaviors contribute to climate change as well as the looming consequences of climate change for them as individuals, their communities and the nation. For example, as natural disasters, such as hurricanes and flooding, become more severe over time, the public may begin to understand the consequences of climate change on a personal level. Several participants suggested that the problem might be less about the public understanding the effects of climate change and more about understanding how they as individuals can make personal changes with positive impacts; currently there is no clear association with individual actions and the global problem.

It was suggested that visualization tools and techniques could have significant usefulness in conveying this relationship to individuals and stakeholders. It was also suggested that public education on climate change is likely to be a long-term process, much as were campaigns initiated

decades earlier against smoking and encouraging recycling. Both required concerted and sustained education campaigns over many years to have an appreciable positive impact on society.

2.4.4 Articulating the Relationship of Land Use Patterns to Climate Change

Participants in the workshop generally agreed that making fundamental changes in how land use and transportation are planned and integrated are essential to both mitigating and adapting to climate change. However, because MPOs in general have little, if any, authority to make land use decisions, most transportation planning efforts directed at climate change will likely have only minimal positive impacts. Furthermore, since there is great variation in land use planning and decision-making across municipalities and the nation, it may be exceedingly difficult to develop any workable federal laws, policies or regulations to require more explicit linking of land use and transportation through the MPO process.

Several participants suggested that the MPO Certification process might provide a tool by which the need to integrate transportation and land use planning could be facilitated. Because SAFETEA-LU requires coordination of regional growth and development plans with the MPO planning process and LRTP, USDOT has an opportunity during MPO certification reviews to enforce this requirement by tasking both the MPO and its planning partners at the state and local levels with doing a better job in transportation-land use coordination. For example, the certification review could include suggestions to the MPO on best practices based approaches from other comparable MPOs or organizations.

Participants concurred that the next couple of decades may reveal a change in settlement patterns across the nation as baby boomers age and their children head out on their own. Both of these groups have in recent years demonstrated a preference for living in areas with mixed land use patterns and multimodal, non-SOV transportation options. If these patterns are borne out in coming years, the ability to create plans with positive climate change adaptation results may be much more feasible.

2.4.5 Need for Tools to Address Climate Change Planning Challenges

Participants identified various tools that could motivate the public to make behavioral changes that would help address climate change challenges. They include:

- Financial incentives, tax breaks, etc.
- Making the out-of-pocket cost of transit vs. the cost of gas competitive
- Subsidizing regional rail and reducing short airline flights (less than 500 miles)

In addition, they identified various tools that would both help address climate change generally and facilitate a greater MPO role in motivating the public. They include:

- Federal guidance
- Funding
- Technical support
- A method for economic analysis
- Inventories of ports, airports, off-road facilities, etc.
- Consistency of measures

Furthermore, they indicated that the federal government could support MPOs by improving the level of confidence in the few tools that are currently in practice.

There was also a discussion about forecasting and the availability of data and guidance. It was observed that MOVES is still not ready to be used and that the lack of detailed CO_2-to-operating speed relationships limits its use. Since the Mobile model does not capture the detail necessary to represent CO_2 properly, the MPOs are left without a reasonable way of forecasting. This was perceived as both a limitation in the available science and in the methodologies and available tools.

Another concern discussed during the meeting was the lack of understanding about contribution of mobile sources to the overall mix of GHG. This limitation in knowledge is of concern because it both undermines the credibility of MPO forecasts and inhibits the ability of the MPOs to discuss the importance of GHG policies in regions that are skeptical of or not motivated by climate change.

2.4.6 Need for Continuous Communication and Information Sharing among Planning Partners

Partly in response to the proceedings of this workshop and partly due to a recognition of the limited information and support that has been available thus far from the federal government and others, workshop participants unanimously agreed that opportunities for sharing information across MPOs, state DOTs, localities and the federal government need to be made much more frequent and accessible. Most of the participants stated that they hoped this workshop would be the first of many such opportunities to share experiences and learn from their peers at other MPOs across the country as they work to address the complex issues associated with climate change. Several also suggested that AMPO's listserv and website could be tremendously useful vehicles for information sharing and knowledge transfer.

APPENDICES

A. WORKSHOP AGENDA

B. SUMMARY OF PRE-WORKSHOP ASSIGNMENT RESPONSES

C. PRESENTATIONS

MPO Peer Workshop on

Planning for Climate Change

Seattle, Washington

March 6-7, 2008

Convened by

Federal Highway Administration

and

Association of Metropolitan Planning Organizations

Hosted by

Puget Sound Regional Council

PSRC

Managed and Facilitated by

Resource Systems Group, Inc.

Burlington, Vermont

RSG INC.

RESOURCE SYSTEMS GROUP, INC.

MPO Peer Workshop on
Planning for Climate Change
March 6-7, 2008
Seattle, Washington

Agenda*

Thursday, March 6

1:00 – 1:30 pm	Welcome & Opening Remarks ▪ Peter Plumeau, RSG, Inc., Workshop Facilitator ▪ Diane Turchetta, FHWA Office of Planning
1:30 – 2:45 pm	Setting the Stage - Presentations from: ▪ Kelly McGourty, Puget Sound Regional Council (WA) ▪ Anne McGahan, Boston MPO (MA)
2:45 – 3:00 pm	Break
3:00 – 5:15 pm	Presentation & Discussion – Workshop Participants' Interests, Issues and Objectives (summary of pre-workshop questionnaire responses) – Peter Plumeau Roundtable – Each Participant Provides Briefing on Current Situation
6:00 – 8:00 pm	Dinner (location TBD)

Friday, March 7

7:30 – 8:00 am	Continental Breakfast
8:00 – 8:30 am	Pinpoint Key Issues for Breakout Group Discussions
8:30-10:00 am	Facilitated Breakout Group Discussions on Issues, Options and Needs – Part 1
9:45 – 10:00 am	Break
10:00 – 11:45 pm	Facilitated Breakout Group Discussions on Issues, Options and Needs – Part 2**

* Note: All activities are at Puget Sound Regional Council offices unless otherwise noted.
** Each participant will change a different topic area in the second part of breakout groups.

12:00 – 1:00 pm	Lunch – Networking & Open Discussion
1:00 – 1:30 pm	Breakout Group Results – reports & facilitated discussion
1:30 – 2:30 pm	Key themes, issues and needs for MPOs ▪ Develop high-level outline of workshop report ▪ Possible topics/issues for future workshops
2:30 – 3:00 pm	Closing Comments ▪ Diane Turchetta, FHWA Office of Planning ▪ Peter Plumeau, RSG
3:00 pm	Adjourn

MPO PEER WORKSHOP ON PLANNING FOR CLIMATE CHANGE

MARCH 6-7, 2008

SUMMARY OF PRE-WORKSHOP ASSIGNMENT RESPONSES

1. How is your MPO addressing climate change issues in the LRTP and overall planning activities? What planning tools (e.g., modeling) have you used in this effort?

    - Minimal focus on the connection between climate change and transportation, however air quality and quality of life are incorporated into the plan.
    - Future plans to address climate change include:
        - A series of conferences featuring national/international speakers, including the topics of sustainability, air quality and climate change.
        - A program to assist local governments in reducing their environmental impact, specifically with regard to transportation and air quality via reducing VMT and increasing fleet efficiency.
    - Created a regional growth visioning effort, collaborating with 5 MPOs, 2 RPCs, and several other organizations, which is based on four principles: conservation, countryside, centers, and corridors. This document will shape the development of future LRTP updates, and is currently in the implementation phase.
    - Adopted targets geared toward reducing greenhouse emission, including reduction of VMT, congestion, travel time, and single-occupant vehicles, and increasing percent non-motorized trip share and transit mode share.
    - Updated the travel demand model to include climate change related performance measures, including CO reduction, proportion of population and employment within major activity centers and proportion of population within ¼ mile of transit.
    - The next LRTP will include a comparative analysis that estimates greenhouse gas emissions and air quality criteria under two scenarios: current trend and 20 year development plans.
    - Including policies and proposed actions in Vision 2040, an overall growth, transportation, and economic strategy. These new policies will be incorporated into the LRTP.
    - Improving travel demand model to better analyze transportation and land use strategies that are proposed as mitigation to climate change.
    - Working with FHWA and EPA on utilizing the draft MOVES model to analyze greenhouse gas emissions from new transportation strategies.
    - Assessed impacts of investment alternatives on CO_2 as part of the RTP environmental impact report (required in the state of California).

- Selected CO_2 as one of six key performance measures to assess projects for consideration in the fiscally constrained RTP. (The other five measures were delay, PM emissions, accident reductions, VMT reduction, and affordability).
- Will use a multiplier of VMT for greenhouse gas emissions for autos, transit, and freight. Will produce a land use plan, which will have an independent effect on greenhouse gas emissions via residential density and energy efficiency measures. Will potentially need to consider alternative fuels' impact on greenhouse gas emissions.
- Lots of research, no modeling.
- Will contract with a consultant to assist the MPO with modeling greenhouse gas emissions from transportation.
- Several MPOs did not address climate change in their LRTP and had few planning activities that related to the workshop topic primarily because these MPOs are in attainment areas. However, climate change plans for these MPOs include:
  - The LRTP does include a section on environmental mitigation.
  - Extensive environmental planning, primarily with respect to protection and preservation of the Illinois River (susceptible to erosion). Thus, this MPO is developing land use policies and ordinances to address this problem, which encourages sustainable development and conservation practices.
  - Anticipate that state mandated emissions reductions will force a change in the MPO plans.
  - Discussions within the MPO Board about how to address climate change. The MPO is unsure whether climate change would be directly referenced in the plans or if existing strategies (that currently aim to reduce greenhouse gas emissions) would be enhanced.
- One MPO did not address climate change in their LRTP and had no planning activities other than those associated with their non-attainment status. These activities include:
  - Emission reduction strategies
  - Effective transportation networks
  - Aggressive investment in the expansion of the transit network and modes.

