

SAP-4.7

Prospectus for

**Impacts of Climate Variability
and Change on Transportation
Systems and Infrastructure –
Gulf Coast Study**

U.S. Climate Change Science Program

Lead Agency

U.S. Department of Transportation

Contributing Agency

U.S. Geological Survey

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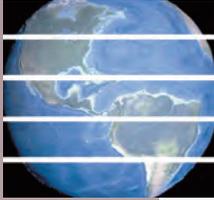
<http://www.climate-science.gov/>

This prospectus has been prepared according to the *Guidelines for Producing Climate Change Science Program (CCSP) Synthesis and Assessment Products*. The prospectus was reviewed and approved by the CCSP Interagency Committee. The document describes the focus of this synthesis and assessment product, and the process that will be used to prepare it. The document does not express any regulatory policies of the United States or any of its agencies, or make any findings of fact that could serve as predicates for regulatory action.

U.S. CLIMATE CHANGE SCIENCE PROGRAM

Prospectus for Synthesis and Assessment Product 4.7

Impacts of Climate Variability and Change on Transportation Systems and Infrastructure – Gulf Coast Study



1. OVERVIEW: DESCRIPTION OF TOPIC, AUDIENCE, INTENDED USE, AND QUESTIONS TO BE ADDRESSED

1.1. Background

Through consultation with transportation professionals, researchers, and partners, the U.S. Department of Transportation (DOT) has identified a need within the transportation community for improved information about climate variability and change when making transportation decisions. A sound transportation system is vital to the Nation's social and economic future. Investments in transportation are substantial, and result in infrastructure that lasts for decades. Transportation plans and designs should therefore be carefully considered and well informed by a range of factors, including consideration of climate variability and change. Climate also affects the safety, operations, and maintenance of transportation infrastructure and systems. This research will investigate the potential impacts of climate variability and change on transportation infrastructure and its operation, and provide guidance as to how transportation planners and decisionmakers may incorporate this information into transportation planning decisions to ensure a reliable and robust future transportation network.

While this research focuses on the implications for transportation systems and infrastructure of climate variability and change, the Department is also conducting research to better understand the contributions of transportation emissions of greenhouse gases (GHGs) to the process of global change, to identify transportation strategies and technologies to increase energy efficiency and reduce GHG emissions from transportation sources, and to develop and improve analytic tools for use by transportation researchers and decisionmakers.

In October 2002, the U.S. DOT Center for Climate Change and Environmental Forecasting (the Center)—with the support of the U.S. Environmental Protection Agency (EPA), Department of Energy (DOE), and the U.S. Global Change Research Program (USGCRP) / Climate Change Science Program (CCSP)—sponsored an interdisciplinary workshop to define research priorities regarding the potential impacts of climate variability and change on transportation. Sixty-four leading experts and decisionmakers participated, exploring the key challenges climate variability and change may pose for transportation in specific regions and for specific transportation modes, including roadways, transit, rail networks, airports, vessels, pipelines, and marine ports. DOT has posted workshop background papers and a report of the workshop at <http://climate.volpe.dot.gov/workshop1002/index.html>. This product will address priority areas identified at the workshop, including: 1) assessment of potential impacts on critical infrastructure locations and facilities, 2) development of improved tools for risk assessment and decisionmaking, and 3) assessment of response strategies.

To select DOT's initial research project, a cross-modal DOT working group solicited and reviewed a range of project concepts for research that would address the needs identified in





the stakeholder workshop. In developing its recommendation the working group assessed the extent to which the research would:

- Increase the knowledge base regarding the risks and sensitivities of transportation infrastructure to climate variability and change, the significance of these risks, and the range of adaptation strategies that may be considered to ensure a robust and reliable transportation network
- Provide relevant information and assistance to transportation planners, designers, and decisionmakers
- Build research approaches and tools that would be transferable to other regions or sectoral analyses
- Produce near-term, useful results
- Address multiple aspects of the research themes recommended by the October 2002 workshop
- Build on existing research activities and available data
- Strengthen DOT partnerships with other Federal agencies, state and local transportation and planning organizations, research institutions, and stakeholders.

The Gulf Coast Study was selected by DOT as the first of a series of research activities that the Center will pursue to address these research priorities. This initial product will focus on the low-lying Gulf of Mexico coastal zone which has little topographic relief but it is heavily populated. In addition, the area's transportation modes are both unique and economically significant. For example, the Ports of New Orleans and Houston are the top two ranking U.S. ports in tonnage. Roughly two-thirds of all U.S. oil imports are transported through this region. Pipelines traversing the region transport over 90 percent of domestic Outer Continental Shelf oil and gas. Almost half of the Nation's repetitive flood damage claims are paid to homeowners and businesses in this region, and the efficacy of evacuation during storms is an important determinant of the safety and well-being of its population. This region is subject to the direct effects of hurricanes and tropical storms. Given its low elevation, the area is also particularly vulnerable to flooding and storm surges that accompany hurricanes and tropical storms. These effects may be exacerbated by global sea-level rise and local land subsidence.

The overarching questions in this research area are, "How may climate variability or change affect decisions required to plan, build, and manage our transportation network? What tools do transportation decisionmakers need to integrate information on climate variability and change into their investment and management decisions?" These are large questions that will require substantial research over time. This study may serve as a prototype for analysis in other regions of the potential risks to transportation from climate variability and change, and the range of response strategies that may be considered.

1.2. Project Description

This study will identify the potential effects of climate variability and change in transportation infrastructure and systems in the central U.S. Gulf coast. The purpose of this study is to develop knowledge and tools that will assist transportation decisionmakers in incorporating climate-related trend information into transportation system planning, design, engineering, and operational decisions. Implications for all transportation modes—surface, marine, and aviation—will be addressed. This project will develop decision-support tools to assist transportation decisionmakers in assessing risks and evaluating response strategies:

- Develop knowledge about potential transportation infrastructure sensitivities to climate changes and variability through an in-depth synthesis and analysis of existing data and trends
- Assess the potential significance of these sensitivities to transportation decisionmakers in the central U.S. Gulf Coast region
- Identify potential strategies for adaptation that will reduce risks and enhance the resilience of transportation infrastructure and services
- Identify or develop decision-support tools or procedures that enable transportation decisionmakers to integrate information about climate variability and change into existing transportation planning and design processes.

There are several intended uses for the products of this three-phase study. The findings of this study will help

inform local and regional transportation decisionmakers in the central U.S. Gulf Coast. The study will also contribute to research methodologies in this new area of investigation that can be applied to other regions and communities. For example, Phase I will identify priority databases and methodologies for the integration of data for analysis in a GIS format, develop formats for mapping products, and develop criteria for assessing and ranking infrastructure sensitivities to the potential impacts of climate variability and change. Each of these outputs will offer useful information and example methodologies to research activities in other regions, as well as to transportation and planning decisionmaking processes in other areas. This research will also help scientists and science agencies better understand the transportation sector's information needs, leading to improved data and better decision support.

1.3. Federal Sponsors

DOT and the U.S. Geological Survey (USGS) signed a Memorandum of Understanding (MOU) in January 2004, agreeing to cooperate on research that will inform decisionmakers and the public about the potential effects of climate variability and change on the Nation's transportation systems. Pursuant to an interagency research plan agreement developed under this MOU, DOT will be the lead agency, supported by USGS, with other Federal agencies participating as appropriate. Primary research support will be provided by USGS. USGS has the staff and facilities needed to perform much of the work envisioned by DOT. In addition, USGS has established partnerships and cooperative agreements with other Federal agencies and universities in the Gulf Coast region that enable the completion of this study in close coordination with DOT.

2. CONTACT INFORMATION FOR RESPONSIBLE INDIVIDUALS AT THE LEAD AND SUPPORTING AGENCIES

DOT is the lead agency for this product. Participating agency contacts follow.

Michael Savonis
Center for Climate Change and Environmental Forecasting
Department of Transportation
Michael.Savonis@fhwa.dot.gov

Virginia Burkett
National Wetlands Research Center
U. S. Geological Survey
Virginia.Burkett@usgs.gov

3. LEAD AUTHORS

This study will require an interdisciplinary approach that integrates natural science disciplines with expertise in risk assessment, transportation, and planning. DOT and USGS will develop a research team that provides the necessary expertise in multiple fields, based on each agency's mission and core capabilities. USGS will coordinate the provision of scientific research support, coordinating expertise in climate change science and impacts assessment; meteorology; hydrology; storm-surge analysis and modeling; risk analysis; and economics. DOT will provide expertise in transportation planning, engineering, design, and operation through a Transportation Analysis Team. The team will include individuals with expertise in ports, rail, highways and transit, pipelines, aviation, emergency management, and transportation planning and investment. As part of this team, DOT's Bureau of Transportation Statistics (BTS) will support geospatial and other data collection and analysis related to transportation.

Authors of the research project reports will be USGS scientists, DOT researchers, and cooperating researchers with demonstrated expertise in the technical areas listed above. A prospective list of lead authors has been identified by DOT and USGS. Biographical information for principal researchers and authors is included in Appendix A.

- Virginia Burkett, Ph.D. USGS
[Coordinating Author]
- Leticia Alston, Ph.D., Texas A&M
- Thomas Doyle, Ph.D., USGS
- Kay Drucker, DOT Bureau of Transportation Statistics



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- Ronald Hagelman, Ph.D., University of New Orleans
- Ivor van Heerden, Ph.D., Louisiana Board of Regents Health Excellence Fund Center
- Steve Hartley, M.S., USGS
- Robert Kafalenos, DOT Federal Highway Administration
- Barry D. Keim, Ph.D., Louisiana State
- Eric Lindquist, Ph.D., Texas A&M
- Joanne R. Potter, DOT (consultant)
[Coordinating Author]
- Michael J. Savonis, DOT Federal Highway Administration
- Arnie Vedlitz, Ph.D., Texas A&M.

Additional lead authors and contributing authors can be nominated to the lead agency contact, Mr. Michael Savonis, at any time prior to initiation of the research project (i.e., until the final prospectus is approved by the CCSP Principals and is published on the CCSP web site). The lead agency will select authors (lead and contributing authors) from the pool of those nominated at that time.

4. STAKEHOLDER INTERACTIONS

4.1. Stakeholder Participation

As discussed above, the focus of this research project grew out of stakeholder input obtained through an interdisciplinary workshop held in October 2002 by the DOT Center, with the support of the EPA, DOE, and USGCRP / CCSP. Participants provided input on research priorities regarding the potential impacts of climate variability and change on transportation. The workshop background papers and a report of the workshop are available at <http://climate.volpe.dot.gov/workshop1002/index.html>.

The study requires an interdisciplinary approach drawing on the participation of a range of local and regional decisionmakers and stakeholders from transportation and environmental agencies, regional planning offices, industry, and other key participants. Consultation with local and regional decisionmakers and stakeholders will be embedded

in the research process, and will be initiated by the research team in the first stages of the project and maintained as an ongoing project component. Contacts with local and regional decisionmakers and stakeholders will be primarily one-on-one meetings for data collection and to obtain insights relevant to the project. The research team will develop, in consultation with the sponsoring agencies, the specific processes used to collect project input and information from stakeholders.