2. What are your MPO's sources of information for climate change planning and analysis?
   - National/International
     - Department of Transportation
     - Department of Environmental and Natural Resources EPA State Inventory Tool

- IPCC Assessment reports
- EPA
- FHWA
- Transportation Research Board meeting
- Peers in the United States and European Union

- State
  - Georgia EPD for air quality issues
  - Department of Transportation
  - Department of Ecology
  - California Air Resources emission and vehicle fleet data
  - State-level policy statements
  - Maryland Climate Change Commission
  - Governor's blue ribbon council on climate initiatives
- Local
  - The association of cities and counties
  - Utility companies for electric and gas usage
  - Municipal governments for local operations such as buildings, fleet, solid waste water and sewage
  - School Districts/Systems, Universities, etc.
  - County planning offices
  - Local greenhouse gas plans
  - Center for Neighborhood Technology
- Other
  - Data from other research efforts
  - News media
  - Websites
  - Academic papers

- Other MPOs
- Conferences and workshops on climate change planning and analysis
- Pew Center
- Travel demand model
- Smart Growth America (*Growing Cooler* publication)
- Best practice reports

- Universities
  - Contract with Dr. C. David Cooper, a national recognized air quality expert at University of Central Florida, to perform a transportation emissions inventory and evaluate emission reduction strategies.
  - The Land Assessment and impact Evaluation Model (LEAM) developed by the University of Illinois, which can measure environmental impacts such as carbon emissions under various growth scenarios.
  - University of Washington Climate Impacts Group

3. How do you coordinate with other planning and operating agencies (e.g., land use agencies, environmental agencies, transit agency, etc.)? How are state and local governments?

   - Through an interagency consultation group which includes all federal and state transportation partners, USEPA, Georgia EPD and local transit providers.
   - Local governments, planning agencies and transportation operating agencies take an active role at the technical staff level and on the MPOs policy Board.
   - Met with Governor's staff to support and coordinate efforts.
   - Participate in Mayor's campaign to reduce greenhouse gas emissions and call attention to importance of climate change.
   - Coordinate closely with the following entities through good working relationships:
     - Local agencies – ports, counties, cities, and school districts.
     - State agencies – rail, marine, transit, trails, and highways.
     - Federal agencies – FHWA, DOT, FTA, EPA, etc.
     - Elected officials
   - Many of these functions are in-house. Staff works cooperatively and is cross-trained in transportation, land use, and environmental planning.

- Via the MPO technical committee (public works staff) and policy committee (elected officials).
- Monthly coordination meetings and technical meetings (the latter was formalized through the last LRTP update).
- A region-wide future planning initiative (The Wasatch Choices – 2040 Initiative) brings most planning agencies in the state to the table.
- Coordinate with agencies through other planning processes, including the Department of Environmental Conservation for the LRTP update.
- Local "Green Team" comprised of city and county departments and other agencies.
- Through a variety of MPO committees.
- Local council of governments to provide socio-economic data for travel demand model.
- Bay Area Partnership Board, which is made up of executives from federal, state, transit and local agencies that advise the Commission in areas of transportation planning and financing.
- Colorado Department of Public Health and the Environment uses the output from the MPO's travel model for air quality modeling.
- Work with the Regional Air Quality Council on developing and implementing the SIP.
- Strong partnerships with the Metro Mayors Caucus and Colorado Counties, Inc.

4. Do you work with other MPOs in your state on climate change planning? How?

- Yes. Interagency meetings and collegial relationships are the primary source for collaboration.
- Yes. The six local MPOs developed a regional growth vision with climate change as a topic. However, this issue requires additional emphasis.
- Yes. Plan to discuss climate change at next MPO Advisory Council meeting that brings together all MPOs in the state.
- Yes. There is a monthly coordination meeting for all MPOs in the state.
- No, not at this time.
- No. There is a state association of MPOs with an annual conference, but climate change has not been addressed to date.
- No. Probably will in the future via the state's long-range planning efforts.

- No. Philosophical and ideological differences between MPOs create blockages to coordination. However, due to recent circumstances, there may be opportunity for communication to open up in the future.
- No. Other MPOs in the state have not done any climate change planning to date.
- No, but the MPO is trying to initiate a "Front Range Transportation Planning Program" that could potentially include climate change as an issue.

5. To what extent have you engaged the public in climate change planning? How?

- No specific focus on engaging the public on this topic [yet], but the public has been indirectly involved through:
  - Activities supporting RTP development.
  - Regional growth visioning process.
  - Strategic planning efforts related to transit service.
  - Environmental planning (for example, workshops for homeowners on various topics such as forest management and stream bank stabilization)
  - Public meetings allow for the opportunity to comment on all transportation plans, including the LRTP and TIP.
  - Information and surveys on MPO website.
  - Local grassroots and local government efforts to address climate change.
  - Presentations at the MPO Board meetings.
- Plans were guided by citizen's committees, including a public forum and public hearing.
- Public and focused workshops.
- Telephone polls.
- Input from citizen advisory committees at regularly scheduled monthly meetings.
- Regular briefings to the Commission at monthly meetings which are open to the public.
- Held a conference in December 2007 on climate change (~150 people).
- Released a white paper that committed the MPO to addressing climate change in the LRTP.
- MPO Executive Director invited to speak on local climate change-focused panels.
- E-newsletter sent out on environmental issues related to transportation.

6. What obstacles, if any, affect your ability to address and integrate climate change issues into your plans and planning process (e.g., technical ability, staffing constraints, adequacy of information, institutional coordination & communication, etc.)?

    - Technical ability
    - Data and information integrity and availability
    - Integrating models into the planning process
    - Other issues, such as transportation funding and congestion strategies, have higher perceived priority than climate change
    - Doubt [from some] that climate change is a problem
    - Individual actions are considered insignificant (scale of problem is too large)
    - More science-based information is needed in an easily understood format
    - Gap between theoretical and pragmatic responses
    - Managing change on an unprecedented scale
    - Finding a dynamic, multi-responsive, flexible solution
    - Getting the public to realize the impact of climate change
    - No regulatory authority to implement plans
    - Measurement techniques
    - Guidance on how to prevent non-attainment status
    - Resource constraints
    - Political support
    - Staffing constraints
    - No obstacles yet (not addressing the topic)
    - Finding locally relevant data and developing locally relevant analysis
    - Software that is available is difficult to use and/or inaccurate for small project scale.
    - Anticipated changes in U.S. standards for greenhouse gas emissions for vehicles
    - Addressing climate change from a 30-year planning perspective.
    - Finding a role for the MPO in the greenhouse gas emissions reduction goals.
    - Lack of funding causes partner agencies to question importance of climate-focused projects.

Puget Sound Regional Council
PSRC

PLANNING FOR CLIMATE CHANGE IN THE PUGET SOUND REGION

Washington State Activities

- Executive Order 07-02: Washington Climate Change Challenge
    - increase in clean energy jobs, reduce reliance on imported fuels, greenhouse gas emission reduction goals to:
        - **1990 levels by 2020;**
        - **25% below 1990 levels by 2035;**
        - **50% below 1990 levels by 2050**

- SB6001: adopts into law the Governor's emission reduction goals, sets performance standards for electric utilities

- HB 1303: directs the state to analyze vehicle electrification, sets goal for all state fleets to run on electricity or biofuel by 2015

- Other actions
    - Clean Car Standards (affected by EPA denial of CA's petition)
    - Western Regional Climate Action Initiative
    - Climate Registry
    - Initiative 937 – large utilities required to meet 15% of their annual load with renewable energy resources by 2020

- Climate Advisory Team established to recommend strategies for meeting the Climate Change Challenge

    - Draft report released for public comment, extended through January 22, 2008
    - Five sectors: transportation, agriculture, energy, forestry, residential/commercial/industrial
    - 45 recommendations
    - 13 Transportation recommendations, including ridesharing/transit programs, VMT reduction goals, pricing, transit-oriented development, bicycle/pedestrian infrastructure
    - Recommendations due to Governor by February 7, 2008

- Current legislative action: green jobs, VMT reduction goals, emissions reporting, etc.

Local Activities

- **King County**
  - Global Warming Action Plan: goal to reduce emissions by 80% below current levels by 2050
  - Climate Preparedness Guidebook
  - Renewable Energy Order – renewable energy and efficiency requirements
  - GHG emissions included in State Environmental Policy Act reviews

- **Seattle**
  - Climate Action Plan
  - Launched the US Mayors Climate Protection Agreement - 21 Puget Sound cities, 3 counties have joined
  - Seattle Climate Partnership
  - City Light Net Zero GHG Emissions Goal

- **Tacoma**
  - Green Ribbon Climate Action Task Force

- **Snohomish County**
  - Executive Order to address climate change

PSRC Activities

- **Draft Vision 2040 (the region's growth, environmental, transportation and economic strategy)**

  - New environmental framework includes climate change
  - Policies related to climate change
    - MP-En-3: [partial] Reduce the impacts of transportation on air and water quality and climate change
    - MP-En-20: [partial] Address the central Puget Sound region's contribution to climate change by, at a minimum, committing to comply with state initiatives and directives regarding climate change and the reduction of greenhouse gases
  - Climate change addressed throughout the document – environment, transportation, development patterns, etc.
  - Goal: The region will reduce its overall production of harmful elements that contribute to climate change**.**
  - Action: Regional Climate Action Plan

- **Destination 2030 Update (the region's long-range metropolitan transportation plan)**

  - Per Board direction, climate change included as an issue in the scoping process
  - Issues include:
    - How do we address climate change in the Destination 2030 update?
    - How do we address both mitigation (e.g., reducing emissions) and adaptation (to predicted impacts such as flooding, roadway deterioration)?
    - How should energy consumption (e.g., reliance on foreign oil) be addressed?
    - How do we address the state emission reduction goals?
    - Should there be specific alternatives or strategies included?

- **Technical Work**
    - FHWA grant for improvements to PSRC's travel demand model
        - To more accurately answer questions related to the impacts on climate change, greenhouse gas emissions from various strategies such as pricing, TDM, land use
    - Working with FHWA, EPA on access to the new, improved emissions model (MOVES)
        - Ability to analyze carbon dioxide emissions by varying speeds, currently unavailable in the existing model
        - Pilot project for early release of the model
    - Creation of Climate Change Technical Working Group
        - Air quality consultation partners, major regional agencies to discuss technical needs and regional consistency for analyses
        - Soon to be expanded with additional members
    - Case Study with the Volpe Institute
        - Best practices for integrating climate change into planning processes

DRAFT

Carbon Dioxide, Climate Change, and the Boston Region MPO

A Discussion Paper

Boston Region MPO Staff

Prepared by Ben Rasmussen

August 2007

Reviewers:
Cathy Lewis
Anne McGahan
Scott Peterson
Karl Quackenbush
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Carbon Dioxide, Climate Change, and the Boston Region MPO

August 2007

INTRODUCTION

Climate change will likely have significant impacts on the Boston region. If climate trends continue as projected, the climate and weather patterns in Boston at the end of this century will look more like those now found in Richmond, Virginia, or Atlanta, Georgia.[1] More severe weather events, a rise in sea level coupled with storm-induced flooding, and warmer temperatures would impact the region's infrastructure, economy, human health, and natural resources.

Greenhouse gases (GHG) contribute to climate change, and 84% of the United States' GHG emissions are composed of carbon dioxide (CO_2), a common emission from motor vehicles and the burning of fossil fuels.[2] In Massachusetts, transportation sources emit more CO_2 than any other sources.

Transportation planning policies and decision-making can affect a reduction in the transportation sector's CO_2 emissions. To have a significant effect, however, some important considerations and trade-offs must be faced. Improving mobility for alternative mode users, particularly transit, may result in reduced mobility for motorists. For example, shifts in investments to increase transit mode split may reduce funding for highway projects.

The purpose of this document is threefold. Part I provides the Boston Region Metropolitan Planning Organization with an overview of climate change and its local impacts. Part II provides a summary of the MPO's plans and programs that are already resulting in the reduction of GHG emissions. Part III provides specific potential "next step" actions to deliberately continue existing programs or start additional GHG-reducing initiatives.

Current Policy Context

To better understand the current political context surrounding climate change, this section outlines current policies in the region that are relevant to climate change and CO_2 emissions. In August 2001, the Conference of New England Governors and Eastern Canadian Premiers (NEG/ECP) adopted the first and only regional action plan in North America for addressing climate change. This agreement, known as the Climate Change Action Plan 2001, reflected the conviction of the NEG/ECP that climate change is a significant environmental concern that will have a major impact on the region's environment and economy. In 2004, the Massachusetts Climate Protection Plan adopted the same targets as the Climate Change Action Plan 2001.

With the Climate Change Action Plan, the NEG/ECP, and subsequently the Commonwealth, made a commitment to take steps to address climate change by setting specific GHG emission reduction targets for the region and the Commonwealth:

- Short-term: Reduce GHG emissions to 1990 levels by the year 2010.

- Medium-term: Reduce GHG emissions 10% below 1990 levels by the year 2020.
- Long-term: Reduce GHG emissions sufficiently to eliminate any dangerous threat to the climate; current science suggests this will require reductions as much as 75–85% below current levels.

In line with these targets, Governor Deval Patrick signed the Regional Greenhouse Gas Initiative (RGGI) in January 2007, committing Massachusetts to a multi-state effort to reduce emissions of CO_2 and address global climate change. States participating in RGGI are developing a regional strategy for controlling emissions, including a market-based, multi-state cap-and-trade program[3] that will require electric power generators to reduce their emissions of CO_2.

On April 2, 2007, the Supreme Court ruled in "Massachusetts v. Environmental Protection Agency" that the Environmental Protection Agency (EPA) has the authority to regulate heat-trapping gases in automobile emissions. The decision increases the likelihood that the EPA will approve Massachusetts's and 11 other states' programs to limit tailpipe emissions, beginning with the 2009 model year.

On April 12, 2007, Mayor Menino enacted an executive order that requires Boston city government to cut GHG emissions to 80 percent below 1990 levels by the year 2050. As a first step, the city government must cut emissions by seven percent below 1990 levels by 2012.

Six days later, Governor Patrick signed an executive order that directs agencies to cut energy use 20 percent below 2002 levels by 2012 and 35 percent by 2020. It also requires them to cut their GHG emissions to 25 percent below 2002 levels over the next five years, to 40 percent by 2020, and to 80 percent by 2050.

Most recently, Governor Patrick changed Massachusetts environmental policy so that private developers planning projects large enough to warrant a state environmental review are required to estimate GHG emissions for these projects and reduce the emissions with measures such as energy-efficient lighting, alternative fuels, or commuter shuttles. This policy change takes impacts such as emissions from smokestacks and heating with fossil fuels into consideration, as well as the effect of thousands of workers driving to a new development.

PART I: OVERVIEW OF CLIMATE CHANGE

Climate change refers to unstable weather patterns caused by increases in the average global temperature. There is a consensus among climate scientists that these changes result from atmospheric concentrations of CO_2, methane (CH_4), nitrous oxide (N_2O), and other heat-trapping gases. These GHGs form a blanket of pollution that stays in the atmosphere.

Increasing concentrations of GHGs are causing a rise in average global temperatures. Greenhouse gases warm the earth's atmosphere and are so-called because they simulate the effect of a greenhouse, trapping heat within the atmosphere and contributing to an increase in the earth's temperature. GHGs may be the fundamental cause of sea level rise and climate instability

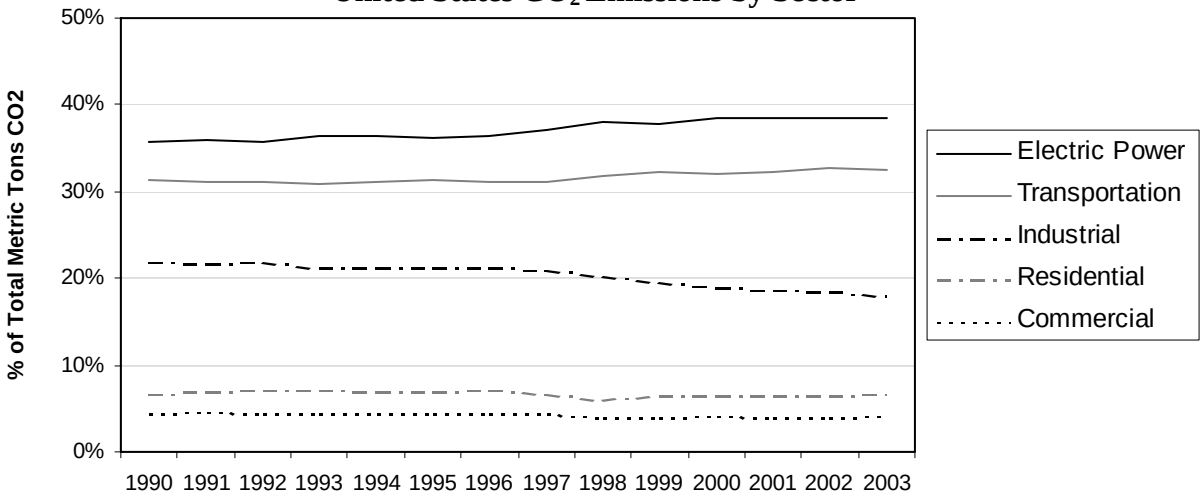
characterized by severe weather events such as storms, droughts, floods, and heat waves. Appendix A contains information on global climate change trends and impacts.

National, Regional, and State Trends and Impacts

Trends

The United States is responsible for more than one-third (36%) of the world's CO_2 emissions – more than any other country.[4] In the United States, CO_2 emissions rose 20.4% percent between 1990 and 2005.[5, 6] As a sector, transportation is the second largest CO_2 emitter in the United States (Figure 1).

FIGURE 1
United States CO_2 Emissions by Sector[7]



Emissions per capita in Massachusetts are lower than the national average, with the state emitting 1.9% of the total CO_2 emitted in the U.S. while housing 2.4% of the population, but it is still a comparatively large amount of the world's GHG emissions. Massachusetts' emissions are likely lower than other states per capita due to relatively cleaner energy sources and to there being a high proportion of people living in the inner core area in and around Boston, where population densities are high, work and other destinations are close by, and transit alternatives are available. Overall, Massachusetts ranks 25th in total state CO_2 emissions.