Individuals or organizations interesting in providing input should contact Dr. Virginia Burkett at the e-mail address provided in Section 2.

4.2. Expert Panel/Federal Advisory Committee

To help ensure a high-quality research initiative, USGS and DOT will identify individuals to provide technical advice to the project through an Expert Panel, which shall be chartered as an Advisory Committee under the Federal Advisory Committee Act. Members of the Advisory Committee will have expertise in local and regional decisionmaking processes and tools; transportation planning, engineering, and operations; and scientific expertise in modeling, geospatial data and analysis, climate change science, meteorology, and hydrology. The Advisory Committee will fill four roles in this study:

- 1) Provide perspectives on the implementation and refinement of the study approach
- 2) Provide expert guidance on transportation-sector information needs and potential climate change impacts
- 3) Review the synthesis of climatic data, status and trends analyses, and scientific literature relevant to the project
- 4) Review and comment on data products and draft reports.

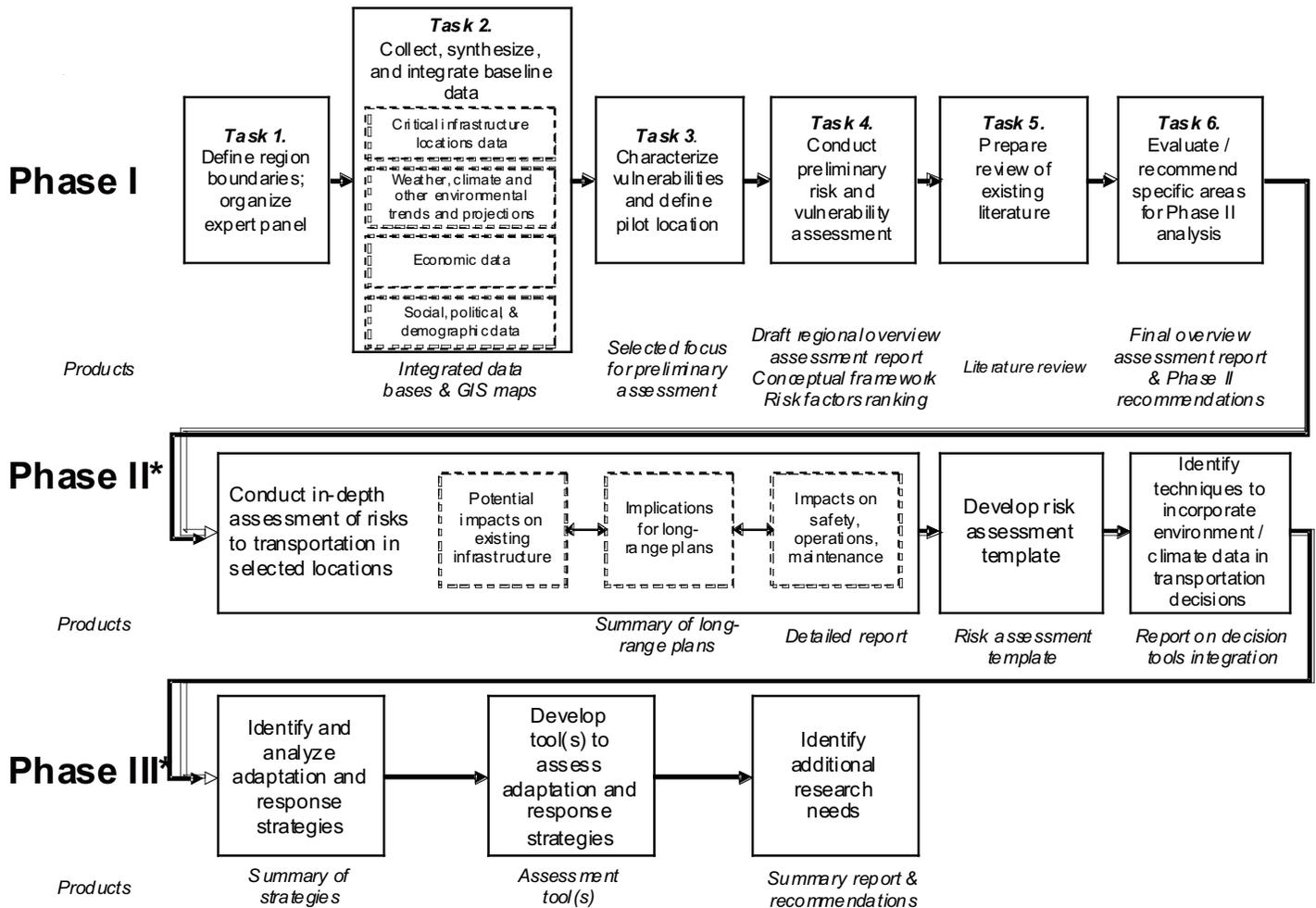
Members of the Advisory Committee will be regularly engaged throughout the research project to provide appropriate guidance and input according to their areas of expertise. The Committee will receive regular updates on the status of the research, and may be individually consulted to review data products and draft reports for each task prior to

proceeding to subsequent tasks. A password-protected web site will be established to facilitate participation by Committee members in review of draft materials. It is expected that most communications with the Committee will take place through e-mail correspondence and teleconference. The Committee will meet in person twice during the research process, at meetings open to the public. The meetings will take place within the study region.

The Advisory Committee will be selected jointly by DOT and USGS during the first task of Phase I based on recommendations from lead authors, CCSP member agencies, and state/local stakeholders.