FIGURE 2
Massachusetts CO_2 Emissions by Sector (2003)[8]

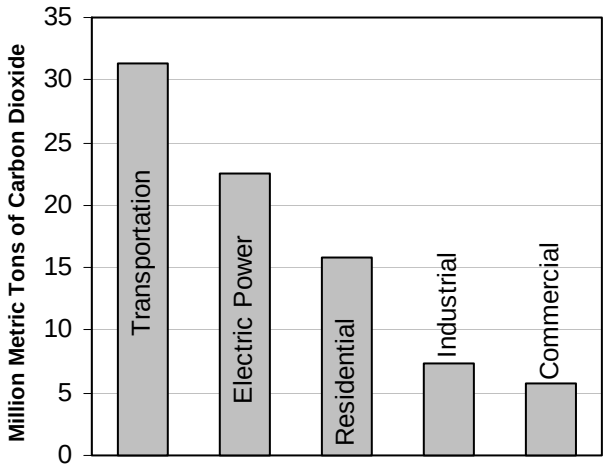
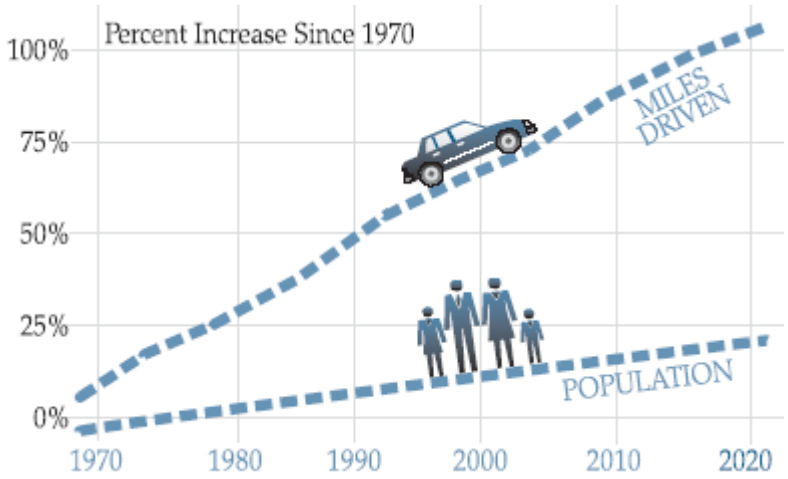


Figure 2 shows that CO_2 emissions are higher for the transportation sector than for any other sector in Massachusetts. Between 1990 and 1998, annual vehicle miles traveled (VMT) in Massachusetts rose 13%, from 45 billion miles to 51 billion miles. Figure 3 shows how VMT is outpacing population growth in the Commonwealth.

FIGURE 3
Miles Driven and Population Growth in Massachusetts[9]



Massachusetts anticipates a 33% overall increase in CO_2 from the transportation sector between 1990 and 2020.[10] This is due in part to increasing VMT, but is even more attributable to increasing sales of less efficient vehicles, which include light trucks and sport utility vehicles.[11] Additionally, diesel fuel, the predominant fuel for freight, is a major source of GHG emissions in Massachusetts. National projections in 2004 showed diesel fuel consumption growing 14% from 1997 to 2010, which represents an increase of more than 40% above 1990 levels.[12] Although modest efficiency gains in all forms of freight transportation are expected over the next decade, they will be offset by increased freight travel as more goods are produced and consumed for a growing national population. Vehicle miles traveled by heavy-duty trucks are expected to

increase by nearly 24% from 1998 to 2010, according to projections from the U.S. Energy Information Administration.[13]

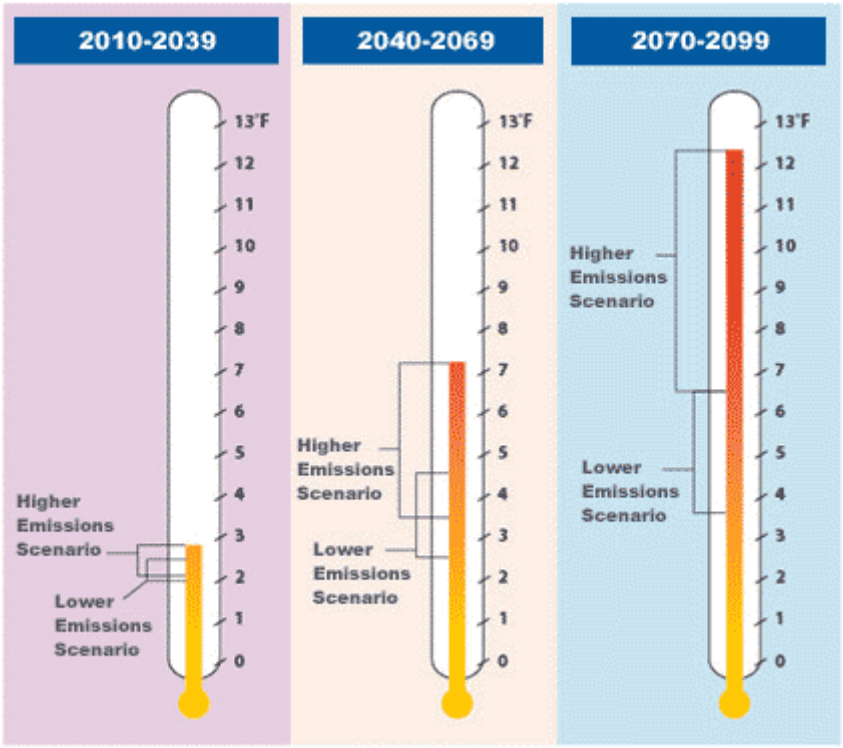
Impacts

Historically, sea level rose 11" along the coast of Massachusetts in the last century.[14] Over the same time period, precipitation increased 16.8% and temperatures increased 1.7°F in coastal areas of New England.[15] For parts of New England, wintertime warming has been nearly three times the summertime warming.[16]

Temperature Increases

The Union of Concerned Scientists recently developed two GHG emissions scenarios and examined their impacts on temperature increases for the Northeast (which includes New England, New York, New Jersey, and Pennsylvania) and Massachusetts. The higher emissions scenario represents a continued heavy reliance on fossils fuels, causing heat-trapping emissions to rise significantly over the century. The lower-emissions scenario represents a shift away from fossil fuels in favor of clean energy technologies, causing heat-trapping emissions to decline by mid-century. Both scenarios assume a world with high economic growth and a global population that peaks mid-century and then declines. Based on these scenarios, temperatures in New England could increase on average by 3.5° F to 12° F by 2100 (Figure 4).[17]

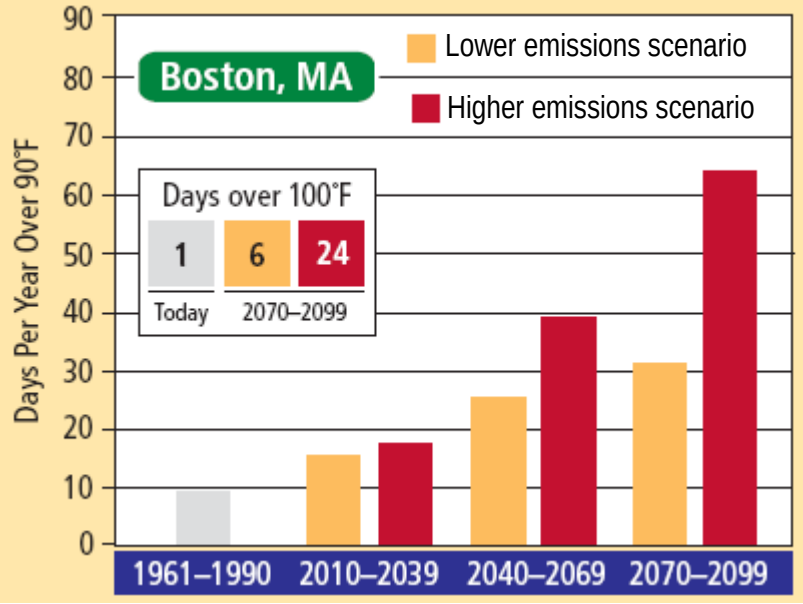
FIGURE 4:
Changes in Average Annual Temperature in New England[18]



Under these scenarios, this study determined that Boston, which previously experienced an average of 10 days per year with temperatures exceeding 90°F, would have up to 63 such days by 2100 with 24 days over 100°F (Figure 5).[19] Such increases in extremely hot days may result in an appreciable increase in high-energy consumption days and the need for requisite peaking units, which are ancillary electricity-producing facilities.[20]

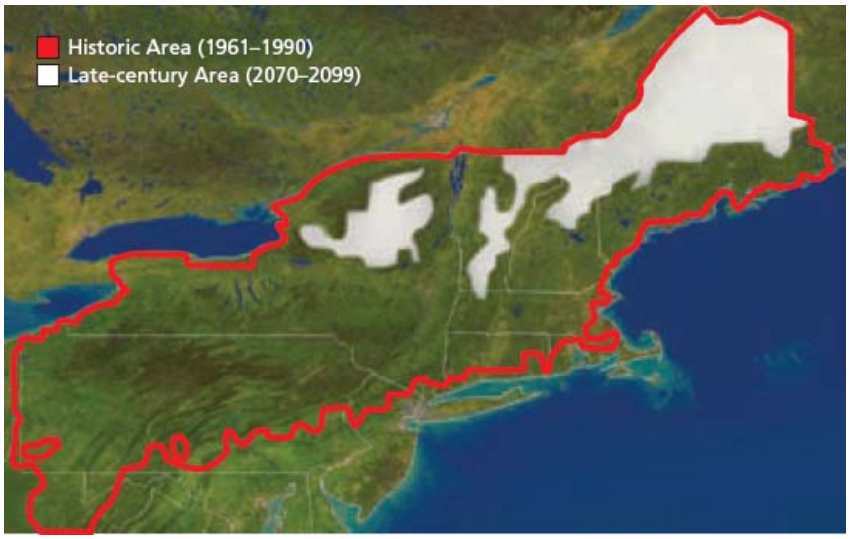
Hotter weather with more frequent and severe heat waves also pose multiple health risks that include a rise in heat-related illness, more frequent periods of harmful outdoor air quality, and the spread of certain diseases.[21] Those most at risk from high and continuous heat include the elderly, young children, and people who already suffer from certain illnesses, particularly heart disease.[22] In Boston, elevated heat-stress mortality rates occur in certain lower-income and immigrant neighborhoods, suggesting that these communities are more socially vulnerable to heat than others.[23]

FIGURE 5:
Extreme Heat in Boston[24]



Higher temperatures and a changing climate translate into less snow for the Northeast. Figure 6 shows that far less of the Northeast will experience a typical snow season toward the end of the century under the higher emissions scenario. The red line in the map shows the area of the northeastern United States that had at least a dusting of snow on the ground for at least 30 days in the average year. The white area shows the projected retreat of this snow cover by the end of this century.