5. DRAFTING: PROCESS AND MATERIALS TO BE USED

This research will be conducted as a multi-year project with three phases, with products generated by phase, as illustrated in Figure 1. In Phase I, the research team will 1) compile data in geospatial format that is needed to assess the vulnerability of the transportation sector in the Gulf region; and 2) develop and demonstrate an approach for conducting an integrated assessment of transportation risks for a geographic region. This approach will then be refined and applied to selected locations during Phase II.



*Study design of Phases II and III will be refined based on findings of Phase I.

Figure 1. Gulf Coast Study Design



A detailed scope for Phase I will be defined in the interagency research plan agreement. The research objectives and approach for Phases II and III will be developed in detail based on the findings and recommendations of Phase I. An Expert Panel composed of local and regional decisionmakers and stakeholders will provide input to the final scoping of each phase.

The following subsections provide an overview of the objectives and anticipated products for Phase I. The anticipated objectives and products for Phases II and III are then summarized.

5.1. Phase I – Synthesis of Existing Data and Information and Preliminary Vulnerability Assessment

Research conducted in Phase I will provide an integrated geospatial overview of climate and weather trends and projections in the central U.S. Gulf Coast region with other relevant environmental, economic, and demographic data; and an overview assessment of relative risks and vulnerability to transportation infrastructure and facilities in the region based on these data. An important component of Phase I is the compilation of data such as shoreline erosion, land-use change, and land-surface elevation trends which stem from processes that are independent of climate but significantly influence the impacts of sea-level rise and climatic variability on transportation in low-lying coastal areas. These factors can lead to unique vulnerabilities when combined with increased sea level or precipitation, but they are poorly understood in terms of their cumulative impacts on transportation infrastructure. This is the first study of its kind to attempt to integrate the suite of climate and non-climate variables into knowledge and decision-support tools to support transportation decisionmakers. These geospatial products and public domain data will be made available to regional and local transportation planners and decisionmakers in state and regional agencies for their use.

The research team will develop and demonstrate an approach for conducting an integrated assessment of

transportation risks. Based on the overview assessment, a limited number of sub-locations will be selected for in-depth analysis in Phase II using this approach.

5.1.1. Phase I Tasks

Phase I will be conducted through the following five tasks:

- *Task 1: Define Regional Boundaries and Organize Expert Panel/Advisory Committee.* In consultation with the sponsoring agencies, the research team will provide a map and brief descriptive report of the proposed study area and its boundaries, and establish and convene an Expert Panel/Advisory Committee. The Expert Panel/Advisory Committee will review the research plan and assist the research team in further refining the study approach.
- *Task 2: Collect, Synthesize, and Integrate Geospatial Information and Baseline Data for the Region.* The research team will collect and synthesize data summarizing trends and projected changes in key climate, weather, demographic, economic, and geophysical variables in the Gulf Coast region, drawing on historic data, simulation models, and published literature. To the extent sufficient data are available, projections will be presented for time frames to 2030 and 2050, with projections to 2100 for selected variables. Data will include:
 - Trends, projections, and alternative methodologies (e.g. analogs from the past or other locations) related to climate, sea level, erosion, subsidence, and other factors that influence Gulf Coast transportation
 - Critical infrastructure locations, including highways, railroads, terminals, marine ports, pipelines, airports, and intermodal facilities
 - Relevant economic data
 - Relevant social, political, and demographic data
 - Geospatial trends from data collected by the National Geodetic Survey's National Spatial Reference System
 - Tide and stream gauge data from NOAA's National Water Level Observation Network and the USGS surface water observation network.

Detailed information on scope and criteria for data will be developed in the interagency research plan agreement. The research plan will also address how any potential data gaps will be dealt with, including consideration of the use of earlier time frames, use of proxy data, and use of expert judgment to supplement missing data. The research team will present summary trends of data using maps, graphs, and tables as appropriate. The research team will provide a consolidated report accompanied by associated geospatial products.

- *Task 3: Characterize Range of Vulnerabilities within Study Region and Define Pilot Location for Task 4.*

Based on an analysis of data and projections identified in Task 2 and other relevant factors, the research team will recommend one potential research site for the Phase I preliminary vulnerability assessment. This recommendation will be derived from three sub-tasks:

- Consideration of the impact of projected changes in climate and weather on transportation infrastructure
- Assessment of the vulnerability of Gulf transportation infrastructure as a product of additional stressors, such as subsidence, and of socio-demographic factors, such as population concentrations and presence of critical infrastructure
- Assessment of indicators of the feasibility of further study.

The research team will characterize potential impacts and develop a region-wide description of how climate variability and change may affect existing transportation infrastructure and long-range plans for transportation systems in the region, including maintenance, design, operations, and planning implications.

The research team will narrow the focus of the study on potential climate variability and change impacts to a subset of specific locations along the Galveston Bay to Mobile Bay corridor that exhibit particular transportation infrastructure vulnerability. This will be accomplished by assessing the layered GIS information on physical and social vulnerability. It is estimated that three locations of a regional (metropolitan planning organization) or county level within the study area will be selected in which the age, condition, and location of transportation infrastructure make them particularly vulnerable to physical/structural

damage from climate variability and change factors such as sea-level rise, storm surge, precipitation changes, and temperature changes. In consultation with the Expert Panel, one location of a regional (metropolitan planning organization) or county level within the study area will then be selected. Key factors for the determination of this location may include:

- Areas currently under environmental stress (from processes such as erosion and subsidence)
- Topographical characteristics that create potential areas of vulnerability to climate change, such as elevation and presence of water features
- Presence of key infrastructure defined in terms of economic importance (carrying capacity)
- Presence of multiple transportation modes in single locations.

Based on an analysis of these factors and consultation with the Expert Panel/Advisory Committee, the team will recommend an individual study site for Task 4.

- *Task 4: Preliminary Risk and Vulnerability Assessment.* The objective of Task 4 is to integrate information from Tasks 2 and 3 and to apply these variables in a conceptual framework at the specific location identified at the end of Task 3. The research team will conceptualize and critically examine a risk and vulnerability assessment matrix that integrates information from Tasks 2 and 3. The matrix will be examined by the DOT transportation analysis team, by the Expert Panel/Advisory Committee and by a sample of local decisionmaker stakeholders. This preliminary model will then be applied to a selected location for testing and refinement.

The research team will provide a report summarizing the preliminary assessment of risks, vulnerabilities, and recovery potential for the study location, and propose a conceptual model for a risk-vulnerability-recovery decision matrix and summary of results from an external assessment of the matrix.

The resulting risk and assessment tool will be further developed in Phase II. The product of Phase I will be a conceptual model; further refinement to operationalize this framework and assign meaningful values will occur in Phase II.



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- *Task 5: Prepare Review of Existing Literature.* The researcher team will oversee development of a review of existing literature on the impacts of climate change on transportation infrastructure. The results of this literature review will indicate the depth and breadth of existing research in this area and may provide context for understanding the key results of this study.
 - *Task 6: Final Report and Recommendation of Specific Areas for Phase II Analysis.* The research team will recommend locations for further study in Phase II, based on criteria developed in consultation with the Expert Panel/Advisory Committee and the project sponsors. A final overview assessment report of Phase I will be produced.

5.1.2. Phase I Products

The expected deliverables include a consolidated report accompanied by geospatial products, such as:

- A compilation and synthesis of existing weather and climate trends and model projections; economic, social, and demographic data; and locations of key infrastructure and facilities (through geospatial mapping products)
- An assessment of regional and local trends in sea level, subsidence, erosion, streamflow, temperature, and other related factors that influence the vulnerability of existing transportation infrastructure
- A ranking of infrastructure sensitivities to potential impacts of various climate variability or change factors in the central U.S. Gulf Coast, relative to their significance to transportation
- A conceptual framework for risk and vulnerability assessment, piloted at one study location
- Recommendation of specific locations for in-depth analysis in Phase II, focusing on the impacts of selected climate variability and change factors.

5.2. Phase II

The objective of research in Phase II is to conduct an in-depth assessment of impacts and risks to selected areas and

facilities (as identified in Phase I) and to contribute to the development of risk assessment tools and techniques that can be used by transportation decisionmakers to analyze the vulnerability of other areas.

The expected products of Phase II research follow:

- An in-depth assessment and report of selected high-priority impacts on specific areas, facilities, or corridors
- Building on the conceptual framework developed in Phase I, a risk assessment template for use by transportation decisionmakers to identify and assess potential vulnerabilities
- A report on the integration of climate data into existing transportation decisionmaking processes.

Phase II will be scoped in detail based on the results of Phase I, and additional products may be identified at that time to support this objective.

5.3. Phase III

The objectives of Phase III are to identify the range of potential adaptation strategies available to federal, regional, and local transportation managers to respond to the risks identified in Phases I and II; to identify the potential strengths and weaknesses of these responses; and to develop an assessment tool that may assist transportation managers in selecting adaptation strategies appropriate to their agency, community, or facility, and to the identified sensitivity to climate change.

The expected products of Phase III research follow:

- A compilation and description of potential adaptation strategies for use by transportation managers
- An assessment tool or tools for use by transportation managers in evaluating adaptation strategies
- Recommendations for further research.

Phase III will be scoped in detail based on the results of Phases I and II, and additional products may be identified at that time to support this objective.

5.4. *Proposed Approach for Evaluation and Communication of Uncertainty and Confidence Levels, where Applicable*

Any assessment of potential climate change impacts must consider both the variability and change in climate and the vulnerability of the elements affected. Rather than relying on a single model for the climate components of this assessment, a range of plausible climatic and environmental futures will be determined based upon three principal considerations: historic trends; consensus in the published literature regarding the trajectory of sea-level change, regional climatic trends, and extreme events; and areas of agreement in output among various climate models. Where and when appropriate during the research project, confidence levels will be discussed based on observational evidence, models, and widely-accepted theory, following guidance published by Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC). Broadly framing the assessment approach using IPCC guidance is consistent with the DOT Center Strategic Plan for 2001-2005. The interpretation of climate model output, status and trends analyses, and scientific literature will involve some degree of expert judgment and evaluation. In some cases alternative methodologies (e.g. analogs from the past or at other locations) may be applied to validate both the scenarios and the assessment of potential impacts. These types of data and information products will be reviewed by technically qualified individuals on the Expert Panel to ensure that they are valid, complete, unbiased, objective, and relevant.

6. REVIEW

Final reports for each of the three phases of this research effort will be subject to multiple reviews to ensure quality, including review by federal government agencies, peer review consistent with the OMB “Peer Review Bulletin,” and review by the general public. These reviews will be conducted when the final reports of each phase are ready.

The academic process of peer review is founded on the structured, collegial evaluation by peers who are qualified

to render judgment on the material to be reviewed. In addition to peer reviews by staff from DOT and USGS—and potentially other federal agencies, which were not involved in the development of the study products—there will also be formal, independent, external peer review. All reviews will be conducted at a level commensurate with the importance of the interpretive products generated by the study team. Review of draft products by the Advisory Committee will occur at a date to be agreed upon with the Committee membership. The study team will address all comments from the Advisory Committee and the external peer reviews in a formal fashion, documenting each comment and each response.