FIGURE 6
The Changing Face of Winter[25]



Air Quality

Hotter summers could set the stage for an increase in the number of days that fail to meet federal air-quality standards.[26] In the absence of more stringent controls on ozone-forming pollutants, the number of days with poor air quality is projected to quadruple in Boston under the higher-emissions scenario.[27] Such days could increase by half under the lower-emissions scenario.[28] Deteriorating air quality would exacerbate the risk of respiratory, cardiovascular, and other ailments in Massachusetts, which already has the highest rate of adult asthma in the United States.[29] In Boston, eight-hour maximum ground-level ozone concentrations are projected to increase 13 to 21 percent under the higher-emissions scenario and zero to five percent under the lower-emissions scenario.[30]

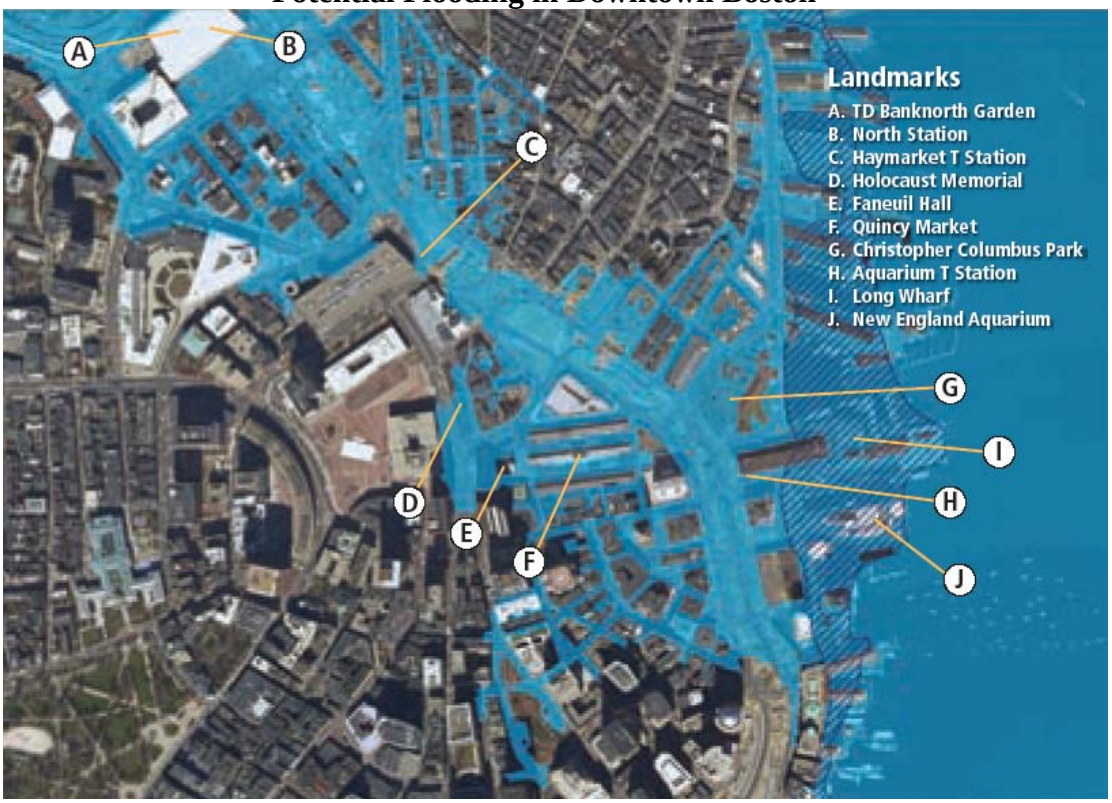
Sea Level Rise and Flooding

Massachusetts and all coastal states will lose beachfront in the coming years as climate change causes rising sea levels and stronger coastal storms.[31] By the end of the century, sea levels are expected to rise four to 21 inches under the lower-emissions scenario and eight to 33 inches under the higher-emissions scenario, with the potential for additional increases due to more rapid melting of major polar ice sheets.[32] Regardless of scenario, Boston can expect a coastal flood equivalent to today's 100-year flood every two to four years on average by mid-century and almost annually by the end of the century.[33]

As today's 100-year maximum flood height of 9.7 feet becomes a more common occurrence in Boston, the new 100-year maximum flood height is projected to rise to more than 12 feet under the higher-emissions scenario by the end of this century.[34] This means that many more existing buildings and properties as well as associated transportation and other infrastructure will be at risk of flooding. Figure 7 shows the current Federal Emergency Management Agency 100-year flood zone (hatched darker blue) as well as the extent of the projected 100-year flood zone in 2100 (lighter blue) under the higher-emissions scenario for the waterfront/Government Center

area of Boston.[35] Under this scenario, important Boston landmarks (such as Faneuil Hall) and transportation infrastructure currently not at great risk of flooding could witness repeated flooding in the future unless they are protected from such events beforehand.[36] Flood elevations under the lower-emissions scenario are roughly half a foot lower than the flooding depicted in this figure (but are still two feet higher than the current 100-year flood).[37]

FIGURE 7
Potential Flooding in Downtown Boston[38]



The Commonwealth has a very high risk of coastal and river flooding because of its long coastline, numerous rivers and streams, and concentrated development in combination with high exposure to heavy rainstorms, hurricanes, and nor'easters. One study estimates that property damage and emergency services due to rises in sea level over the next 100 years could range from $20 billion to $94 billion if there are no adaptive responses except rebuilding after floods.[39] For more information on the impact of sea level rise and flooding in the Boston region, please see Appendix B.

Transportation Impacts

The principal way in which climate change will affect the transportation system is through extreme climate events, in particular events that produce significant flooding or snowfall. Sea level rise impacts will become evident during extreme events when storm tides will be higher, increasing the frequency and severity of coastal flooding. In economic terms, the impacts of extreme weather events on the transportation system are of two types.

The first is the damage inflicted upon infrastructure, such as flood damage to road, rail, and bridges. According to the Union of Concerned Scientists report, "In 1996, heavy rains raised the level of Boston's Muddy River, flooding a tunnel entrance to the 'T,' the city's subway system. The damage from this flooding closed a busy subway line for several weeks and cost… roughly $75 million. While the main reason for this damage and disruption is simple—the tunnel entrance was not flood-proof—it also underscores the broader vulnerability of Boston's transportation infrastructure: its subway system—the country's oldest—was not built with certain conditions in mind, including significantly higher sea levels and storm surges."[40]

The second is the economic cost of interruptions in the operation of the transportation systems, which prevent, for example, employees from going to work, shoppers from getting to stores, and goods from being delivered. One study estimates that traffic delay due to flood events over the course of the 21st century in the Boston region may increase by about 80% and lost trips over the same period may increase by 82% over delay and lost trips that would be expected in the absence of climate change.[41]

Social, Economic, and Natural Impacts

New England and Massachusetts may be affected by climate change in several other ways. These impacts are attributable, at least in part, to temperature increases and sea level rise. All of these impacts have economic implications since important Massachusetts industries such as tourism and agriculture rely on the state's climate and natural resources.[42] These impacts include more frequent and damaging weather events, water shortages, and adverse changes in the state's ecosystems, native species, and commercial fish stocks.[43]

PART II: CURRENT MPO POLICY AND ACTION

As stated in JOURNEY TO 2030, the MPO's current long-range transportation plan, the MPO will continue to support projects and programs to reduce emissions of CO_2 in the region. Several of the policies and visions that the MPO created to guide the development of JOURNEY TO 2030 and to steer decision-making for transportation in the region may lead to MPO actions that may reduce GHG emissions over time. Primarily, these policies can be found under the Environment, Land Use and Economic Development, and Mobility topics in the plan. A few of the policies under the System Preservation, Modernization, and Efficiency; Safety and Security; and Public Participation topics may also lead to ways the MPO can reduce GHG emissions in the region. Appendix C lists the policies that may lead to a reduction of GHG emissions over time.

There are three basic ways the MPO and its partners currently work to reduce GHG emissions. First, the MPO funds projects that provide people with transportation options other than single-occupancy vehicles (SOVs) to travel to work, school, and other destinations. Alternative modes to SOVs include transit, bicycling, walking, and carpooling. Second, MPO investments, such as the reconstruction of intersections, reduce VMT and roadway congestion, therefore cutting back emissions. Third, the MPO funds the use of alternative fuels, which release less GHG emissions than traditional fossil fuels. This third method is discussed within the context of the other two methods as described below.

Alternative Modes

Transit

One American person using mass transit for an entire year, instead of driving to work, can keep an average of over 5,000 pounds of CO_2 from being discharged into the air, and one full, 40-foot bus takes 58 cars off the road.[44] A 10 percent nationwide increase in transit ridership would save 135 million gallons of gasoline a year and prevent 2.7 billion pounds of CO_2 being added to the atmosphere (one gallon of gasoline creates 20 pounds of CO_2).[45, 46]

The Massachusetts Bay Transportation Authority (MBTA) is a significant part of the region's transportation system, both by providing people with an alternative to SOVs and by running buses, subways, trains, and maintenance and operations vehicles throughout the region. The Massachusetts Bay Transportation Authority's (MBTA) 2003 long-range capital planning document, the Program for Mass Transportation (PMT), contained information for each project's projected percentage reduction in CO_2 emissions on weekdays regionwide and on the ratio between the capital cost of the project and the anticipated reduction in CO_2 emissions on weekdays regionwide. The 2008 PMT will consider how the MBTA's CO_2 emissions reduction goals fit into state and other CO_2 emissions reduction goals.