For products requiring external peer review, the sponsoring agencies will develop a pool of technical reviewers to review the draft product. The review will be equivalent to a journal peer review with each reviewer preparing an independent review. Independent reviewers will include both scientific and technical experts, and non-scientist decisionmakers, to assess the clarity of the draft product.

All selected authors and reviewers will be provided with the information quality guidelines issued by the Department of Commerce and NOAA (which also incorporate compliance with the overall Office of Management and Budget guidelines: *OMB Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies*).

Final research products and reports will be submitted for the CCSP review process, including participation as appropriate by partner agencies and Interagency Working Groups and posting for public comment.

Reviewers will be selected by the sponsoring agencies in consultation with the research team and the CCSP Agency Principal Representatives. Recommendations for individuals to serve as reviewers should be submitted to Dr. Virginia Burkett, at the e-mail address provided in Section 2.

The dates of expert peer review and public comment period will be determined by the sponsoring agencies, and posted



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on the CCSP web site no less than 30 days in advance of the review.

7. RELATED ACTIVITIES

This project is not related to other national or international assessment processes, and project products are not committed for any other purpose. Coordination with other research activities of CCSP agencies will occur through regular reports to the CCSP Agency Principal Representatives by the sponsoring agencies.

8. COMMUNICATIONS

Throughout the research process, ongoing dialog with local and regional decisionmakers, technical resources, and transportation practitioners will be facilitated through the meetings of the Expert Panel and one-on-one interviews with stakeholders, and workshops.

At each phase, opportunities for broad distribution of all research information and products will be pursued. These will include use of video conferencing; participation by individual members of the research team in professional conferences, panels, and workshops; and the submission of articles to relevant scientific and professional journals.

A final conference of regional stakeholders will be held to review the final draft report of Phase III.

All research products and reports from this project will be identified as CCSP-sponsored products, published in a consistent format as part of the family of CCSP-sponsored products, and will be consistent with DOC/NOAA information quality guidelines. DOT and USGS, working with the CCSP Office and its communications subgroup, will develop a communications and dissemination plan to ensure broad availability to the scientific community and the public (excluding classified data or proprietary information). This dissemination plan will include use of the CCSP web site, announcements of the availability of project reports

and products, and direct distribution as recommended by CCSP.

All products of this research initiative (excluding classified data or proprietary information) will be made available to the transportation and research communities and the general public through posting on the DOT Center for Climate Change web site and through publication and distribution of relevant reports.

9. PROPOSED TIMELINE

Completion of Phase I research is estimated to be completed within 18 months from approval of the Interagency Agreement between DOT and USGS and initiation of research. The Advisory Committee is expected to be established in the summer of 2006. A draft report, anticipated in late 2006, will be submitted for peer review and to CCSP for review. The report is expected to be released as final in the fourth quarter of 2007. The schedule for production and distribution of the final report will be contingent on the review process. Although Phase II and III timelines will ultimately depend on the results from Phase I, DOT anticipates a research period of 18 months for each phase.

Appendix A: Lead Authors – Brief Biographical Information**Virginia R. Burkett, Ph.D.**

Dr. Burkett is chief of the Forest Ecology Branch at the National Wetlands Research Center of the U.S. Geological Survey, U.S. Department of Interior, where she has worked since 1990. She also serves as an Associate Regional Chief Biologist for the USGS Central Region. Her expertise includes coastal wetland ecology, wetland forest ecology and restoration, coastal management, and wildlife and fisheries management. Dr. Burkett has served as Director of the Louisiana Coastal Zone Management Program, Deputy Director and Director of the Louisiana Department of Wildlife and Fisheries, and Assistant Director of the Louisiana Geological Survey. She has published extensively on the topics of global change and low-lying coastal zones. Nominated by the U.S. government, she was a Lead Author on the United Nation's IPCC Third Assessment Report (2001) of global climate change and its impacts on coastal and marine ecosystems and she was recently appointed as a lead author of the IPCC's Fourth Assessment report that will be published in 2007. During 2002-2004 she served as a member of the National Research Council's Panel on River Basin and Coastal Systems Planning. Burkett received a B.S. in zoology and an M.S. in botany from Northwestern State University of Louisiana; her doctoral work in forestry was completed at Stephen F. Austin State University in 1996.

Thomas W. Doyle, Ph.D.

Dr. Doyle is a systems ecologist in the Forest Ecology Branch at the National Wetlands Research Center of the U.S. Geological Survey, U.S. Department of Interior, Lafayette, Louisiana, where he has worked since 1989. Dr. Doyle's experience includes over 20+ years of field and modeling studies in temperate and tropical ecosystems of the southeastern United States and Caribbean. His expertise focuses on ecosystem analysis and modeling with a special emphasis on development of forest succession and landscape simulation models and understanding the role of natural and anthropogenic disturbance on forest structure and diversity of coastal ecosystems of the Gulf of Mexico and Caribbean regions. Doyle's field projects and model applications have addressed projected impacts of global climate change, sea-level rise, elevated carbon dioxide, and hurricanes on coastal ecosystems along with specific resource management issues of wetland restoration, fire, wastewater pollution, and landscape fragmentation. He has published extensively on the topics of global change and hurricane impacts on a variety of coastal ecosystems. Doyle was a Lead Author on the Environmental Protection Agency regional assessment for the Gulf Coast entitled "Preparing for a Changing Climate: Potential Consequences of Climate Variability and Change – Gulf Coast Region. Doyle received a B.S. in botany at the University of Louisiana, Monroe, Louisiana in 1976 and an M.S. and Ph.D. in ecology from the University of Tennessee, Knoxville in 1980 and 1983, respectively.

Kay Drucker

Ms. Drucker is a transportation specialist at the Bureau of Transportation Statistics (BTS), U.S. Department of Transportation. Ms. Drucker manages and supports ongoing transportation data, data harmonization and analysis projects at BTS with a focus on areas of environmental and international transportation data relevance. Ms. Drucker represents the Bureau as a core staff member in the U.S. DOT Climate Change and Environmental Forecasting Center. She is responsible for supporting the Bureau's international outreach and partnership activities, including the coordination of trilateral transportation data projects with Canada and Mexico through the North American Transportation Statistics Interchange, which includes the exchange

of environmental data and information. Ms. Drucker received her Master's degree in Technology and International Public Policy with an emphasis on transportation policy from the University of Denver (1999) and her undergraduate degree in International Relations with a minor in Tourism (1992) from the California State University, Chico. She has worked in the transportation data collection, analysis and dissemination field for the last five years and has managed a range of projects from transportation survey development to ITS data system analysis to preparing transportation statistical publications for use by the U.S. Congress.

Ronald R. Hagelman III, PhD

Dr. Hagelman received his BA in History and Geography from the University of Texas at Austin in 1988. Following the completion of his undergraduate degree, he entered the reinsurance/insurance marketing industry, where he worked full-time until 1994, and part-time while in graduate school until 1997. During this period he served as VP of Marketing for two separate marketing consulting firms and successfully started, ran, and eventually sold his own marketing consulting agency located in New Braunfels, Texas. In 1994 Ron returned to graduate school, where he completed his master's in Applied Environmental Geography in 1997 and his PhD in Environmental Geography in 2001. Both degrees were earned from the Department of Geography at Texas State University in San Marcos, Texas. Dr. Hagelman's dissertation dealt with the current and historical impacts of urban flooding and flood management policy in San Antonio, Texas. His dissertation was awarded the Association of American Geographers Hazards Specialty Group, Gilbert White Dissertation Award for 2002. Dr. Hagelman has been employed as an Assistant Professor in the Department of Geography at the University of New Orleans in New Orleans, Louisiana since August 2001. He currently teaches courses in World Geography, Environmental Impact Assessment, Hazards and Disasters, Urban Geography, Human Geographic Field Methods, and Coastal Environments. In addition, Dr. Hagelman has been involved in numerous research grant projects through the Center for Hazards Assessment and Risk Technology (CHART) located on the UNO campus. Grantors for these projects include The Environmental Protection Agency, The US Army Corps of Engineers, the Federal Emergency Management Agency, the Louisiana Department of Natural Resources, and the Natural Hazards Research and Applications Information Center at the University of Colorado. The above efforts have, thus far, resulted in publications relating to environmental equity and toxic air releases, social impacts of coastal environmental restoration, freeze-disaster impacts within the citrus industry, and temporal change analysis of regional census data.

Stephen B. Hartley, M.S.

Mr. Hartley is currently employed as a Senior Geographer at the USGS/National Wetlands Research Center. Mr. Hartley is responsible for the installation, configuration and overall maintenance of software, hardware and networking for Geographical Information Systems (GIS) operations. His specific duties include managing and coordinating GIS projects, performing image analysis, developing prototype GIS products, troubleshooting, quality control, personnel management and training, and client-interfacing. He provides support for the Coastal Wetlands Planning, Protection and Restoration Act and several other federal studies. Hartley is a co-principal investigator, along with Dr. James B. Johnston, for the Louisiana GAP Project. Also, Mr. Hartley provides training in the usage of several GIS/RS software packages. He is a certified ESRI ArcView instructor (7 yrs). He received his Master of Science degree in geology in 2000

from the University of Louisiana at Lafayette. Mr. Hartley has published several technical reports, articles, and map products that illustrate his experience in GIS and remote sensing.

Ivor van Heerden, Ph.D.

Dr. van Heerden is currently Director of the Center for the Study of Public Health Impacts of Hurricanes, a Louisiana Board of Regents Health Excellence Fund Center. His research and teaching activities focus on coastal and river basin processes and sedimentation, environmental management, habitat restoration, technology transfer, aiding industry in the expansion of their activities with minimal environmental impacts, and sustained natural resource utilization and tourism related to the natural environment. Dr. van Heerden has served as Assistant Secretary for the Louisiana Department of Natural Resources, which is charged with implementing the state's Coastal Wetlands Conservation and Restoration Plan. He was also formerly Professor-Research and Director of Natural Systems Management and Engineering Program for the Louisiana Geological Survey, which is part Louisiana State University (LSU). He received his undergraduate degree in geology from the University of Natal in South Africa (1976), and an M.S. and Ph.D. in Marine Sciences from LSU in 1980 and 1983, respectively. Dr. van Heerden has served as Deputy Director of the Hurricane Center at LSU since 1999.

Robert S. Kafalenos

Mr. Kafalenos is an air quality specialist at the Federal Highway Administration (FHWA), U.S. Department of Transportation. He is an FHWA representative to the U.S. DOT Climate Change and Environmental Forecasting Center. Mr. Kafalenos develops policy on the Congestion Mitigation and Air Quality Improvement (CMAQ) Program and also provides assistance to FHWA Division offices on implementing the CMAQ program. He currently manages development and implementation of the CMAQ electronic reporting initiative. Mr. Kafalenos earned a Master's in Environmental Management/Resource Economics and Policy at Duke University in 2001.

Barry D. Keim, Ph.D.