In line with the PMT and JOURNEY TO 2030, the MPO allocates millions of dollars of funding to transit projects annually. This funding is used to maintain, improve, and expand the existing transit system. Near-term transit upgrade projects include the Blue Line modernization, Fairmount Line improvements, the redevelopment of Ashmont Station, station accessibility improvements, and the procurement of new buses. Despite these expenditures, many un-met transit needs still persist in the region.

The MPO also allocates Congestion Mitigation and Air Quality (CMAQ) and transit funds for cleaner transit vehicles. In recent and coming years, these projects include: undertaking bus diesel retrofit programs, purchasing hybrid locomotive switches, monitoring and controlling bus emissions, and procuring emission control diesel buses.

Bicycle and Pedestrian Projects

Non-motorized (bicycle and pedestrian) transportation produces no emissions. According to the Regional Bicycle Plan, 66% of our trips, by any mode of transportation, are less than five miles; 68% of us live within two miles of a transit station; and 31% of us live within one mile of a shared-use path.[47] Despite these relatively short distances, bicycling remains a marginal transportation choice for work and errands, comprising less than 1% of trips in our region.[48] The Metropolitan Area Planning Council conducted a survey on bicycle issues in the region that identified reasons more people do not bicycle to work, to shop, or to visit friends. The survey found that approximately 45% of respondents would bicycle more often if the route were safer for bicycling.[49]

The MPO allocates funding for bicycle and pedestrian projects in the region to make the use of these modes of transportation safer, more attractive, and more viable as a mode choice. Over $23.7 million of the funding in the MPO's Federal Fiscal Years 2007-2009 Transportation Improvement Program (TIP) is programmed for bicycle and pedestrian projects using CMAQ funds. These projects mainly include multi-use paved paths. Recent projects include the Peabody Bikeway, the Upper Charles Trail in Milford, and a portion of the reconstruction of Somerville Avenue in Somerville. The MPO also funds a bicycle parking program and conducts studies and workshops to improve bicycling and walking conditions throughout the region in an effort to get more people to use these modes for traveling to work and running errands.

Massachusetts is one of three states that requires state agencies to accommodate bicycles and pedestrians into the design and construction of every project. This requirement is reflected in the Massachusetts Highway Department's *Project Development & Design Guide* (2006). The design guide provides for the accommodation of pedestrians and bicyclists in line with Chapter 87 of the Acts of 1996. By integrating these guidelines into their design, new roadway projects will accommodate both bicyclists and pedestrians.

Reduction of VMT and Roadway Congestion

Congestion Mitigation and Air Quality Improvement Program

The MPO programs funds for projects that help improve air quality and reduce traffic congestion as part of its CMAQ program. Projects eligible for funding under this program include public transportation improvements, traffic flow improvements (usually through intersections and interchanges), travel demand management, bicycle and pedestrian projects, alternative fuel projects, inspection and maintenance programs, intermodal freight transportation, public education and outreach, idle reduction technology, and intelligent transportation systems. Recent projects using CMAQ funds include the signalization and improvements on Route 28 in Reading, the bus diesel retrofit program, the suburban mobility program, and the region's bicycle parking program. In recent years, the MPO's target for spending CMAQ funds has been approximately $13 million a year.

Freight Projects

Freight transportation accounts for 6.3% of total CO_2 emissions in the United States.[50] Much of New England's freight is transported by truck, contributing to CO_2 emissions and congestion in the region. Among other reasons, the perishability and short-haul distances of many of the commodities transported in the region necessitates truck freight transportation. The MPO helps to decrease truck CO_2 emissions and improve freight mobility by funding projects that rehabilitate weight-restricted bridges and reduce congestion. For example, weight-restricted bridges in the region require detours of truck traffic that could take up to one and a half hours, thereby increasing traffic and CO_2 emissions.

Moving a larger percentage of freight by rail has the potential to reduce GHG emissions since trains are three times more fuel-efficient than trucks on a ton per mile basis. According to the American Society of Mechanical Engineers, if 10% of intercity freight now moving by highway

were shifted to rail, 2.5 million fewer tons of CO_2 would be emitted into the air annually nationwide.[51] An increase in the movement of rail freight via more frequent service in the Boston region would have to be coordinated with passenger rail operations so as not to diminish passenger service that may use the same tracks. Additional infrastructure would also be necessary to accommodate more frequent rail freight in the region.

One way of increasing the movement of rail freight without increasing the frequency of trains in the region is to double-stack rail cars. Double stack rail cars, which have two containers stacked on one another, move freight more efficiently than single stack cars. Since one rail car can carry as much as 3.5 truckloads, one double stack car can carry approximately seven truckloads. Since many bridges over rails in the Boston region are too low to accommodate double-stack rail cars – there are approximately 56 railroad bridges in the region with a vertical clearance of less than 21 feet, which is the threshold for double stack cars – it is Massachusetts policy that new bridges over rail lines, and bridges over rail lines that are scheduled for reconstruction, are built with a vertical clearance of 21 feet in order to accommodate double-stack rail cars.

PART III: FUTURE MPO ACTIVITIES

Because transportation is a significant source of CO_2 emissions in Massachusetts, slowing the growth of emissions in the transportation sector is important. While the MPO and its partners should continue the work that reduces CO_2 emissions as described above, there are several additional actions that can be taken to reduce GHG emissions in the region within the purview of the MPO. Some actions can be taken exclusively by the MPO, and other actions can be led or carried out by the MPO in partnership with other agencies and organizations.

While these actions can effect a reduction in the transportation sector's CO_2 emissions, some important considerations and trade-offs must be faced to have a significant effect. Improving mobility for alternative mode users, particularly transit, may result in reduced mobility for motorists. For example, shifts in investments to increase transit mode split may reduce funding for highway projects. These kinds of decisions over time could impact our current lifestyle through prohibiting or discouraging the continuance of our current travel behavior.

Other MPO Actions

Other MPOs are becoming increasingly involved in climate change issues and reducing CO_2 emissions. Since 2002, the New York State Department of Transportation has required that New York MPOs include estimates of energy use and GHG-related emissions in their TIPs and transportation plans with an analysis showing no-build versus build conditions.

The Board of Directors of the Metropolitan Washington Council of Governments in Washington, DC, recently adopted a regional initiative designed to address global climate change by controlling harmful emissions locally. The Board created a new Climate Change Steering Committee to make recommendations for reducing the region's GHG emissions. In addition to establishing a reduction goal for the region, the committee will consider several other action items, including:

- Measuring local GHG emissions and their impact on the region;
- Preparing a catalogue of activities currently underway in local jurisdictions;
- Identifying best practices for local governments; and
- Recommending climate change policy and potential advocacy positions on federal, state, and local climate change proposals.

During the update to its regional plan, the Puget Sound Regional Council (PSRC) in Seattle, Washington, received numerous comments urging the updated plan to address climate change. To integrate climate change into its planning process, PSRC drafted several goals and policies under its environment policy area that called for decreasing per-capita CO_2 emissions and energy use, increasing alternatives to driving alone, and preparing for climate change impacts. PSRC also models CO_2 emissions to compare alternative development scenarios as part of its long-range transportation planning process.

Goals

Lowering the transportation sector's GHG emissions in the Boston region requires:

- Creating a more efficient transportation system through supporting alternative modes and reducing congestion and VMT,
- Using more fuel-efficient and cleaner vehicles, and
- Making investments that support land uses that will reduce VMT.

Ways to achieve these goals are listed below.

Consistent with its policies, the MPO can adopt these goals and take steps to lead them. The MPO can add these goals to the list of policies under the Environment topic to integrate them into the MPO's current planning process.

The possible actions below are based on actions and ideas from the Massachusetts Climate Protection Plan, other MPOs, MPO staff, and other sources. Each possible action is broadly categorized as something that can be accomplished in the short-term, mid-term, long-term, or a combination thereof.

A Transportation System that Emits Less GHG Emissions

If desired, the Boston Region MPO can create a transportation system that curtails the anticipated growth of GHG emissions and reduces current emissions. Spending decisions would be based on reducing transportation-related CO_2 emissions in the region by encouraging people to travel in more climate friendly ways, such as taking transit, ride-sharing, bicycling, and walking; alleviating congestion; and ultimately reducing VMT. To attain this goal, the MPO can take some of or all of the following actions.

Possible MPO Actions:

- *Short-Term* – Model CO_2 emissions with the region's transportation model. With the appropriate programming, the region's transportation model can provide the MPO with information on the CO_2 emissions of existing and/or future transportation networks. This information can be reported alongside other emissions that MPO staff routinely models and compared to see the relative benefits of some investments.
- *Short-Term* – Enhance transportation planning and decision-making criteria.
  - Add CO_2 emissions as criteria in transportation decisions. By adopting criteria that estimates a project's CO_2 emissions for Plan and TIP projects, the MPO can be informed on what projects' CO_2 emissions will be and can make decisions accordingly.
  - Use Plan and TIP criteria to support GHG-reducing programs and projects. Give greater emphasis to Plan and TIP criteria and projects that support sustainable land use and transit-oriented development; that promote transit, ridesharing, and TDM coordination; and that include bicycle and pedestrian improvements that will generate significant use of these modes.
- *Short- to Long-Term* – Fund pedestrian and bicycling programs and facilities that are likely to result in auto trips being replaced by non-motorized trips. Planning and infrastructure investments can improve and increase non-motorized transportation.
- *Short-Term* – Create a CMAQ-funded program in the TIP to implement minor and simple pedestrian, bicycle, and congestion-relieving intersection improvements recommended in MPO studies.
- *Short- to Mid-Term* – Conduct an inventory of successful transportation-related climate change-curbing activities that agencies and municipalities in the region are undertaking. Develop best practices for agencies and municipalities in the region based on this inventory and relevant national best practices.
- *Mid-Term* – Continue to support transit agencies in their efforts to increase parking at train stations to encourage greater use of public transit. Increased parking spaces at crowded train stations would encourage more people to drive to transit, thereby shortening their overall auto trip. These studies would also consider train capacity since trains would need to have enough available capacity to accommodate any additional riders.
- *Mid- to Long-Term* – Favor transit investments near commercial or residential development. Providing transit stations near commercial or residential development can increase transit mode share and reduce VMT.