Dr. Keim currently serves as Louisiana State Climatologist. His teaching and research interests at Louisiana State University focus on climate change and variability, extreme climatic events, hydroclimatology, applied climatology, and the humans dimensions of climate change. Some recent publications include *New England Weather, New England Climate* (2003), and the following journal articles, "The Sea Breeze: Structure, Forecasting, and Impacts" in *Reviews of Geophysics* (2003), "The Influence of Regional Storm Tracking and Teleconnections on Winter Precipitation in the Northeastern United States" in *Annals of the Association of American Geographers* (2003), "Warming Winters and New Hampshire's Lost Ski Areas: An Integrated Case Study," in *International Journal of Sociology and Social Policy* (2003), "Synoptic-Scale Controls on the Central New England Seabreeze" in *Weather and Forecasting* (2003), and "Are there Spurious Precipitation Trends in the United States Climate Division Database?" in *Geophysical Research Letters* (2005).

Eric Lindquist, Ph.D.

Dr. Lindquist is an Associate Research Scientist at Texas A&M University with a joint appointment with the Institute for Science, Technology and Public Policy (ISTPP) and the Texas Transportation Institute (TTI). He has been at TTI for ten years and has been jointly involved

with ISTPP for the past three years. His Ph.D. is in political science (Texas A&M University 2002), as is his Master of Urban Planning (1994). Dr. Lindquist's research and educational background is in transport and environmental policy, political decision and policy processes, and agenda setting and problem definition of public policy solutions. He has most recently been actively involved in research on the public understanding of science in regard to global climate change and the use of scientific information by intergovernmental decision makers and the general public on the Gulf Coast. He is also currently Co-Principal Investigator on a major grant for NOAA focusing on the utilization and understanding of climate variability and climate change science. His transportation research has ranged from such issues as intelligent transportation systems policy, sustainable transportation, tourism and transportation and hazardous transport and ITS.

Joanne R. Potter

Ms. Potter is a Senior Associate of Cambridge Systematics. She holds a Master's Degree in City Planning from the Massachusetts Institute of Technology (1994) and a Bachelor of Arts from the University of Massachusetts, Amherst (1976). Since 1998, she has worked with the Federal Highway Administration's (FHWA) Office of Planning and Environment to plan and implement innovative programs for FHWA and DOT related to transportation and environmental issues, often in collaboration with other operating administrations and with federal, state, and local partners. Working with DOT staff and senior managers, Ms. Potter facilitated the creation and implementation of the U.S. DOT Center for Climate Change and Environmental Forecasting (the Center). She coordinated a scenario-based planning process and was primary author of the Center's five-year strategic plan. Ms. Potter provides strategic planning support to the Center's research on the potential impacts of climate variability and change on transportation, and coordinated a 2002 interdisciplinary workshop sponsored by DOT and federal partners to identify research priorities in this area of investigation. She has assisted several other DOT programs in planning their research agendas, including strategic planning for FHWA's Planning and Environment Research Program, the initial design of the Surface Transportation-Environment Cooperative Research Program, and development of a strategic plan for FHWA's Surface Weather Research Program. She is coauthor of *Transportation in an Age of Climate Change: What Are the Research Priorities?*, TR News 2003, and author of *Workshop Summary*, in The Potential Impacts of Climate Change on Transportation: Workshop Summary and Discussion Papers, DOT 2003.

Michael J. Savonis

Mr. Savonis has been the Team Leader for Air Quality in the Office of Natural and Human Environment of the Federal Highway Administration, U.S. Department of Transportation, since 1996. He has twenty years of experience in transportation, with extensive expertise in air quality, planning, and emerging environmental issues. Mr. Savonis oversees and administers FHWA's transportation / air quality research program, oversees policy development and implementation of the Congestion Mitigation and Air Quality Improvement Program, and oversees FHWA's public education program on air quality strategies. He was instrumental to the creation of the U.S. DOT Center for Climate Change and Environmental Forecasting and the development of the Center's Strategic Plan, and leads FHWA's participation in Center activities. He has been a member of the Air Quality Committee of the Transportation Research Board (TRB) since 1999, and has been chair of the TRB Subcommittee on Transportation Control Measures since 2000. He is author or coauthor of several papers and reports on transportation / air quality and related

topics, including: *Transportation in an Age of Climate Change: What Are the Research Priorities?*, TR News, Transportation Research Board, 2003 ; *Toward a Strategic Plan for Transportation Air Quality Research, 2000-2010*, Transportation Research Record, 1738; and *Clean Air Through Transportation: Challenges in Meeting the National Ambient Air Quality Standards*, report to Congress, 1993. Mr. Savonis holds a Master's Degree in Regional Planning from Cornell University (1985) and a Bachelor of Science degree in Chemistry from the State University of New York at Buffalo (1977).

Arnold Vedlitz, Ph.D.

Dr. Vedlitz is holder of the Bob Bullock Chair in Government and Public Policy and Director of the Institute for Science, Technology and Public Policy (ISTPP) in the George Bush School of Government and Public Service at Texas A&M University. He is a Professor of Political Science at Texas A&M University and Professor of Health Policy at the Texas A&M Health Sciences Center. He is currently Principal Investigator on three major grants focusing on the utilization and understanding of climate variability/climate change science and the use of scientific information by intergovernmental decision makers and the general public on the Gulf Coast. This research is supported by two grants from the National Oceanic and Atmospheric Administration (NOAA) and one from the U.S. Environmental Protection Agency (USEPA). He is also the co-editor of a new book forthcoming from MIT Press, author of an important book on public policy and author of dozens of scholarly articles and book chapters in the field of politics and public policy. His teaching and research focus on science and technology policy, minority politics, public policy, inter-group conflict, American political behavior, urban politics, and political psychology. (Ph.D., Political Science, University of Houston, 1975; M.A., Government, Louisiana State University, 1970; B.A., Government, Louisiana State University, 1968).