Possible MPO Interest/Partnership Opportunities:

- *Short- to Long-Term* – Maintain and upgrade public transit service and improve the efficiency of transit vehicle operations. Funding projects that improve facilities and services and that enhance the capacity of the region's transit system can increase the number of transit riders and decrease the number of cars on the region's roads.
- *Mid- to Long-Term* – Support the expansion of ride-sharing and carpool programs and high-occupancy vehicle (HOV) lanes in the region to promote efficient travel. More visibility and encouragement to use existing ride-share lots, and the creation of more ride-share lots, can lead to more carpooling in the region. More HOV lanes in the region would provide an additional incentive for people to carpool.

Promote Fuel-Efficiency and Cleaner Vehicles

Possible MPO Actions:

- *Short- to Long-Term* – Continue to fund transit vehicle retrofits and the purchasing of cleaner motor vehicles and train engines in public transit fleets. Cleaner transit by purchasing more efficient vehicles can curb global warming emissions by 10 to 15 percent compared with conventional buses.[52] Cleaner train engine technology can also help to reduce diesel soot and particulates.[53]
- *Short- to Long-Term* – Upgrade bridges to lift weight restrictions for freight and accelerate the double-stacked bridge program. There are two rail bridges in the region that are limited to 263,000 pounds per train carload, which limits the movement of freight within and across the region. Weight-restricted roadway bridges could also be upgraded to prevent long detours. In addition to these upgrades, increasing the clearance of bridges to allow for the passage of double-stacked railcars would create more efficient freight movement in the Boston region.

Possible MPO Interest/Partnership Opportunities:

- *Short- to Long-Term* – Support the acquisition of clean and fuel-efficient vehicles for public fleets. State and regional agencies and municipalities should buy more efficient cars and trucks and increase the use of lower-carbon fuels. By doing this, agencies and municipalities will assemble a cleaner fleet and save money on energy.
- *Short- to Long-Term* – Promote the use of cleaner diesel equipment on state-funded construction projects.
- *Short- to Mid-Term* – Support initiatives to eliminate unnecessary idling. The Massachusetts anti-idling regulation prohibits idling the engine of any motor vehicle while the vehicle is stopped in excess of five minutes (with exceptions for activities such as maintenance and operating auxiliary equipment such as delivery lifts). With technology that is now available, buses can be automatically switched off if left idling for over five minutes.

Coordinate with Land Use Decisions

Many GHG-reducing initiatives can be advanced by changes in land use, particularly when coordinated with changes in transportation services. While land use decisions are not made by the MPO, the MPO should continue consulting with municipal, regional, and state agencies to ensure that transportation investments are coordinated with land use changes and plans. Through this process the MPO can make and support investments that promote alternative mode choices in development areas.

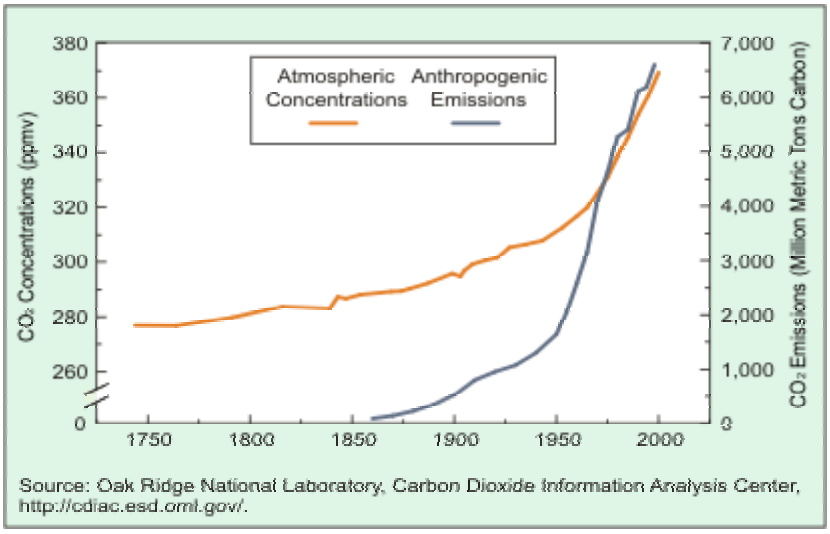
Possible MPO Interest/Partnership Opportunities:

- *Short- to Long-Term* – Support the sustainable redevelopment of urban areas that enables residents to live near their work or live near transit. Providing people with the option to live nearer to their work or closer to public transit reduces the need for long trips to and from work.
- *Short- to Long-Term* – Continue to support compact development and discourage sprawl. Through revised zoning laws, many towns are returning to a more compact, traditional New England style of development that relies less on the automobile and can allow people to complete more of their daily tasks via transit, by bicycle, or on foot. This support can include activities such as funding the design and construction of roadways that control traffic speeds and allow pedestrians to cross safely and prioritizing and funding projects that encourage the redevelopment of existing urban areas instead of funding projects that may encourage new, auto-dependent development in the suburbs.

Appendix A: International Trends and Impacts

Globally, more CO_2 is emitted than any other GHG. Human contributions to CO_2 began with the industrial revolution when we began burning wood and fossil fuels in engines and generators and have increased sharply over the last half-century. Atmospheric concentrations of CO_2 are the highest they have been in 140,000 years, with concentrations growing from 290 parts per million (ppm) in 1870 to 373 ppm today. Figure 1 shows how this increase corresponds with an increase in human-caused, or anthropogenic, emissions.

FIGURE 1
Trends in Atmospheric Concentrations and Anthropogenic Emissions of CO_2



The third warmest year on record was 2003, following 2002, while 1998 remains the warmest year. The International Panel for Climate Change, a group sponsored by the United Nations and the World Meteorological Organization, representing more than 2,000 leading climate scientists, predicts an average temperature increase of 5 to 9°F by 2100, with a wider range of outcomes possible. To put this number in perspective, only about 9°F separates the world at the beginning of the twenty-first century from the world at the end of the last Ice Age, more than 10,000 years ago.

Current global impacts of climate change include:[54]

- The number of Category 4 and 5 hurricanes has almost doubled in the last 30 years.
- Malaria has spread to higher altitudes in places like the Colombian Andes, 7,000 feet above sea level.
- The flow of ice from glaciers in Greenland has more than doubled over the past decade.
- At least 279 species of plants and animals are already responding to global warming, moving closer to the poles.

Scientists predict more severe global impacts in the future:[55]

- Deaths from global warming will double in 25 years to 300,000 people a year.

- Global sea levels could rise by more than 20 feet with the loss of shelf ice in Greenland and Antarctica, devastating coastal areas and cities worldwide. As much as one-tenth of the world's population (630 million people) live in coastal areas that are within 33 feet of elevation from sea level.
- Heat waves will be more frequent and more intense.
- Droughts and wildfires will occur more often.
- More than a million species worldwide could be driven to extinction by 2050.

Appendix B: Sea Level Rise and Flooding in the Boston Region

Sea level rise in the coastal zone will lead to more severe flooding events, and a decrease in the average recurrence interval of design floods such as the current 100-year storm.[56] An increase in mean sea level will add to the base elevation of any storm surge, giving it more power to overtop both natural and constructed protection. A continuation of today's sea level rise rates would give the 10-year storm the intensity of the current 100-year storm before the end of this century and the 100-year storm the intensity of a 500-year storm.[57]

With a worst case scenario of a one-meter (39.4 inches) increase in sea level rise, the expected area at risk to permanent inundation makes up 1.2 percent of the total land area of the Boston region, with some towns expected to experience up to a six percent loss. Specifically, while most municipalities are expected to lose less than one percent of their total land area, the Towns of Nahant and Hull are exceptions: in both municipalities, considerable amounts of residential area would be lost as a result of a rise in sea level of one meter.[58]

Flooding can seriously damage the built environment, paralyze transportation, interrupt energy distribution, and impair wastewater plants, posing threats to the economy of the region and the health of its inhabitants. The areas vulnerable to the most extreme river flood events have a disproportionately high representation of low value houses that are likely to be uninsured.[59] If the frequency of very severe events increases as expected under climate change, households with relatively poor ability to cope will become more vulnerable. Table 1 shows the number of properties and estimated damage climate change could cause in riverside areas. A localized case study found that with increased flood discharges in rivers, bridge foundation scour could become a problem.[60]

TABLE 1
Properties Damaged by River Flood under Baseline (No Climate Change) and Climate Change Scenarios – Cumulative to 2100, maximum of 3 events per year[61]

	Residential		Commercial		Industrial	
Scenario	**Units**	**Cost ($ mil)**	**Hectares**	**Cost ($ mil)**	**Hectares**	**Cost ($ mil)**
No climate change	334,979	6,226	8,834	22,741	30,321	1,789
Climate change	604,491	12,121	16,161	41,096	54,795	3,964
Increase	*80%*	*95%*	*83%*	*81%*	*81%*	*122%*

Appendix C: Policies that Will Likely Result in the Reduction of Carbon Dioxide Emissions

Environment

- Give priority to projects that maintain and improve public transportation facilities and services so as to increase public transportation mode share and reduce reliance on automobiles.
- Give priority to projects that reduce congestion or manage transportation demand to improve air quality.
- Promote the use of low-polluting or alternative fuels, efficient engine technology, and other new, viable technologies that protect resources.
- Consider environmental issues during project selection; in particular, air quality and the reduction of pollutants (CO, NOx, VOCs, particulates, and CO_2), the protection of water resources (soil and water contamination, stormwater management, and wetlands impacts), greenfields and open space, and wildlife and ecosystem preservation; and value those projects that reduce negative impacts.
- Consult with environmental and cultural resource agencies and entities on environmental effects, particularly through the existing NEPA/MEPA processes.
- Encourage, through planning and programming, transportation choices that promote a healthy lifestyle such as walking and bicycling.

Land Use and Economic Development

- Make transportation investments where existing or planned development will encourage public transportation use, walking, and bicycling.
- Give priority to projects in areas identified in local and regional plans as being suitable for concentrated development and/or redevelopment, including brownfield redevelopment; support initiatives that increase sustainability.
- Consider both existing development and densities in transportation decision-making and give priority to projects that support them.

Mobility

- Support projects and programs that improve public transportation service by making it faster, more reliable, and more affordable.
- Fund projects that expand the existing transportation system's ability to move people and goods in areas identified in the Boston Region Mobility Management System, the MBTA Program for Mass Transportation, the MPO's Regional Equity Program, and MPO and EOT freight studies, and through public comment. This includes encouraging options that manage demand. Adding highway capacity by building general-purpose lanes should

be considered only when no better solution can be found and should be accompanied by proponent commitments, developed in the environmental review process, to implement transportation demand management (TDM) measures.

- Assist agencies and communities in planning and implementing projects that provide bicycle and pedestrian routes, networks, and facilities.
- Support programs that meet public transportation needs in suburban communities, including improving access to existing public transportation and partnering with others to initiate new intra-suburban services linking important destinations.

Safety and Security

- Support designs and fund projects and programs that address safety problems and enhance safe travel for all system users. This includes designs and projects that encourage motorists, public transportation riders, bicyclists, and pedestrians to share the transportation network safely.

System Preservation, Modernization, and Efficiency

- Make investments that maximize the efficiency, effectiveness, reliability, and flexibility of the existing transportation system.

Public Participation

- Use the MPO's criteria, based on MPO policies, in decision-making and project selection.
- Solicit the input of environmental, cultural resource, community, business, economic development, and other appropriate agencies on MPO activities, to promote the integration of these interests with transportation planning and programming.

NOTES

[1] New England Regional Assessment Group. *Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change. New England Regional Overview*, U.S. Global Change Research Program, University of New Hampshire. 2001: 96 pp.
[2] U.S. Department of Energy, Energy Information Administration, "Greenhouse Gases, Climate Change, and Energy." http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html. Date accessed: Apr. 25, 2007.
[3] A cap-and-trade program is a flexible, market-based approach to achieving real emissions reductions at the lowest possible cost. The design of RGGI, like any other cap-and-trade program, includes the following basic components: First, the states determine the emissions sources to be covered by the cap. Second, the states establish the total amount of emissions to be allowed from all of the sources, commonly referred to as the "emissions cap." Third, each state issues one allowance for each ton of emissions, up to the amount of the cap, and those allowances are distributed to the generators and the market. Lastly, every covered source is required to have enough allowances to cover its emissions at the end of each compliance period. Sources that do not have enough allowances to cover their projected emissions can either reduce their emissions, buy allowances on the market, or generate credits through an emissions offset project. Sources that reduce their emissions and have excess allowances may either bank those allowances or sell them to other sources. Emissions trading guarantees that the most cost-effective reductions are implemented at the plants
[4] Corbin, R. *An Inconvenient Truth in the Classroom.* 2006: 59 pp.
[5] Energy Information Administration, "Emissions of Greenhouse Gases in the United States 2005." http://www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html. Date accessed: Apr. 27, 2007.
[6] This increase is antithetical to the Kyoto Treaty, an international agreement signed by 169 countries, which calls for a 55% global reduction of carbon dioxide based on 1990 levels. As one of the original signatories of the Kyoto treaty in the early 1990s, the United States agreed to reduce emissions by 6% from its 1990 levels. The United States has not ratified the treaty.
[7] U.S. Environmental Protection Agency, "Energy CO2 Emissions by State." http://www.epa.gov/climatechange/emissions/state_energyco2inv.html. Date accessed: Apr. 27, 2007.
[8] U.S. Environmental Protection Agency, "Energy CO2 Emissions by State." http://www.epa.gov/climatechange/emissions/state_energyco2inv.html. Date accessed: Apr. 27, 2007.
[9] Office for Commonwealth Development. *Massachusetts Climate Protection Plan.* The Commonwealth of Massachusetts. 2004: 51 pp.
[10] *Ibid.*
[11] *Ibid.*
[12] *Ibid.*
[13] *Ibid.*
[14] *Ibid.*
[15] New England Regional Assessment Group. *Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change. New England Regional Overview*, U.S. Global Change Research Program, University of New Hampshire. 2001: 96 pp.
[16] *Ibid.*
[17] Union of Concerned Scientists. "Climate Change in the U.S. Northeast: A Report of the Northeast Climate Impacts Assessment." Oct. 2006; 35 pp.
[18] *Ibid.*
[19] *Ibid.*
[20] Kirshen, P., et al. *Infrastructure Systems, Services and Climate Change: Integrated Impacts and Response Strategies for the Boston Metropolitan Area*, also known as *Climate's Long-term Impacts on Metro Boston (CLIMB).* Civil and Environmental Engineering Department, Tufts University; School of Public Policy, University of Maryland; Center for Transportation Studies, Boston University; and Metropolitan Area Planning Council. EPA Grant Number: R.827450-01. 2004: 164 pp.
[21] Office for Commonwealth Development. *Massachusetts Climate Protection Plan.* The Commonwealth of Massachusetts. 2004: 51 pp.
[22] Union of Concerned Scientists. "Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions." July 2007; 146 pp.
[23] *Ibid.*

[24] Union of Concerned Scientists. "Climate Change in the U.S. Northeast: A Report of the Northeast Climate Impacts Assessment." Oct. 2006; 35 pp.
[25] *Ibid.*
[26] Union of Concerned Scientists. "Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions." July 2007; 146 pp.
[27] *Ibid.*
[28] *Ibid.*
[29] *Ibid.*
[30] *Ibid.*
[31] Sea level rise has two components, both related to temperature increases. The first is thermal expansion of seawater as it warms, and the second is an increase in the amount of water in the ocean basins resulting from the addition of fresh water as continental ice sheets and glaciers melt.
[32] Union of Concerned Scientists. "Climate Change in the U.S. Northeast: A Report of the Northeast Climate Impacts Assessment." Oct. 2006; 35 pp.
[33] Union of Concerned Scientists. "Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions." July 2007; 146 pp.
[34] *Ibid.*
[35] *Ibid.*
[36] *Ibid.*
[37] *Ibid.*
[38] *Ibid.*
[39] Kirshen, P., et al. *Infrastructure Systems, Services and Climate Change: Integrated Impacts and Response Strategies for the Boston Metropolitan Area,* also known as *Climate's Long-term Impacts on Metro Boston (CLIMB).* Civil and Environmental Engineering Department, Tufts University; School of Public Policy, University of Maryland; Center for Transportation Studies, Boston University; and Metropolitan Area Planning Council. EPA Grant Number: R.827450-01. 2004: 164 pp.
[40] Union of Concerned Scientists. "Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions." July 2007; 146 pp.
[41] Kirshen, P., et al. *Infrastructure Systems, Services and Climate Change: Integrated Impacts and Response Strategies for the Boston Metropolitan Area,* also known as *Climate's Long-term Impacts on Metro Boston (CLIMB).* Civil and Environmental Engineering Department, Tufts University; School of Public Policy, University of Maryland; Center for Transportation Studies, Boston University; and Metropolitan Area Planning Council. EPA Grant Number: R.827450-01. 2004: 164 pp.
[42] *Ibid.*
[43] Office for Commonwealth Development. *Massachusetts Climate Protection Plan.* The Commonwealth of Massachusetts. 2004: 51 pp.
[44] National Safety Council, "Auto Emissions Fact Sheet." http://www.nsc.org/ehc/mobile/mse_fs.htm. Date accessed: Apr. 16, 2007.
[45] *Ibid.*
[46] United States Department of Energy and the U.S. Environmental Protection Agency. "How can a gallon of gasoline produce 20 pounds of carbon dioxide?" http://www.fueleconomy.gov/feg/co2.shtml. Accessed Apr. 2007.
[47] Metropolitan Area Planning Council and the Boston Region MPO. "Regional Bicycle Plan." Mar. 2007: 90 pps.
[48] *Ibid.*
[49] *Ibid.*
[50] Scott, J. and H. Sinnamon. *Smokestacks on Rails: Getting Clean Air Solutions for Locomotives on Track.* Environmental Defense. 2006: 39 pps.
[51] American Association of State Highway and Transportation Officials. *Transportation – Invest in America: Freigh-Rail Bottom Line Report.* 2003: 123 pp.
[52] Dutzik, T., et al. *Shifting Gears: 20 Tools for Reducing Global Warming Pollution from New England's Transportation System.* MASSPIRG Education Fund, Clean Water Fund, and Massachusetts Climate Action Network. 2006: 61 pp.
[53] In addition to CO_2 emissions, scientists have recently identified black carbon (soot) as having a large and fast-warming impact on the atmosphere.
[54] Corbin, R. *An Inconvenient Truth in the Classroom.* 2006: 59 pp.
[55] *Ibid.*

[56] A design flood is a hypothetical flood representing a specific likelihood of occurrence.
[57] Kirshen, P., et al. *Infrastructure Systems, Services and Climate Change: Integrated Impacts and Response Strategies for the Boston Metropolitan Area*, also known as *Climate's Long-term Impacts on Metro Boston (CLIMB).* Civil and Environmental Engineering Department, Tufts University; School of Public Policy, University of Maryland; Center for Transportation Studies, Boston University; and Metropolitan Area Planning Council. EPA Grant Number: R.827450-01. 2004: 164 pp.
[58] *Ibid.*
[59] *Ibid.*
[60] *Ibid.*
[61] *Ibid.*